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ANNUAL MEETING AMERICAN CHEMICAL SOCIETY

The Fifty-Third Meeting of the American Chemical Society convened in New York City, Monday, September 25th, to Saturday, September 30th, with headquarters at the Chemists' Club and Hotel Astor. Division Meetings took place at Columbia University, the Chemists' Club, New York College of Pharmacy and the Grand Central Palace. The special Industrial Conferences are reported elsewhere in this issue.

The Council met at 4:00 P.M. on Monday at the Chemists' Club and were the guests of the New York Section at dinner, continuing their deliberations throughout the evening. The following officers were elected for the coming year: Charles L. Parsons, *Secretary;* Dr. Charles H. Herty was chosen *Editor* of the JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY, with authority to revise his Board of Associate Editors; this action was later confirmed by the directors. Dr. Herty succeeds Prof. M. C. Whitaker who declined reëlection. The Council deferred the election of the Treasurer to the directors, who elected Dr. E. G. Love *Treasurer*. The next annual meeting of the Society will be held September 1 to 10, 1917, in Boston.

The registration took place at the Chemists' Club under the direction of Mr. H. R. Moody. The total registration was 1905, including 1438 members and 467 guests of which 194 were ladies. A special room was provided on the mezzanine floor for the Ladies' Committee headed by Mrs. Leo H. Baekeland. Mrs. Frank Hemingway and her associates assisted the visitors in arranging for the various functions provided for their special entertainment. On Wednesday morning, a special automobile tour, in charge of Mrs. J. Merritt Mathews and Mrs. J. M. Muir, started from the Chemists' Club, went through the various large parks, and reached Longview at Hastings-on-Hudson in time for luncheon. On Thursday, the ladies visited Altman's and Tiffany's stores, where special arrangements had been made by Mrs. R. N. Shreve and Mrs. Morris Loeb for exhibits not ordinarily seen. Later, luncheon was served at the Woman's City Club and at the Woman's University Club. Choice seats were reserved for Thursday evening at the Criterion and for Friday afternoon at the Strand, where the ladies were entertained under the leadership of Mrs. Maximilian Toch and Mrs. Chas. Baskerville. The Chemical Show was open to the ladies with Mrs. Bernhard C. Hesse directing the guides who conducted the strangers through the exhibits.

The official opening meeting was held at the Horace Mann Auditorium, Columbia University, with J. Merritt Mathews, Chairman of the New York Section of the Society, in the chair. The Address of Welcome on the part of New York City, delivered by Health Commissioner Dr. Haden Emerson, appears in full on p. 870. In welcoming the Society on behalf of Columbia University, President Nicholas Murray Butler stated that he considered the assembly of the American Chemical Society as the mobilization of a very large part of the civilized fighting army. He emphasized especially the necessity for proper sanitation and protection of the health of the employees in connection with manufacturing operations in order that they may be commercially successful. The audience was interested to hear that Dr. Mitchell, who occupied the Chair of Chemistry in the old Kings College, 100 years ago, was the first, and has been the only, chemist to have a seat in the Senate. Later on, his successor, Dr. Chandler, organized the work of the Department of Health of New York City on a scientific basis and thus carried the chemistry of that day into public service. Dr. Butler expressed his appreciation of the intelligent and unselfish devotion of the unusual group of young men scientists and experts who are giving their services to the general public in New York City, making possible the results reported in Dr. Emerson's address.

In turning over the meeting to Dr. Herty, Dr. Mathews took occasion to express the appreciation of the New York Section for his vigorous and unstinted labor in Washington in connection with the bill recently passed, protecting the chemical industries, particularly those relating to coal-tar products.

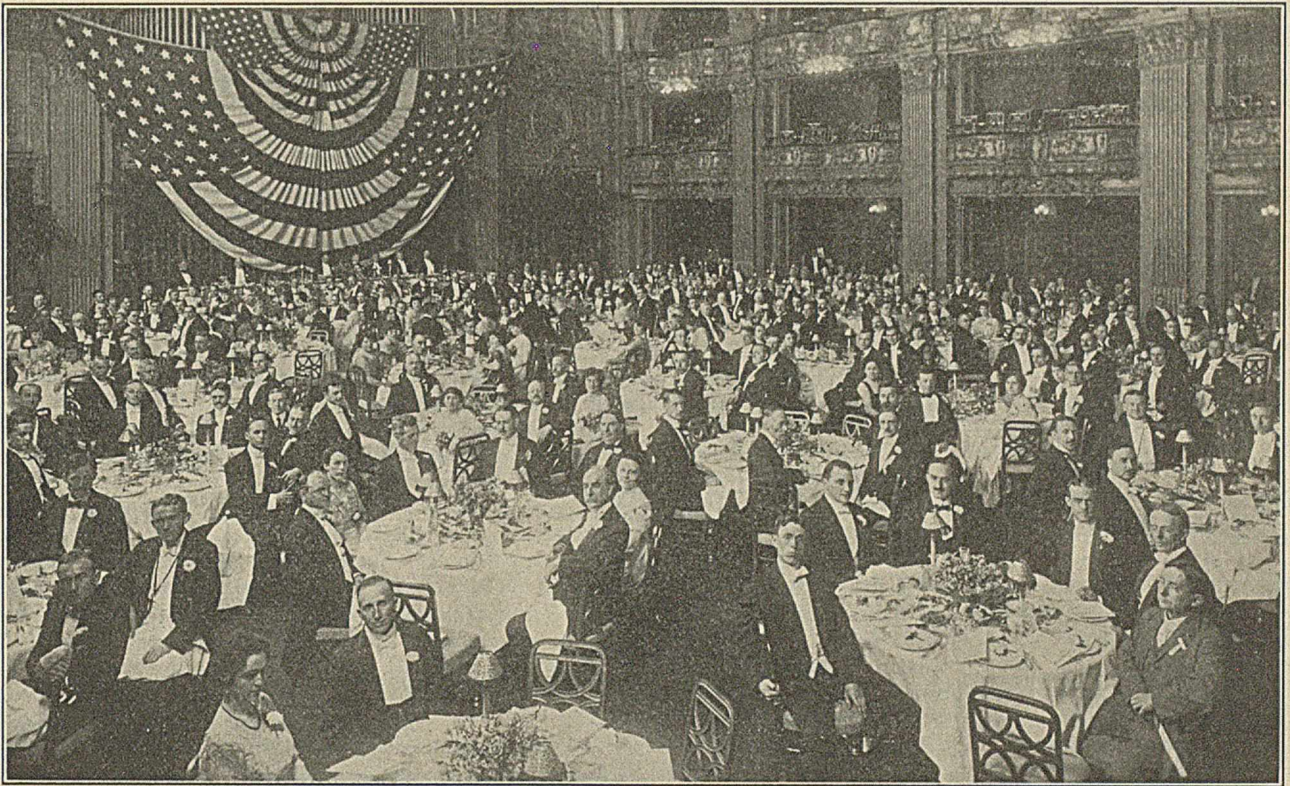
Dr. Herty responded for the American Chemical Society to the Addresses of Welcome. He said that he was glad to be present and called attention to the many factors which had worked against the American Chemical Society meeting in New York. He was particularly struck by the coincidence that there was no better indication of the rapid strides in the chemical industry during the last few years than the fact that only four years ago in the room in which the opening meeting was held, Dr. Bernthsen demonstrated publicly for the first time in America the synthesis of ammonia from nitrogen and hydrogen gases, and that now this synthesis is practically the mainstay of Germany's strength.

At the business meeting held Tuesday afternoon, in the Horace Mann Auditorium, in addition to the Presidential Address by Dr. Herty, addresses were made by General William Crozier, Chief of Ordnance, War Department, and Mr. John E. Gardin, Vice-President of the National City Bank. These addresses appear in full below.

On Tuesday evening a reception was held at the Astor Hotel. Members, guests and members of the American Electrochemical Society and the Technical Association of Pulp and Paper Industry were invited. About 400 guests were present. After the guests had gathered, the dancing hall was opened and at a late hour delightful refreshments were served.

Wednesday evening was left open for visiting the Second National Exposition of Chemical Industries at the Grand Central Palace. Further discussion of this Exposition can be found elsewhere in THIS JOURNAL.

On Thursday evening the members of the American



AMERICAN CHEMICAL SOCIETY BANQUET AT THE WALDORF-ASTORIA, SEPTEMBER 29TH

Chemical Society were the guests of the American Electrochemical Society at a Smoker, held in the ballroom of the Astor Hotel. Mr. Wallace P. Cohoe had charge of the exercises of the evening. The meeting was opened by songs of the American Electrochemical Society, words of which were printed on pamphlets and in which the company joined at various times during the evening. A masque entitled "The Odyssey of Science" was presented. The principal part was taken by "Chemistry" in the rôle of Cinderella. The lover and rescuer of "Chemistry" from "Despair" was "Research," and the arch enemy was "Capital," who read a paper entitled "On the Evil of the Theorist." "Common Sense" played the part of the Great Reconciler. Prof. Ambrose Jeffries, brother of Jim Jeffries, and a ventriloquist, furnished considerable entertainment during the evening. Mr. Saunders appeared in the rôle of a dashing golfer with such bravado that no one took up his bet. During the evening a female dummy "Maid in America" was abducted by some member of the audience and her subsequent fate is unknown. Mr. Winter gave a humorous monologue, "Bureau of Mine," "to disclose many scientific secrets, but not to talk about radium." About 800 people were present, and cigarettes, beer, sandwiches, cheese, crackers and sour pickles were the refreshments served in abundance. The American Chemical Society is greatly indebted to the American Electrochemical Society for a highly enjoyable evening.

On Friday evening the Subscription Banquet was held in the handsomely decorated ballroom of the Waldorf-Astoria, jointly with the members of the American Electrochemical Society and the Technical Association of Pulp and Paper Industry: 341 persons were present. Dr. W. J. Schieffelin acted as toastmaster. Mr. Ellwood Hendrick read a poem entitled "Rollo and His Uncle," which appears below. President Herty spoke briefly of his pride in the rapid growth of the Society. Mr. Charles H. Sherrill, for years the representative of the United States in Argentina, gave an interesting and convincing plea for closer relations between the United States and South America. Dr. Arthur D. Little spoke briefly of the relations of the chemical engineer to industrial progress, and Mr. Frank S. Washburn told of the present-day opportunities and achievements of the chemist. After the serving of the delicious nine-course banquet, members and guests indulged in dancing.

On Saturday 200 members joined an all-day excursion up the Hudson River on a boat specially chartered by the American Electrochemical Society. The weather was delightful. A negro orchestra of four went with the party and furnished music for dancing. The crowd sang, ate good things and had a jolly good time. The courtesy of the American Electrochemical Society was greatly appreciated by all.

The American Chemical Society was well cared for in New York and Mr. J. Merritt Mathews, Chairman of the Local Section, is to be complimented on the excellence of his plans and the cordial manner in which his various committees took up their duties. The visitors and guests will long remember the Annual Meeting in New York City.

ROLLO AND HIS UNCLE

"Dear Uncle, I would like to be
A man of circumstance,"
Said Rollo, having just been kissed
By several different aunts.

"I want to be a man of might,
Want to be left alone,
I do not want, when I grow up
To hear the sugary tone
Of praise, because I am so sweet.
I do not want to be
So kissable." Quoth Uncle, "Then
Just study chemistry."

Address yourself to mercaptans,
Butyric acid, or
Naphthylamine, and other things
Of which th're plenty more.

I once was young myself, my child
And understand your pain;
Those blandishments are hard to bear;
They leave a psychic stain.

"Then Uncle dear," said Rollo, "How
Shall I begin my work?
I want to be a chemist and
I do not want to shirk
The preparation for the task,
The study, the career,
That promises immunity
Which is to me so dear?

"Ah, times have changed," his uncle said,
"But nowadays, at first
For physics and for calculus
You'd better show a thirst.
It makes a good impression, and
If you would be in style,
Show off your mathematics, but
At mere reactions, smile.

You'll find professors do not care
About The Ways of Stuff;
"Free Energy's" their ruling thought
And that is most enough
To satisfy the questing minds
That give you your degree
So bear in mind you must be glib
About free energy.

In elementry inorganic
You may learn a few
Reactions, but time presses and
You'll have to hurry through
The work in hand, because to-day
But few professors care
For all that old-time, text-book stuff;
Of this you should beware.

Soon you begin in earnest and
Proceed, for instance, with
A standard work in chemistry
By Alexander Smith.

Read carefully, my boy, because
Your teacher may not want
Even to think of half the text.
He'll tell you that he can't
Spare all the time to bother with
The personality
And ways of stuff. Then he will talk
About free energy.

Ionization is a theme that
Rules him like a lion;
He'll break all rules of chemistry
To satisfy an ion.

'Tis better, cast all doubt aside
When he begins on this;
If you should raise a question he
Will scowl at you and hiss.

I used to think theology
Was rather rough on doubt,
But chemistry, with ions, beats
Theology all out.

You'd better join the church before
This course is well begun
Because you'll need to exercise
The art of faith, my son.

Solutions he'll discuss at length
Provided always they
Contain solute to solvent as
The needle in the hay.

So, while he talks and wanders on
Read carefully your book;
If he says 'Physical Chemistry,'
Put on a pleasant look.

When you begin analysis
You'll start qual-*i*-ta-tive,
And get in loose and messy ways
As surely as you live.

Why teachers do not change and give
The *quan*titative first
Is something I can't understand
Except that no one durst.

In other walks of life we learn
First to be neat and clean;
In chemistry on t'other hand
The opposite has been
The modus operandi—which
Is after all, like life;
We lean to virtue in old age;
In youth to sin and strife.

Then you'll have physical chemistry,
The darling of the gods,
The measurement of things in dreams,
Philosophy of suds,
Mass action where there is no mass,
The phase rule and the law
Of whatsoever might occur,
Or what you ever saw.

And now forget what you have learned;
Most everything you know;
Organic chemistry's your task
And other things are not so
Which you have pinned your faith upon,
The things are turned about.
Though once your greatest need was faith,
Your present need is doubt.

The harmony of nature has
Not entered in between
The two domains of chemistry,
Alas! there is a screen
That has been made, the light of truth
To sunder, to divide
Which makes those universal laws
Fit one or t'other side.

Now, let us say, you've turned the trick
And taken your degree
And all the kissing aunts have gone
Beyond, along with me.

It may be that you'll wonder as
You rub your bearded face
Just what it was that started you
As chemist in the race.

It may be that your tastes will change
And you will want to be
In favor with the ladies, and
Want their society.

But even then, do not lose hope, for
Chemists, somehow, find
As mates the most delectable
Of all womankind." . .

"Oh, Uncle, dear!" cried Rollo, then,
"I beg of you desist;
I am resolved, when I grow up,
That I shall not be kissed."

—*Ellwood Hendrick*

ADDRESS OF WELCOME

By Dr. Haden Emerson

In acting on behalf of His Honor, the Mayor, to welcome you to New York, it is a privilege of no small degree to greet those who have accomplished a more direct assimilation of the products of theory and research into the body of industry and practical production, than any other representatives of science and commerce. As the present administration of New York City has devoted itself to the application of personal standards and business practice in public affairs, so the Department, which I have the honor to represent, has devoted itself to an increasing degree, to placing preventive medicine as applied to public health administration, among the exact sciences.

New York City is not unlike the human body in the complexity of its functions and the differentiation among its units. Just as the study of human physiology made scant progress until functions, organs, and even individual specialized cells were subjected to close scrutiny, so in analyzing the city from the point of view of the Health Department, we have passed from a study of boroughs and wards, to the survey of census units, the investigation of hazardous trades, and still further, to the medical examination of the men and women individually, whom we know will suffer in a certain proportion from preventable diseases and incapacity, even when, to their own minds and senses, they are in perfect health. It is worth as long a search to find the unrecognized typhoid carrier, the origin of most city epidemics of typhoid fever, as to search for the uncompleted synthetic in a hydrocarbon series.

Advancing from the general principles of the sanitation of environment, to the precise control of the particular infectious individual, from policies to persons, we are continuously reducing the number of deaths and the cases of preventable disease, not before the rates prevailing in many smaller communities, where the distribution of population per acre is more naturally favorable to healthy living, but below the rate of other large cities in the world. New York is surpassed in certain particulars by various cities, but in our general death-rate, and in our infant mortality rate, the most accurate and the most sensitive indices of a city's health, New York City has a better record than London, Paris or Berlin. In the first year of the organization of the Board of Health (1866), there were 3000 deaths recorded to every 100,000 population—in 1915, 1400 deaths; or to put it in other words, if the death-rate of fifty years ago had prevailed in 1915, there would have been recorded 166,000 deaths or 88,000 more than actually occurred.

The death-rate from typhoid fever decreased 80 per cent.

The deaths from small-pox during the first decade of health administration numbered 6260—in the last decade, 7.

In 1915, there were relatively 2,600 fewer deaths from diphtheria than in 1866. Scarlet fever showed a decrease in mortality of 95 per cent—measles decreased 50 per cent.

The greatest achievement of the administration was the reduction in the mortality from diarrheal diseases among children under 5 years of age—in 1915 a little over 3900 children died from this disease, whereas if the rate of 50 years ago prevailed, 13,000 children would have succumbed—a yearly saving of over 9000 lives.

Fifty years ago, 4 out of every 10 children born, died before completing the first year of life—to-day, only 1 out of every 10 born, dies before the end of the first year.

And now, what is the next step in the endless controversy with ignorance, prejudice, inertia, and the pressure of commercial competition, the four great obstacles to health protection.

Unhesitatingly I say, it is a forward march upon occupational disease, the health hazards of industries. Two great groups vie with each other for the unenviable distinction of producing per thousand employees more cases of industrial disease, accidents and deaths, than any others. Opinions differ as to which holds the palm, but whether we put the metal industries first, because they dominate with their great numbers of employees, or choose the chemical industries, because the variety of hazards is greater, there is no doubt as to the joint burden of these two groups for a vast amount of preventable disease.

It is not enough that we see and admit the necessity of removal of fumes, gases and dust, and provide a better general ventilation of shops and furnaces, we must enroll ourselves now, and for all time, among the teachers for self-protection.

If a fraction of the thought and money had been spent on the protection of the worker, that has been lavished on the protection of the product against foreign competition, no cry of preparedness would be heard in the land. A healthy nation with a spirit of regard for its most priceless and most wasted resources, its human lives, will always keep out of touch of its nearest competitor in vital, as in financial resources.

In one new factory, in this city, devoted to the production of aniline dyes, not a week passes without at least one serious case of aniline poisoning. No insurance company would, knowingly, take as a risk, the workman in the autoclave room.

See the ever lengthening list of specific and incapacitating volatile poisons handled recklessly and with utter disregard of human wastage, in the cause of the manufacture of explosives, rubber articles and aniline derivatives or compounds.

The chemical industry employs upwards of 50,000 workers now, exclusive of all those working in the petroleum industry, the paint industry and the processes of manufacture which require the use of chemicals, such as dry cleaning, felt hat making, etc.

In Germany, Weyl has shown that out of 165,820 employees in the chemical industry, in 1905, there were sicknesses of 8 days duration in 88 per cent of all employees—there were 11,000 accidents, gases, hot vapors and explosions causing most of them.

Leyman showed that laborers and mechanics contributed 27 and 45 per cent, respectively, of the sickness rate from internal diseases and 37 and 43 per cent, respectively, for sickness from external affections.

The manufacture of hydrochloric acids, sulfates, chromates, caustic potash, chloride of lime and trinitrophenol are especially prone to cause respiratory diseases.

Next to the workers in lead products and compounds, those who work in aniline manufacture suffer most commonly from poisoning.

Curschman's recent statistics show that the sick rate in chemical works with improved sanitary conditions is still 54.9 per cent per annum of the entire force, with an average duration of sickness of 17.8 days.

Gentlemen of the American Chemical Society, I appeal to you, as the brains and hearts of the greatest present, and most rapidly growing industries of our time, to consecrate a part, at least, of your deliberations to a constructive policy of education of the workmen in the factories.

Technical improvements in method, automatic devices, painstaking supervision, will play a part, but the great hope and opportunity, the foundation stone of permanent remedy, is in education of the workmen.

Health officers owe it to you to include among the preventable diseases that they are engaged by the public to prevent the diseases of occupation.

For every 1000 men employed in industry in the United States, 3.39 are killed and but 0.91 in France, with Prussia, Great Britain and Belgium in between, with rates of 2.06, 1.28 and 1.10, respectively.

Before giving you my message of invitation, I wish to indicate briefly, the character and extent of the chemical activities of the Health Department of this city.

The Department of Health produces curative and preventive sera, and bacterial products, and carries out a variety of diagnostic tests of chemical and biological character. It maintains, also, analytical laboratories to assist in the regulation of food and drug products. It carried out in the last year 358,406 diagnostic tests, of which there were 96,585 bacterial examinations for milk, water and other foods. The Department produced 3,762,100 cc. of serum products and 201,000 cc. of vaccine products and in the past year, 56,000 Wassermann reactions, 11,000 complement fixation tests for gonococcus infection have been made in our diagnostic laboratories.

Any who are free and interested, will be welcomed at our research laboratory, at the foot of East 16th St., where representatives of the Department will be available to play the part of hosts. Furthermore, if there are phases of our activities in the direction of inspection of the manufacture and distribution of foodstuffs, which you wish to study while in the city, Mr. Lucius P. Brown, a member of your Society and the Director of the Bureau of Food and Drugs of the Department of Health, will be responsible for your guidance and so far as possible, your conveyance, to points of special interest.

CHEMISTRY AND THE NATIONAL WELFARE

By General William Crozier

The published title of the very short address which I have been honored by a request to make to you is "Chemistry and the National Welfare;" but as there is very little which I can tell you about chemistry, even in connection with the national welfare, which you do not know better than I, it seems that a better title would be "Chemists and the National Welfare," for I think it is likely that there are some aspects of your relations to the military element of the national welfare to which I have given more contemplation than you have. It is not difficult to admit the general need of the military service for the class of knowledge which you represent, and the wide publicity which the European war has given to the indisputable importance of the chemistry of explosives has enabled not only the educated layman, but even the superficially informed man in the street, to appreciate that war cannot be carried on in these days without a great draft upon the services of chemists and chemical engineers. It has also been made apparent that for a proper utilization of the chemical as well as other professional and technical knowledge of its citizens, for military purposes, the Government cannot rely alone, nor even very largely, upon the services of the professional men in its own employ, but that it must receive the benefit to be had from drafts upon the national resources in this kind of knowledge, as well as upon industrial establishments and other civic organizations and societies, as well as individuals.

It would in all probability be admitted in any discussion between reasonably well informed men, that the affairs of the Government should be so conducted in time of peace by those charged with their administration as to prepare for the utilization in an emergency of the country as resources in capacity of all kinds which contribute towards military success, so that it would be necessary only to follow plans already made in order to set going the machinery of utilization with a promptness and smoothness which would depend only upon the intelligence and industry with which the plans had been laid. This preparation is not always such an easy matter. Although there is powerful sanction for it, and evidence that men of intelligence in responsible positions have intended to provide means for it, there is also evidence that there are persons in positions of influence, and of some power and responsibility, who do not share the view that the Government should in ordinary times place such reliance upon the private resources of the country as would require coöperation with those resources in the production and improvement of war material during those times of peace which constitute the periods of preparation for war. There is in recent legislation some evidence of this conflict of view which necessarily operates to a certain extent to the embarrassment of those governmental agencies whose duty it is to prepare the country for war, in accordance with the wishes of the people as expressed through their Representative in Congress.

In the National Defense Act, approved June 3, last, there is found the following wise provision:

> "The Secretary of War be, and he is hereby, authorized to prepare or cause to be prepared, to purchase or otherwise procure, such gauges, dies, jigs, tools, fixtures, and other special aids and appliances, including specifications and detailed drawings, as may be necessary for the immediate manufacture, by the Government and by private manufacturers, of arms, ammunition, and special equipment necessary to arm and equip the land forces likely to be required by the United States in time of war: PROVIDED, That in the expenditure of any sums appropriated to carry out the purposes of this section the existing laws prescribing competition in the procurement of supplies by purchase shall not govern whenever in the opinoin of the Secretary of War such action will be for the best interest of the public serivce." (Sec. 123.)

The object of this legislation is apparent. You will know the length of time which is required for fitting even a going manufacturing concern with the special tools, fixtures, and other appliances necessary to turn out in large quantities such articles as small-arms cartridges, for instance, or fuses for field-artillery ammunition. It is conservatively estimated that a plant well equipped for the manufacture of a military rifle of a given model would require something like 8 or 9 months to supply itself with these special fixtures, etc., for use with its already installed machinery, in sufficient quantity to enable it to turn out a rifle of a different model in some such reasonable number as 1000 per day. The value of advance preparation in the matter of these special appliances is, therefore, recognized in this legislation; and there is further latitude given to the Government in the proviso that in the expenditure of appropriations for carrying out this legislation such selection may be exercised, irrespective of competition, as, in the opinion of the Secretary of War, will be for the best interest of the public service. The spirit of the legislation is most helpful. It will be observed that no appropriation is made, but that funds are to be provided in other acts.

One of these Acts is the one known as the "Fortifications Act," approved July 6th last. In it we find, among other items, the following:

> "For the procurement of such gauges, dies, jigs, tools, fixtures, and other special aids and appliances, including such plans, specifications, and detailed drawings as may be necessary for the immediate manufacture of arms, ammunition, and other material necessary for the defense of the country, and for plans for and the installation of such material in private plants in the United States under such contract and agreement as may be made by the Secretary of War, $1,000,000: PROVIDED, That not exceeding twenty-five per centum of said sum may be used in obtaining from plants so equipped such war material as may be desired: PROVIDED FURTHER, That not exceeding $50,000 worth of such material may be purchased from any one person or company, and in making such expenditures the laws prescribing competition in the procurement of supplies by purchase shall not govern."

Here is a generous provision for carrying out the object of preparing for the utilization of private industries. It is apparent that in the legislation quoted the spirit of such utilization was in the ascendant.

Other legislation, however, is not quite so encouraging. In the same Act—the Fortifications Act—are found the following:

> "That except as expressly otherwise authorized herein no part of the sums appropriated by this Act shall be expended in the purchase from private manufacturers of any material at a price in excess of twenty-five per centum more than the cost of manufacturing such material by the Government, or, where much material is not or has not been manufactured by the Government, at a price in excess of twenty-five per centum more than the estimated cost of manufacture by the Government: PROVIDED, HOWEVER, That whenever in the opinion of the President, an emergency exists affecting the general welfare of the United States, he may waive the limitations contained in this section."

* * * * *

> "That expenditures for carrying out the provisions of this Act shall not be made in such manner to prevent the operation of the Government arsenals at their most economical rate of production, except when a special exigency requires the operation of a portion of an arsenal's equipment at a different rate."

The Ordnance Department has taken some pride, and believes it has met with some success, in cheapening the cost of government manufacture. If its own estimate of its success has not been overdrawn it may not be easy to find private manufacturers willing to accept as small an order as might be permitted under the limitation cited above if their prices shall be limited to 25 per cent in excess of the cost to the Government. And there is some possibility that acceptance in such cases may have to be induced by appealing to the patriotism of the manufacturer in coöperating with the Government, without profit, in preparing himself to meet the Government's needs in time of emergency. The requirement for operating the government arsenals at their most economical rate before giving orders to private manufacturers will probably call for their operation at double shift; we will, therefore, be limited in the orders which we can give for keeping private manufacturers in that knowledge of the methods of making war material which comes only from practice, to the extent of the excess of the sums appropriated over and above the amounts which will be necessary to keep the arsenals going at double shift. I am glad to state that the appropriations have been sufficiently generous to provide this excess in most cases; but the extent to which private establishments can be employed in the manufacture of war material, to the advantage of the Government, will be less than it would have been if we had been authorized to operate the arsenals at a single shift only, which is the rate which, in my testimony before Committees of Congress, I have advocated as being of most advantage to the Government.

In another Act, the Army Appropriation Act of August 29, 1916, there is an appropriation of $10,000,000 principally for small-arms ammunition, which is accompanied by the proviso that not more than $5,000,000 of this appropriation may be used in the purchase of ammunition. Here again the authority for making purchases is sufficient to permit a good deal of encouragement of private manufacturers, and, in addition, it is further provided that $25,000 of the appropriation may be used in equipping private manufactories with special tools, fixtures, etc., and that $50,000 worth of orders may be given to individual private manufacturers, in furtherance of their preparation to meet the Government's emergency needs, by War Department selection, instead of by competition. Most of the items of appropriation for munitions, in the Army Appropriation Act, are accompanied by similar restrictions, and in some instances they are likely to be less encouraging than those just mentioned to the preparation for utilizing the national resources. For example, an appropriation of $3,000,000 for ammunition and other articles for small-arms target practice is accompanied by the proviso that not more than $1,500,000 of this appropriation may be used for the purchase of articles not manufactured by the Government and necessary for small-arms target practice, from which it appears that under this item of appropriation the only articles that can be purchased from private manufacturers are those for the manufacture of which the government arsenals are not fitted.

In previous years the restrictions placed upon purchases have been more severe. In the Fortifications Act of March 3, 1915, it is provided that of the sums available "not more than 10 per cent may be used to purchase not to exceed 10 per centum in quantity or value of any article or material herein appropriated for that can be manufactured at the arsenals of the Ordnance Department, except when contract costs are less than the arsenal manufacturing cost," and in the Army Appropriation Act of March 4, 1915, under an appropriation of $100,000 for ammunition, it was provided that not more than $5,000 of the appropriation might be used in the purchase of ammunition.

These illustrations show that in the matter of preparing to utilize the private resources of the country in case of emergency the legislation under which the executive departments must operate looks both ways. It is apparent that there is a sentiment in Congress reflecting a sentiment among the people in favor of such advance preparation, and willing to provide effectually and generously for its promotion, and that there is also a sentiment, which might perhaps be illustrated by the demand for taking the profit out of war, in favor of the greatest possible utilization of government manufacture, to the exclusion of the utilization of private resources, which sentiment has made itself felt in the preparation and passage of the supply bills and other military legislation.

Now, these examples illustrate also something else, and that is the necessity for the interest and support of public opinion for carrying out any governmental plan, whether for the military utilization of private resources or anything else. I am not complaining of the action of Congress, or criticizing that body. I know something of the difficulty of framing legislation and putting it through, when there is conflicting sentiment in the country in regard to a policy; but the greatest difficulty we have to encounter is when there is no sentiment at all, that is when there is public indifference, which is our normal condition in times when the stimulus of a great war in some part of the world is lacking. In such times I have, in a number of years of attendance upon its committees, usually found Members of Congress in advance of their constituencies, in thoughtful consideration of the military necessities of the country. And that thought brings me to your relations to those needs.

The Government has, and will continue to have, a great need for your professional knowledge and professional labors, and in ordinary times there is no great prospect of reward for either. We have just now an illustration in a call upon your membership for assistance in a very important matter. I refer to the nitric acid factory for the erection of which, with the necessary preliminary investigation, and appropriation of $20,000,000 was made by Congress at its last session. The War Department has called upon the National Academy of Sciences for a report which will assist it in reaching a conclusion as to which one of the various known processes for the manufacture of nitric acid, by a method not requiring dependence upon a foreign source of supply, would be most to the advantage of the Government for adoption, in the erection of its plant, taking into consideration all of the legislation in the Appropriation Act concerning the use of the excess capacity of the plant over that which would be required for the Government's military needs in peace time. The National Academy has associated with it the American Chemical Society, and has appointed a committee for the consideration of this subject from the membership of both bodies. These gentlemen will receive no pecuniary compensation for their services. They do not desire any. Their reward will be the consciousness of public duty performed, which in this instance, I am glad to say, will be accompanied by a certain prominence of the subject in which they are working, which has attracted a good deal of attention. But this prominence cannot always or often be had. In ordinary times of peace our people do not think much of military matters. In such times one might almost say that the stomach takes precedence of the chest, and under the title of the business interests of the country absorbs all of the best energies of the people themselves and of the statesmen to whom they entrust the provision of the means and the formulation of the rules for equipping and guiding the ship of state.

I once heard a very prominent and very useful statesman say that what he did not know about military matters would fill a very large book, with the same self-deprecating mock modesty which might have accompanied the statement that he had never learned to play the fiddle, or had time to devote to any other unimportant matter. He was a good man, too, a man of high order, and particularly skilled in feeling the public pulse. Such a man, similarly placed in Europe, would not have made that kind of a statement. I do not think that this situation indicates blameworthiness upon the part of any one. I think that in a country happily situated as ours is, with little direct threat of aggression against it, and with the great underlying causes of wars in which it might become engaged even more obscure than in the case of countries situated otherwise, it is inevitable; but this makes it all the more necessary that the educated and thoughtful men who constitute the membership of bodies such as yours shall think about military matters in a way in which the general public does not think about them, and remember that most of the support of military preparation must come from the topmost intellectual layer, which must make its most valuable contributions, not only without pecuniary reward, but also without the kind of satisfaction which comes from useful public service rendered in a matter which is prominent in the minds of one's countrymen, and, therefore, to be justly and generally appreciated. The labor of providing for military preparation, both in special personal services and in the direction of public opinion towards that object, although essentially to the average man's interest, is the high-class man's burden and it is upon his clear vision and personal devotion that the reliance of the nation must be for appreciation of the necessity for thoughtfulness as to war in time of peace, for intelligent contribution towards preparation for it. For both of these classes of service your membership will be called upon in the future, as it has been in the past, and is now. Your service is indispensable, and in rendering it you will, of course, be guided, as are the gentlemen who are now being specially called upon, by the sense of duty which works without reward.

WAR DEPARTMENT, WASHINGTON

CHEMISTRY AND BANKING

By JOHN E. GARDIN

The present struggle at arms sooner or later will be followed by a struggle, possibly just as fierce, for the supremacy of commercial interests, and in this the chemist will play no small part. At one time England held the whip hand and had absolute control over the chemical industry of the world. But this position has been wrested from her by the plodding and thrifty industrial methods of Germany, and the future necessity of each country standing on its own merits has been brought to the world's attention in a most forceful manner by the present conflict prevailing in Europe.

The familiar economic theory that things should be purchased where they can be produced the cheapest, while fundamentally sound, has, from the practical standpoint, disadvantages that become apparent only in times of stress and trouble. The people of the United States of America, never before have realized how dependent they were upon the German chemist, not alone in the matter of dyes but also of other chemicals, and the sudden collapse of the commercial relationships between the two countries is a calamity. The lesson has been taught us, and it now remains for the people of this country to profit by it. That they will do so, there is not the slightest doubt in my mind. But the great fear is that the attempt will be only a sporadic one and that, just as soon as the European equilibrium has been re-established, matters will again run along the lines of least resistance and, before we know it, we shall again be the vassals of some European power so far as certain industrial products are concerned.

Theoretically I never was a believer in tariffs, having been educated in a school where free trade was considered the acme of scientific government. Practice, however, teaches us a different lesson, and the cost of any other policy must be put to book in our national system, just as the cost of the upkeep of our military and naval service—and that is the protection of our natural resources. It is through the intervention of tariffs that the inequalities of methods of production are equalized, and while to some it may not seem wise statesmanship to have imposed an especially high duty on dyestuffs to take effect after the war, still our legislators are perhaps to be congratulated that they have used foresight in this respect.

The capital invested in the chemical industry in this country, not alone directly but indirectly, is something enormous, and unless we enter upon a campaign of preparedness now, we are likely to receive some very rude shocks when the other war—that is, the economic war of nations—is launched upon us.

Theorizing is all very well, but it does not take a very astute mind to determine that if the flood gates are open for the influx of the world's products later on, a great deal of this capital will be absolutely wiped out, and it, therefore, behooves the banker, the merchant, and the professional man to put his best efforts behind the one thought at the present time, and that is, to create a stability in our production that will resist all attempts of the outsider to overcome.

The chemical industry of the United States is making wonderful strides. It has quadrupled its output since 1880, and doubled it since 1905.

The capital invested is over six times as much as in 1880, and more than double that of 1905. This relates to the group of products classed by the census, from which the above figures are quoted, as "general chemicals." The capital in 1880 was 29 million dollars, in 1910, 155 million and in 1915 approximately 220 million, this estimate of capital for 1915 being based upon official figures of product of that year. The value of products turned out in 1880 was 39 million dollars and in 1915 approximately 158 million.

In addition to this there is a large group of products, many of them very important, classified by the census as "allied industries," including fertilizers, dyestuffs, explosives, essential oils, wood distillation, sulfuric and nitric acids, bone, carbon and lampblack, and paints and varnishes. The value of the output of these "allied industries" is much greater than that of the group classed distinctly as chemicals, having been in 1880 approximately 72 million and in 1915, 400 million; the capital employed in 1880, 57 million, and in 1915 approximately 480 million.

This makes the grand total of output of the groups of manufactures classed by the census as "general chemicals" and "allied industries" about $550,000,000 in 1914 (census of 1915), and the capital invested approximately 700 million dollars, the 1915 figures of capital being estimates based upon known figures of output in that year and also known figures of capital in 1910.

All of the foregoing statements regarding the figures of the 1915 census, and those which follow, are necessarily based upon preliminary returns thus far received from the census of 1915, and must, therefore, be regarded as subject to revision, and in some cases, especially as to capital employed in 1914, merely estimates, based upon stated value of output in 1914 and capital shown by the 1910 census.

Moreover, the figures of the various census years are not absolutely comparable. The first special report on the manufacture of chemicals and allied products issued by the Census Bureau was presented in 1880, covering the manufactures of 1879. This report, like those of succeeding censuses, covered the operation of establishments engaged in the manufacture of acids, sodas, potashes, alums, glycerin, dyestuffs, tanning materials, explosives, fertilizers, pigments, wood distillation, salts and certain elementary substances. In addition, the census of 1880 included in its figures of "chemicals and allied products" soap, candles, glucose and sulfur, while all of these were omitted in the subsequent censuses. In 1890, however, paint and varnish were added to the group of '"chemicals and allied industries," and in 1900 essential oils and lampblack were also added. *Thus the figures of total output and total capital for the various censuses are not absolutely comparable,* though the fact that paints and varnishes were substituted in 1890 for the groups, soap, candles, castor oil, glucose and sulfur, suggest that the changes are not sufficient to affect seriously the grand totals of products and capital employed running through the census records beginning with 1880. The capital figures for 1915 are in all cases estimates, but based upon census figures of production for that year, and the comparison of figures of capital with production in 1910 and earlier censuses.

Attention is especially called to the relation of capital employed to the value of output. The figures quoted are in all cases those of the census, except, as above indicated, that the 1915 figures are my own estimates based upon the census figures of output for that year. It will be noted that a comparison of the figures of capital employed and product turned out shows a steady growth in the amount of capital utilized in the production of a given value of output. In the group "general chemicals," the census figures show, for 1880, 29 million dollars of capital and over 38 millions worth of products turned out. The 1910 census shows 155 million dollars of capital and only 118 million dollars worth of products turned out. This increase in the amount of capital utilized in producing a dollar's worth of chemicals has been steady and consistent, as will be noted by comparing figures of capital and output for each as given by each census. In the allied industries, conditions are similar. In fact, this general rule applied in most of the manufacturing industries, the capital employed in all manufacturing being, according to the census figures in 1910, thirty-five times as much as in 1850, the value of manufactures only twenty-three times as much as in 1850.

It is, however, proper to add that the Census Bureau itself states frankly that its figures of capital employed in the manufacturing industries are far less reliable than those of the value of the output, but as approximately uniform practice has been followed in the collection of the figures of capital from census to census they are presumably worthy of attention in considering the relative growths of capital and output.

The production of chemicals and allied products is quite widely distributed, though occurring chiefly in the section east of the Mississippi.

Chemicals form an important factor in the foreign trade of the United States, both as to imports and exports. Prior to the war, imports of chemicals were largely in excess of exports, but the war has greatly increased the exportation of articles included in the general group "chemicals, drugs and dyes." The total imports of chemicals, drugs and dyes has grown from 48 million dollars in 1896 to 70 million in 1906, and 109 million in 1916. The exports of chemicals, drugs and dyes were in 1896 9 million dollars, in 1906 19 million, in 1914, the year preceding the war, 27 million, in 1915 46 million, and in 1916 124 million, all of the above figures of imports and exports being for the fiscal years ending June 30th.

The United States is apparently the world's largest importer of chemicals, the imports of Germany in 1913, the year prior to the war, being about 75 million dollars, Great Britain 70 million and France 50 million. The exports of Germany for 1913 were 140 million, Great Britain 60 million and France 25 million. It is proper to add, however, that these figures are only approximations, because of the uncertainty as to the grouping of many articles which by certain countries are classed under the general head of chemicals, drugs and dyes, and by other countries otherwise classified.

PRODUCTION OF GENERAL CHEMICALS IN THE UNITED STATES AND CAPITAL EMPLOYED

U. S. Census Figures

Census of	Capital	Product	Employees Number	Wages and Salaries
1880	$29,000,000	$38,600,000	11,000	$6,200,000
1890	55,000,000	59,400,000	17,100	10,100,000
1900	89,100,000	62,700,000	21,200	12,100,000
1905	96,600,000	75,200,000	22,600	14,800,000
1910	155,100,000	117,700,000	27,600	20,300,000
1915(*a*)	220,000,000(*a*)	158,000,000	No data	No data

(*a*) Estimate based on stated value of product in 1915 and stated value of capital and product in 1910.

PRODUCTION OF GENERAL CHEMICALS AND ALLIED PRODUCTS AND CAPITAL EMPLOYED, 1880 TO 1915

Allied products include fertilizers, explosives, dyestuffs, essential oils, wood distillates, sulfuric and nitric acids, carbon, bone and lampblack, and paints and varnishes

	Capital	Product
1880	$86,000,000	$99,000,000
1890	180,000,000	125,000,000
1900	238,500,000	202,500,000
1905	324,100,000	281,000,000
1910	483,700,000	425,100,000
1915	700,000,000(*a*)	550,000,000

(*a*) Estimate based on stated value of production in 1915 census and census figures of capital and product in 1910.

PRODUCTION OF FERTILIZERS, EXPLOSIVES AND PAINTS AND VARNISHES, AND CAPITAL EMPLOYED, 1880 TO 1915

	FERTILIZERS		EXPLOSIVES		PAINTS AND VARNISHES	
Year	Capital	Product	Capital	Product	Capital	Product
1880	$17,913,000	$23,651,000	$6,585,000	$5,802,000	$17,333,000	$29,113,000
1890	40,594,000	39,181,000	13,539,000	11,353,000	45,318,000	54,234,000
1900	60,686,000	44,657,000	19,466,000	17,125,000	60,053,000	69,582,000
1905	68,917,000	56,541,000	42,307,000	29,602,000	75,486,000	90,840,000
1910	121,537,000	103,960,000	50,168,000	40,140,000	103,995,000	124,889,000
1915	No data	168,388,000	No data	42,160,000	No data	149,049,000

Unfortunately the American banks have not the wide powers in connection with this particular industry, or in fact any other industrial undertaking, that the European banks have. The law forces the banks here to pursue merely a commercial business, and it is perhaps well that it is so. The relationships between the banks and the public in this country are quite different from what they are abroad. In America the banks are supposed to be the custodians of their clients' money, whereas in Europe the general idea is that the banks are the investors of the public's money and oftentimes the public is not quite so fortunate in the choice of fiduciary. Therefore, in view of this known circumstance, when failure overcomes a bank, owing to bad investments, it is taken as a natural consequence and unless absolute fraud can be shown no particular odium attaches to the bank's officers. In this country, however, surrounded as we are with legal technicalities, the banks are not in a position to employ customers' money in founding industries of any kind. In fact the law prohibits specifically national banks from owning stock of any character whatsoever.

This does not, however, mean that capital is not available for industrial purposes. No meritorious undertaking is ever allowed to suffer for want of the necessary means to develop it. Capital is a greedy monster and seizes upon every opportunity whereby an increase can be expected and the attention of the investor of the United States to-day is directed in a great measure toward the development of the chemical industry and its allied branches.

Under the protection of the Government through its tariffs, numerous projects will be brought forward for the exploitation of this, that, or the other enterprise, some of them meritorious, others of no value whatsoever. It must be borne in mind that the investor will not trust his money to anything that is not absolutely certain and, this being the case, it is futile to endeavor to attract his attention to anything that does not possess absolute perfection.

Chemistry is out of its swaddling clothes, and while it has a great future in most lines, the experimental stage in a great measure has been past.

Chemistry goes into practically every feature of the world's industrial activity, no matter how lowly it may be, and to be able to command such enormous power in the control of the human requirements, it seems to me the chemist should be a proud individual. In the olden days the alchemists sought the easy means of the transmutation of metals. The modern chemist, through his skill, his industry, and his research, turns the basest product into glittering gold.

NATIONAL CITY BANK
NEW YORK CITY

PRESIDENTIAL ADDRESS

THE EXPANDING RELATIONS OF CHEMISTRY IN AMERICA

By CHARLES H. HERTY

After a year of such strenuous service as characterized that through which we have just passed, it is well that we are again assembled for report on the work of our laboratories and for helpful conference concerning future growth and broader service. A large part of the past year's work has, through the suddenness of the call, been necessarily individualistic; the assemblage of this week furnishes the means for planning more coördinated effort, for mutual counsel and for deepening that spirit of coöperation which is so essential if we are to meet worthily our full responsibilities.

It is again incumbent upon me to address you. In seeking a subject I have put aside the temptation to lay before you statistics illustrative of marvelous growth during the past year, and, in spite of our belief in specialization, it has not seemed suitable to select any one line of development for tracing in thorough detail. This period is still too formative and the demands upon you too many-sided for such restricted discussion. I have, therefore, selected the broader topic "The Expanding Relations of Chemistry in America," using the present participle advisedly as indicative of growth and as mandatory of greater effort if the widening circles of chemical influence are to reach the broad shores of full-fledged accomplishment.

The dynamic center of this movement is the American Chemical Society which now consists of 8136 members, a net growth of more than 1000 during the year just ended. This splendid growth is not only a tribute to the energetic activities of our efficient secretary, but is an evidence of increased activity in chemistry and of a quickened realization of the need of the strongest possible national organization. The strength of this organization, however, is not measured so much by numbers as by the loyal and unselfish response of its members to every call made in its name. To this I can abundantly testify.

In considering the expanding relations of Chemistry in America let me group these under four heads—the relations to university administrations, to the national government, to our daily needs and to national thought.

RELATIONS TO UNIVERSITY ADMINISTRATION

Without doubt university executives have gained during the past year a clearer conception of the fundamental value of chemistry to the nation. Aside from our own exhortations, this conception has been easy of obtainment through the increased publicity given by the daily press and by periodicals to matters chemical, through the difficulty to purchase certain needed supplies, through the feverish activity to meet these unexpected demands, and through the call for young chemists from university laboratories. Has the conception, however, been translated by the makers of university budgets into deeds which will insure an adequate response by the universities to the increased demand which is to be made upon them for chemists possessing the best possible training? I have neither purpose nor desire to criticize, nor even to attempt answer, but I do not hesitate to suggest that in these abnormal times the demands upon chemistry departments are unusually great and should be generously met if we are to view the future with equanimity. The bounds of the service of chemistry to the nation are prescribed by the character and extent of the training given in our universities. Physical equipment must be increased and bettered and staffs must be maintained adequate in number to allow full opportunity for research along with teaching duties.

The stimulus of these remarkable times upon the minds of the students is plainly evident, but here lies a danger. The expansion of existing industrial plants and the creation of new lines of endeavor in chemical industry call for many young men to serve in control work, and the call is often very alluring. It would be a great misfortune if the filling of these new positions should be at the expense of the graduate students of the future. We cannot afford an abridgment of the number of young men thoroughly trained in our universities in the methods of research. Graduate fellowships in largely increased number should be provided, for without such aid the door of opportunity will be closed to many whose full mental potentialities will be needed in the future.

The danger of losses from university ranks, however, is not confined to graduate students; already there are strong indications of a considerable raid by the industries upon the staffs of universities, and the question of professorial emolument is, therefore, not one for leisurely future consideration, but belongs to the immediate present.

To sum up, the university budget for chemistry needs prompt and decided expansion.

In the matter of coöperation between universities and industries definite progress has been made. Four important matters typify this progress.

The New York Section has conducted throughout its winter meetings a symposium on this subject, and these discussions resulted in a request of the Society that a permanent committee be appointed to carry forward vigorously such coöperation.

The General Chemical Company announced the formulation of a new policy in the creation of an advisory staff of university professors.

The Massachusetts Institute of Technology announced a Master's Course in Chemical Engineering, including a School of Chemical Engineering Practice. Through the coöperation of industrial plants a half year of systematic plant experience and training is added to the curriculum without sacrifice of thorough foundation work or training in research. In return for the privileges offered by the plants, the research facilities and the faculty of the Institute will be available for the study of special problems connected with each plant.

A joint meeting of the Puget Sound Section and the Seattle Chamber of Commerce aroused great enthusiasm and resulted immediately in the creation of industrial fellowships in the University of Washington for the study of the problems of the Northwest.

Such illustrations furnish proof that earnest thought is being given to this phase of coöperation and it is inspiring to note how quickly such thoughts are being translated into definite action.

RELATIONS TO THE NATIONAL GOVERNMENT

Forty-nine members of the Society, representing the several states and Alaska, on appointment, responded to the request of the President of the United States that the chemical industries be mobilized under the program of the organization for industrial preparedness. Publication of the correspondence in connection with these appointments would furnish lasting testimony to the loyal and unselfish patriotism of the membership of our organization.

In response to the invitation of the National Academy of Science our representatives are now coöperating in the organization of the research facilities of the nation and in questions connected with the establishment of the government nitrate plant.

If we are to proceed promptly and intelligently with the development of a diversified and comprehensive chemical industry we must know the detailed character and amounts of chemical importations. The statistics now published by the government are inadequate in their itemization. The formulation of the character of the information needed is our responsibility. This is the work of the committee on Government Statistics, of which Committee Dr. B. C. Hesse is chairman. The inauguration of the work has unfortunately but necessarily been delayed. It is now well under way, and for its full consummation I beg to urge the thoughtful aid of every member of the Society, and the coöperation of each of the Local Sections. We have never undertaken any more important or fundamental work than this. If, as a result of this inventory, we are able to state in exact terms the specific character of the information needed by the chemical industries, in order to render this country independent of foreign sources of supply, we shall then have a right to expect with confidence the sympathetic coöperation of the federal authorities.

May I, under this heading, make two suggestions to the National authorities:

First, Provision should be made in the immediate future for the storage of large quantities of government-owned toluene. With the cessation of European war orders for explosives, and with the rapid increase of by-product retort ovens for coke manufacture, we shall eventually have a large over-production of toluene, with consequent lowering of price. The potential value of this hydrocarbon in munitions is too great to allow its sacrifice as a fuel or as an illuminant, and its storage involves no unusual difficulties. The moral effect alone of its known presence in our midst would in itself fully justify the investment as a preparedness measure.

Second, Modern warfare is largely dependent upon the successful work of chemists, not alone in the direct production of munitions, but, through research, in husbanding the resources of the country, and in increasing knowledge which in times of stress may be vital to the nation. In view of the now well recognized fundamental character of such work the military authorities should formulate a definite policy in regard to the chemist, whereby in times of war his services may best be applied to the advantage of his country. The lack of such a policy during the recent enlistment of the National Guard has in several cases interrupted lines of research whose successful outcome would prove much more vital to the power of the army than the presence of the individuals bearing arms. England somewhat tardily recognized that her chemists were more needed at home than at the front, and, therefore, recalled them.

RELATIONS TO OUR DAILY NEEDS

The economic developments of the past two years have emphasized the close relation between normal daily needs and the activity of chemists, particularly through certain shortages which have brought economic distress. Among these shortages three stand out preëminent—motor fuel, potash for fertilizer and coal-tar products, particularly synthetic dyestuffs. Let me discuss the first and second of these briefly and the third somewhat more at length.

MOTOR FUEL—The enormous annual increase of motors using gasoline as fuel, together with the largely increased export of this material, has resulted in greatly increased price of this product. To meet the situation chemists have naturally turned their attention to the "cracking" of the residues of crude petroleum, furnishing thus some relief. In view, however, of the uncertainty of petroleum supply such efforts cannot prove the ultimate solution of the problem. With the cessation of the war further aid may be expected from the benzol recovered in the by-product coke oven plants. With this at its maximum, however, it is estimated that it would equal only 10 per cent of the motor fuel now consumed. Plainly we must look further for the permanent supply, and that seems to me to be alcohol. I am fully aware that there is nothing original in this suggestion. It is mentioned rather for the purpose of urging greater consideration of the problem by chemists, who must solve the problem, by manufacturers of motors who have such great interests at stake, and by lumbermen who, in their mill waste alone, possess the raw material from which, by processes in operation to-day, alcohol could be produced equal in volume to 40 per cent of our present gasoline consumption.

What striking advance in this line could be confidently expected if the automobile manufacturers and lumbermen of the nation would join forces with chemists in the creation of a great research laboratory where the problems of motor fuel could be vigorously attacked, not by the "green powder" method of recent notoriety, but by common sense, scientific investigation, conducted by the ablest of chemists and chemical engineers, unfettered by tradition and filled with the conviction that the day of genuine new things will never end.

POTASH—To meet our present shortage of this valuable fertilizer constituent we have sought relief feverishly through the kelp fields of the Pacific coast, the alunite deposits of Utah, the feldspars, blast furnace and cement works waste, and have as yet obtained but slight relief. Something noteworthy may yet result from these earnest efforts, especially through the aid of the appropriation of $175,000 by Congress for further investigation of kelp, but at present we seem to have adopted the general policy of waiting until the war is ended.

Let me, in this connection, remind you of the old problem: namely, the rendering available *in situ* of the potash now in the fields in the form of silicates. The records of the U. S. Bureau of Soils show that the average weight of a foot acre of the sandy soil of the cotton belt weighs 1,750 tons, and contains an average of 0.1 of 1 per cent potash, or $1^3/_4$ tons K_2O per acre, while the clay soils average in weight 2000 tons per foot acre and show an average potash content of 1.68 per cent or 33.6 tons K_2O per acre. From this material nature slowly supplies available potash for plant food through the action of the soil solution upon the potash bearing silicates, but the process is too slow. Many lines of research are in daily progress in our laboratories whose object is the discovery of "accelerants" for certain chemical reactions. Does not the importance of this problem and its altogether normal character demand of us greater effort to find a suitable accelerant for this world wide process. The problem is easy to state; its solution has as yet proved impracticable. May we not hope that the activities of physical chemists through studies of the soil solution and its action upon the mineral constituents of the soil will be ultimately successful?

COAL-TAR DYESTUFFS—It is unnecessary for me to remind you at this time of the great disturbance of our industrial life which resulted from the cessation of imports of German dyestuffs, nor of the rapid extension of the by-product coke oven whereby we are now assured of a far more than adequate supply of raw material for an Amercan dyestuff industry sufficient for American needs. It is a pleasure to testify to the energy and resourcefulness of our dyestuff manufacturers, who, in spite of competition with the munitions industry for coal-tar crudes and for necessary acids, and with uncertainty as to the future constantly dogging their steps, nevertheless have notably contributed to the relief of the dyestuff famine.

It is my purpose, however, to trace, for the sake of the record, the efforts made during the past two years to obtain legislative assurance of a fair start in the upbuilding of a well rounded, permanent industry, and to point out the character of the legislation which on the last day of the present session of Congress became a law of the land. It is a distressing story, humiliating to all who wish for our country freedom in every possible form. Here is the story.

Immediately after the outbreak of the war the New York Section of this Society, foreseeing economic distress from possible shortage of dyestuffs, appointed a representative and politically non-partisan committee to report on the prerequisites of an adequate self-contained American dyestuff industry. The report, unanimously adopted by this the largest of our local sections, recommended congressional enactment of protective duties amounting to 30 per cent *ad valorem* and $7^1/_2$ cents per lb. specific on finished dyestuffs, one-half these amounts on intermediates and an effective anti-dumping clause. The protective rates of this report formed the basis of the Hill bill, introduced in the House on the opening day of Congress by Representative Ebenezer J. Hill, of Connecticut. In January, 1915, hearings were held on this bill and there was presented the unusual sight of both producers and consumers urging the Ways and Means Committee to report the bill favorably. In spite of this unanimity the report was not forthcoming. Public demand for such legislation, however, increased, and finally, after a conference between leading members of the controlling party in both the Senate and the House with representatives of a large number of producers and consumers, a form of legislation was proposed by the congressional representatives which embodied the *ad valorem* rates of the New York Section but reduced the specific duties by one-third, such specific duties to continue in full force for a period of only five years, after which time they were to decrease 20 per cent annually. Another feature was the proviso that if at the expiration of five years American dyestuff factories were not producing 60 per cent of the values (note this carefully) of American consumption, the specific duties were to be immediately and completely repealed by Presidential proclamation.

In spite of the lowered specific duties, this agreement, confirmed by authorized interviews from Washington, led to increased activity by many producers. It is not difficult to imagine, therefore, the amazed surprise which greeted the appearance of the dyestuff section of the General Revenue Bill, which, while it contained all of the above, showed one other totally unexpected feature, *viz.*, the exclusion of indigo and alizarin and their derivatives from the benefit of the special duty of 5 cents per lb. Such an exception was fatal to the purposes of the bill. The *ad valorem* duty alone would not suffice to promote and encourage the manufacture of synthetic indigo and alizarin. No scientific or technical justification existed for discrimination against these two coal-tar dyes, which constitute 29 per cent of the values of our consumption. Furthermore, the manufacture of at least 10 per cent of dyestuffs could not for the present be attempted in this country because of existing foreign patents. Such considerations show that the possibility of expansion of the home industry within the five-year period to 60 per cent of the values of consumption would be precluded by the terms of the bill itself. Consequently the duration of the special duty for any dyestuff would be restricted to the initial five-year period. Evidently our lawmakers had surpassed the skill of the alchemists, in that they had demonstrated their ability to transform at least bricks into gold.

Pressed for a justification of the exclusion of indigo and alizarin, the Chairman of the Ways and Means Committee made explanation on the floor of the House in a speech which by previous agreement was to conclude the debate. In this speech reference was made to the satisfactory character of the conference with the representatives of the industries; individual manufacturers were referred to as not desiring full protection for indigo and alizarin; and no justification on scientific or technical grounds was attempted. Then the dyestuff section of the bill was adopted by a party vote. Immediately briefs were filed with the subcommittee of the Senate Committee on Finance in charge of this section of the House Bill. These briefs included letters and telegrams from the individuals referred to in the House debate refuting the statements made by the Chairman of the Ways and Means Committee. Moreover they pointed out clearly that the exception of indigo and alizarin was not in accordance with the original conference agreement and would prove disastrous to the entire industry. The Senate sub-committee was convinced and accordingly struck from the bill the objectionable exceptions, and in addition included natural indigo and coal-tar medicinals and flavors, additions in every sense logical, and giving to the classifications of the bill a thoroughly comprehensive character.

With the appearance of the printed hearings and briefs an interesting exhibit was made by the plea of a large consumer of indigo located at Greensboro, North Carolina. Not content with the discrimination given indigo in the measure as passed by the House, he urged its complete removal to the free list. No other consumer of indigo joined in this request. The subcommittee rejected his plea.

The completed section of the Revenue Bill was then endorsed by the full committee and by the majority-party conference, and was adopted by the Senate. In the last hours of the session the section emerged from the joint conference of the majority-party conferees from both Senate and House with indigo and alizarin excluded from the special duty, and carrying along with them, as a sort of legislative by-product, medicinals and flavors. As no record is published of the proceedings of conference committees we are left to assumptions as to the influence which prevailed to give the section its final form; but in the light of the history of the legislation and the personnel of the conferees, as published in the Congressional Record, it is not difficult to imagine whose influence was determinative in maintaining the discriminatory feature of the original House legislation, against which united protest has been made, save for the voice of one consumer. The section in this disastrous form was then adopted by both Senate and House and is now the law of the land.

Such is the answer of the present Congress to the nation-wide (with one exception) call for adequate protective duties for the encouragement and upbuilding of this much-needed industry. The claims of this industry, upon non-partisan legislative aid, are reasonable, because of initial difficulties in manufacture and the character of the competition to be met after the war. These claims are also commanding, through the intimate connection of the industry with adequate munitions for our army and navy. Nevertheless, the measure, professedly enacted for its upbuilding, stands to-day stamped with the evidence either of the most specialized form of legislation for special interests, or of stupidity, as a tax placed upon the consumer without the benefit of an assured home industry, or of stubbornness in maintaining a wrong position rather than admit an error in judgment. I do not believe the citizens of this nation will set the seal of their approval upon such legislation.

RELATIONS TO NATIONAL THOUGHT

In the light of the activities of the past year let us ask ourselves frankly, "What is the position of chemistry to-day in the thought of the nation?" No one can doubt that it occupies a much more prominent place. This is due in part to the superb response American chemists have given to the sudden call upon their resources and ingenuity, in part to the advertisement through the press of the important rôle of the German chemist in the industrial upbuilding of that nation, and to the constant repetition of the phrase that modern war is largely a matter of chemistry and engineering.

Concrete evidence of increased appreciation of chemistry is furnished by the Second National Exposition of Chemical Industries now in progress. Its exhibitors are more than double those of last year; its exhibits show many new products, born of the exigencies of the year; its underlying thought has been broadened to include a more systematic showing of the importance of chemistry to the wise use of natural resources; and its purposes have gained a far wider and more appreciative understanding by our people as a whole.

Again we find evidence in the recent issuance of a special chemistry edition by a prominent trade journal, *The Manufacturers' Record*. The purpose of that unusual issue was not merely to emphasize the advantages of a great section of the country for the upbuilding of chemical industries, but, of far greater importance, it sought to vitalize the thought of the people of that section as to the fundamental character of chemistry among the factors of industrial development.

Furthermore, it must be noticeable to all that slowly but surely an educational campaign is getting under way in the daily press and in periodical literature which will eventually result in the arousal of our people to a full comprehension of the value of chemistry as a national asset.

These are simply signs of the times. We cannot, however, feel that the national thought has as yet grasped in its entirety the all-pervading influence of chemistry so long as Cornell University, with its strong chemistry staff, must delay the replacement of its burned laboratory through lack of funds; so long as Johns Hopkins University, the cradle of American chemical research, must undergo such struggle for the means to erect a new laboratory on the beautiful new site of that institution; so long as members of Congress view chemists and chemical manufacturers as fit subjects for hard bargaining; so long as railway presidents feel that chemistry has no part in the development of the natural resources of the sections traversed by their lines; and so long as waste in any form is allowed to continue unheeded.

Further expansion of the relations of chemistry to the national thought involves:

First—Continued educational effort through the press. Plans for such are being evolved, and these plans are meeting the quickened sympathy of the leaders of the press. Each of us must coöperate in this work. As a class we are not qualified to write in popular style, and in the past we have not troubled ourselves very much about such matters; but we can furnish facts and sound opinions to those who have the work and responsibility of popular presentation, and we should stand ready, each in his own community, to share in such coöperative effort.

Second—An awakening of the financial interests of the country to the fact that the ways of chemistry are not mysterious but applied common sense which constitutes a sure guide.

Third—Continued worthiness of our own efforts. This is our direct responsibility. Thoroughness of training, untiring zeal in work, aggressive conservatism in counsel, courage in new undertakings, independence in thought, generous coöperation, constant search for truth—these must surely lead us to that vantage ground where we can best serve this our country.

CHAPEL HILL, NORTH CAROLINA

ORIGINAL PAPERS

A STUDY OF THE EFFECT OF STORAGE ON MIXED PAINTS[1]

By E. E. Ware and R. E. Christman[2]

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The manufacture of ready mixed paints is a development of comparatively recent years. Pigments ground in oil to be mixed and tinted by the individual painter were much more commonly used than ready mixed paints twenty-five years ago, while it was not at all uncommon practice for the practical painter to mix the dry pigments with oil. It may be possible, if proper precautions be used, and enough time be given, to prepare a satisfactory paint in this way, but extensive investigation has shown that it is much better to grind at least part of the oil with the pigment. The painter to-day has neither the necessary skill nor the unlimited patience required for mixing the dry pigments with the oil, even if it were possible to compound in this manner as satisfactory a product as the paint manufacturer with his years of experience and his intimate knowledge of materials is able to produce by intensive grinding and an intelligent proportioning of the different ingredients.

One of the earliest difficulties encountered in the manufacture and use of ready mixed paints was the tendency of the heavy pigments to settle away from the vehicle if the paint were permitted to stand any time before use. It was soon discovered, however, that the addition of small amount of water containing a suitable emulsifying agent helped to prevent this settling of the pigment. But while eliminating one source of difficulty, the practice has brought on other troubles, a satisfactory remedy for which has never as yet been advanced.

Some emulsified mixed paints, if left to stand for several years, will show evidence of a deterioration which manifests itself in one of two ways, either through the formation of an amorphous soapy blanket between the settled pigment and the supernatant vehicle, or by the gelatination of the entire paint to a mass of about the consistency of soft putty, the vehicle seemingly having entirely disappeared. The first case is usually spoken of as "skinning" and the second as "puttying."

These phenomena have given the paint manufacturer much trouble, and consequently have been the incentive for considerable experimental work in an effort to compound a paint formula that will show them to a minimum extent. While it has been quite generally acknowledged that neither trouble will occur in the absence of water, it has been felt that water exerted only a secondary influence, the principal cause of deterioration lying in some action between the pigment and the oil of the vehicle. Most of the published data has been compiled as a result of investigation along this line.

In 1911 Gardner,[1] in studying the possible effect of pigments upon the paint vehicle, ground the more common ones, both the active and the inert, in raw linseed oil and compared the ash content of the oil before grinding and after it had remained in contact with the pigments for a month. The oils from the mixes containing white lead, zinc oxide and red lead showed an appreciable increase in this ash value, and Gardner advanced the opinion that these pigments have the power of saponifying the oil with the formation of their respective soaps. He stated that the inert pigments have little action by themselves and when mixed with active pigments tend to retard the action of the latter. A few months later Sabin[2] published a reply in which he questioned both of these theories.

In a later publication Gardner[3] described the effects of pigments upon linseed oil after a storage of two years. Various pigments were ground in a good raw oil without drier or thinner, using a sufficient amount of oil to bring the mixture to the desired consistency. The most marked effect on the oil was the change in its iodine number, which was lower in all cases after storage. The oil of the red lead mix showed a final iodine number of 135.4, while in the other cases the value had dropped to approximately 160 from an original value of 181. The acid content of the oil was affected to the greatest extent in the paints containing white lead, red lead, and basic chromate of lead, but to a considerable extent also by both carbon black and graphite. He concluded that the perfect condition of these experimental mixtures warrants the manufacturer in assuming that any properly prepared combination pigment paint may be safely stored in cans for long periods without bad effects, provided that the oil used be of normal grade. He also concluded that the action of the free acids upon the pigments was the real cause of the hardening.

The results of work by Boughton[4] along similar lines are somewhat at variance with those of Gardner in that they show a change in iodine value of not more than ten points in any case, while the only sample in which there was any marked change in the ash content of the oil is the one containing corroded white lead.

In a more recent publication Gardner states[5] that the oil in paint is hydrolyzed by a fat splitting enzyme, lipase, liberated in seeds of the oil-producing type. He claims that the seed is not always steamed before expression to a temperature that will kill all of the microörganisms, and spores which pass into the oil soon develop the enzyme. He further states that the fatty acids formed are partially neutralized by the basic pigments whereby lumps of an insoluble

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[1] Presented at the 8th Annual Meeting, American Institute of Chemical Engineers, Baltimore, January 12–15, 1916.

[2] Holder of the Acme White Lead and Color Works Fellowship in Chemical Engineering at the University of Michigan, 1915–1916.

[1] This Journal, **3** (1911), 628.

[2] *Ibid.*, **3** (1911), 790.

[3] *J. Frank. Inst.*, **174** (1912), 415–423.

[4] This Journal, **5** (1913), 282.

[5] *J. Frank. Inst.*, **177** (1914), 533.

fatty acid soap are formed. He recommends heating cloudy oil to at least 100° C. before shipping, in order to kill all microörganisms.

EXPERIMENTAL

In considering this important problem the authors felt that it might be possible to get a clearer idea of the underlying causes of these deteriorating influences if paint specimens in which the action was pronounced could be procured, and the different products contained therein isolated and examined. Accordingly an effort was made to collect a number of samples of standard commercial paints which had been in storage for considerable time. Those actually used in this investigation had been on the shelves for from 2 to 8 years.

The blanket effect of "skinning," which was very pronounced in some of the samples, was studied first. The paints in which this had occurred were all composite-base paints which had originally contained a small amount of water, while one also contained a considerable proportion of gloss oil.

The oil extracted from the pigment and with the thinner completely distilled off showed an average iodine number of 181 and an acid value of 15. The ash content was low, running about 1.5 per cent and consisting mainly of lead oxide, with some manganese and zinc. The recovered oil was clear and of good color.

Samples of the skin were repeatedly washed with petroleum ether until all adhering oil and pigment were removed. The composition of this skin was variable, the weight of the oxides ranging from 13 to 16 per cent, the average of a number of samples being about 14 per cent. The proportions of the different oxides varied within narrow limits; but a typical analysis, corresponding to 14 per cent oxides, showed:

PbO	12.0	ZnO	87.0	R_2O_3	1.0

The zinc oxide was similarly predominant in all samples analyzed, indicating that it was the active agent in the formation of the skin.

The free acids were liberated from the skin by heating with a dilute solution of mineral acid without access of air, the fatty acids dissolved in ether and the ether solution evaporated under vacuum.

In the first experiments hydrochloric acid was used as the liberating agent, which procedure gave free fatty acids exhibiting the following constants:

Neutralization Value	Saponification Value	Iodine Value
166 to 167	203 to 205	170 to 178

Such abnormal differences between the neutralization and saponification values clearly show, according to Browne,[1] the presence of an unsaturated lactone. The amount of this lactone was estimated according to the method of Lewkowitsch[2] and found to be 20 per cent of the total acid. As the purified lactone was liquid it seemed hardly probable that it was formed as a product of reaction during storage of the paint, for in that case it would have remained in solution in the oil rather than have been precipitated in the skin. It was no doubt formed during our manipulation when the fatty acid was freed from the zinc soap, the action being accelerated by the presence of the resulting zinc chloride which acted as a condensing agent. Zhukov and Shellakov[1] studied a similar reaction and came to the conclusion that zinc chloride has the power of throwing the double linking along the carbon chain until it reaches the gamma position, where it is converted into the lactone. Concentrated sulfuric acid exerts a similar influence, although the dilute acid has no action.

The acids of the skin when liberated by dilute sulfuric acid proved to be more nearly the usual linseed oil acids, as indicated by the following constants:

Neutralization Value	Saponification Value	Iodine Value
193.5	203.0	181.0

This remaining difference between the neutralization and saponification values showed that the free acids still contained some lactone, probably due to the condensation of a small amount of gamma hydroxy acid which may have been present, and which, on liberation, changed immediately to the lactone.

The Gusserow-Varrentrapp or lead-salt-ether method for the separation of solid and liquid fatty acids showed a solid acid content in the skin of 10–12 per cent, a figure not inconsistent with that of 7.5 per cent ordinarily given for raw linseed oil.

Samples of the skin were dissolved in hot alcohol-ether solution, and gave upon titration an apparent neutralization value as high as 168. This at first suggested the possibility that the skin was a product of the coagulation of a colloidal suspension of pigment and fatty acid, but experiments to establish this failed to yield definite results and were abandoned.

On extracting the skin with hot absolute alcohol the entire mass was dissolved. On cooling, a white flocculent material composed of metallic soaps and hydroxides was precipitated, while the residue in the filtered solution, upon evaporation of the alcohol, was recovered as free acids. An extraction with ether failed to show the presence of these free fatty acids and it was decided that during the extraction with alcohol the soaps had been hydrolyzed. This same condition undoubtedly existed when the skin was titrated with dilute KOH in determining its acid value, which would account for the high value obtained. Weaker hydroxides, $Ba(OH)_2$ and NH_4OH, acted similarly, as did an absolute alcohol solution of KOH. To check these observations, a pure zinc soap of linseed oil was prepared. This soap exhibited the same tendency to hydrolyze, giving an apparent acid value indicating complete hydrolysis as figured from the formula of zinc linoleate.[2]

Since in the skin or blanket of a mixed paint the metallic soaps present are mostly all those of zinc, which are completely hydrolyzed in analysis, the determination of the acid number of this material does very little toward establishing its constitution.

However, it seems reasonable to assume that the skin consists almost entirely of the neutral metallic soaps of zinc and lead, for any free acid present should be perfectly soluble in the oil which is in contact with

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[1] This Journal, 7 (1915), 30.

[2] "Chemical Technology of Oils, Fats and Waxes," 1, 423.

[1] *J. Russ. Phys.-Chem. Soc.*, 40, 930–9.

[2] Ware and Christman, next issue of This Journal.

the skin. Also if the total weights of the zinc and lead soaps be calculated from the oxides contained in the ash as given above, using 275.5 as the average molecular weight of the fatty acids, they are found to check up to the original weight of the sample taken for analysis.

As a further proof of the identity of the skin as a zinc soap of linseed oil a comparison was made of the melting points of the skin and of the zinc linoleate. The somewhat higher melting point of the former, 81, as compared with 76 for the linoleate, may be accounted for by the presence of the other metallic soaps.

It is not probable that these precipitated metallic soaps that go to make up the skin result from the saponification of the neutral glycerides by the pigments alone, although at different times writers have stated that white lead has this power of saponifying the oil to form a lead soap. Such reactions may occur at high temperatures, but it is doubtful if they proceed to any extent at ordinary temperatures. The results obtained by Gardner and Boughton do not necessarily signify that even the slight changes in the characteristics of the oil as obtained by them are due entirely to the pigment, since the action of any water present must be taken into consideration.

It is possible that the accelerator necessary to this metallic soap formation is lipase, as claimed by Gardner, but it is the opinion of the writers that, although the action of lipase may at times be considerable, it is of secondary importance in the reactions taking place in the ordinary mixed paint. The occasional presence of lipase, the fat-splitting enzyme, in linseed oil has long been established. Zymogen, in the flaxseed, under favorable conditions, is capable of forming the enzyme, and it is of real importance in expressing the oil that the seeds be heated to a high enough temperature to kill any microörganisms present, not only to prevent the formation of lipase in the oil, but also to insure its absence from the press cake. The enzyme has the ability to act upon the cyanogenetic glucoside, linamarin, present in the cake, and, with the aid of water, to convert it into prussic acid, making the cake entirely unfit for cattle food.

However, the authors do not consider that the presence of a fat-splitting enzyme in linseed oil is a frequent cause of trouble. Even when using cold-pressed oil trouble arising from the action of lipase would not be common, for, as shown by Tanaka,[1] the enzyme lipase is inactive in the presence of even dilute alkali, a material which is commonly present as a constituent of the commercial emulsifying agent. And if the action of the lipase be so pronounced it should show in the stored oils as well as in the paints made from these oils.

As a further evidence of the exceptional, rather than common, occurrence of this enzyme in linseed oil, cultures were made according to the method recommended by Gardner, using several different commercial oils and one sample of foots. In no case was any growth apparent after 72 hrs.

The authors believe that the really important hydrolyzing influence is the emulsifying agent. The sodium hydroxide present in the solution has the power of saponifying linseed oil at ordinary temperatures, while the sodium soap so formed, acting as an emulsifying agent, tends to keep the water and oil in contact, giving a better opportunity for further action.

The alkali soaps are at least partially hydrolyzed in water solution and, as the acid formed is soluble in the oil present, there may be a partial recovery of the alkali which furthers the reaction by forming more soap; and we might say that the governing factor in establishing the limit to which hydrolysis will proceed will be the amount of water present. That the same saponification takes place with other alkaline agents is evidenced by the following compilation of data:

ADDITIONS TO OIL			Time	Temp.	Per cent
Water	Na_2CO_3	Others	Hrs.	° C.	Saponified
100 g.	3 g.	....	2	70	1.5
100 g.	..	....	2	70	0.5
100 g.	3 g.	....	18	70	10.0
100 g.	0	3 g. Casein	18	70	1.3
1 g.	0	3 g. ZnO	18	70	2.2
1 g.	0	3 g. White Lead	20	70	2.3
100 g.	3 g.	3 g. ZnO	20	70	5.3
100 g.	3 g.	....	22	70	30.4
100 g.	3 g.	....	22	70	0.8

These results show that the water itself has a small action upon the linseed oil. The carbonate has a marked effect, although the so-called active pigments are almost without effect. The differences in activity between the saponifying agents should be even more marked at ordinary temperatures than at the elevated temperatures employed in this experiment.

When ready mixed paints are stored, the first general reaction is this hydrolysis of the oil by the water, accelerated by the presence of the alkali and perhaps affected to some extent by the pigments. This hydrolysis is necessarily slow since the water and oil are immiscible, and before any large amount of acid is formed the pigment has settled, leaving the clear vehicle above. The acid coming in contact with the top of the settled pigment reacts with the basic materials present, of which zinc oxide is the most active, and forms the corresponding metallic soaps. Originally two molecules of water had hydrolyzed the oil and formed two molecules of the acid, and upon the reaction between these two molecules of acid and the metallic oxide, one molecule of water is liberated. In computing the amount of hydrolysis under such conditions it may be shown that with an amount of water such as is sometimes present in mixed paints it is theoretically possible to get complete hydrolysis of all of the oil. Although this is a condition that does not occur in the average paint the speculations are not greatly overdrawn, and the possibility of injury to mixed paint by the use of improper emulsifying agents is clearly shown.

The zinc soap formed on the neutralization of the acid by the zinc oxide of the pigment is almost completely insoluble in the cold vehicle and is at once precipitated on top of the partially settled pigment. The white lead also unites with the acid, with the formation of the more soluble lead soap, part of which is carried down by the zinc, and so helps to build up the peculiar skin over the pigment. The reactions

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[1] *J. Coll. Eng. Tokyo*, **5**, 1912.

between the acid and the pigments take place readily so that the oil never shows a pronounced free acid value. This value, previously cited as approximately 15, is corrected to 8 when allowance is made for the difference due to the dissolved soaps hydrolyzed during analysis.

Some of the water is probably carried along with the settling pigment resulting in a similar hydrolysis of the oil in the bottom of the can. The metallic soap formed in the midst of the pigment may be the cause of the non-caking of the pigment in stored mixed paints. The opportunities for reaction in the presence of the great excess of pigment are very good, and the tendency is in favor of the formation of the basic soap rather than the neutral soap as present in the skin. Upon extraction of the settled pigment with either the presence of the basic soap was inferred from the fact of its relatively slight solubility. The extracted oil was clear and of good color, with an apparent acid value of 16.8. Upon correction for the ash content of 1.16 figured to hydrolyzable metallic soap, the true acid value would be about 10. The pigment residue from the extraction still contained some fatty acid compounds, the freed fatty acids checking to 2.14 per cent. These were no doubt present as the basic soaps and would represent a weight of 2.76 per cent if figured as the basic zinc soap and 3.8 per cent if figured as the basic lead soap.

As a further evidence of the plausibility of the above analysis of conditions it is possible to synthesize the zinc oxide fatty acid blanket if a small amount of oxide be allowed to stand undisturbed in contact with oil containing a large amount of free linseed oil acids. If one gram of zinc oxide is placed in the bottom of a flask and covered with acid, within 24 hrs. the zinc oxide will swell out through conversion to the soap, giving the characteristic lumpy appearance of the "skin."

This zinc soap is quite insoluble in oil or naphtha, though soluble to an appreciable extent in turpentine. The insolubility of the soap may explain why the constants of the oil in the zinc oxide linseed oil storage tests conducted by Gardner and by Boughton showed no marked changes.

If a small amount of white lead be treated with excess acid in the same manner as succeeded in developing the linseed zinc oxide skin, we find that the action is much slower and several weeks' time is necessary before there are any definite indications of reaction. The lead soap formed is of a finer structure and does not show the same tendency toward coagulation or lumping.

PUTTIED PAINT

The similarities in the reactions giving a puttied paint to those just reviewed is quite apparent. Several cans of the worst cases of puttying were studied, in which the entire liquid portion had seemingly gone solid to a dense soapy mass. These paints were of a grade inferior to that of the paints exhibiting skinning, in that they contained more water as well as considerable rosin in the form of gloss oil.

The oil extracted from the paint and with the thinner distilled off was clear but slightly dark in color. The analytical constants of the oil were as follows:

Apparent Acid Value	Saponification Value	Iodine Value	Ash
33.0	177.0	184.0	4.5

An analysis of the acids of the oil by the Twitchell volumetric method indicated the presence of 14 per cent of rosin acids. The ash consisted mainly of zinc oxide with some lead and lime. These oxides were present as a mixture of linoleate and resinate, a separation of which was not feasible. Assuming the same extent of hydrolysis in the determination of the acid number as had been proven in the cases of the soaps previously examined, the free acid content was shown to be negligible.

In these puttied paints the pigment had settled to some extent and it was found convenient to work with the upper layer, which was puttied vehicle containing a comparatively small amount of pigments. This was quite variable in composition, the percentage of free pigment increasing toward the bottom of the can. The amount of free pigment and of zinc soap being the important determinations, these were ascertained within sufficiently close limits by shaking the sample with cold ether, weighing the residue, liberating the acids in this residue and calculating the zinc linoleate from these acids. The zinc soap of the oil is almost entirely insoluble in cold ether while the resinate of zinc is quite soluble under the same conditions, and since the samples taken were in themselves quite variable the results were as reliable as could be expected. Near the top of the puttied vehicle the pigment constituted 10 to 15 per cent and the zinc soap 20 to 25 per cent of the total. Deeper in the layer the pigment content increased to 25 per cent while the zinc soap content decreased to 15 to 20 per cent. The relative amounts of oil, thinner and resinate of zinc were not determined. The pigments separated from these samples analyzed about 75 per cent zinc oxide.

If a small amount of zinc oxide be allowed to remain in contact with raw linseed oil containing rosin dissolved in petroleum thinner, in a very short time the oxide dissolves to a clear solution. The only apparent change in the solution is an increase in the viscosity. The same condition holds when free oil acids are substituted for the raw oil. There is no tendency toward the formation of the skin; in fact a sample of the skin previously formed dissolved completely in a naphtha solution of rosin upon standing over night.

The assumption is that the rosin acid displaces the oil acids from their zinc soaps with the formation of zinc resinate, which is somewhat soluble in naphtha and considerably soluble in turpentine, ether, and linseed oil.

The paints containing gloss oil seem to be the most susceptible to livering, which may be explained as follows: Although the rosin is usually limed there still remains considerable free rosin acid whose combination with basic pigments takes place in a short time. The resinates so formed are soluble in the vehicle but increase its viscosity to a point that delays the settling of the pigment. The hydrolysis of the oil proceeds as in the case of the skin formation except that, as there is generally more water and more alkali present, the action is faster. The freed acid comes into immediate contact with the unsettled pigment forming the metallic soaps, particularly that of zinc.

The vehicle portion becomes constantly thicker until we have a condition approaching that of a colloidal gel formed from the finely divided zinc soap precipitating from the viscous solution of zinc resinate. This gel has occluded or adsorbed the remaining oil and what little thinner may have been present. Since, during the progress of the reactions, the acids and the pigments are in intimate contact, the opportunity for neutralization is much better than is the case with the skinned paints, which accounts for the low free acid content of the extracted oil. If the rosin of the gloss oil be highly limed or for any other reason the pigments should settle before the oil acids form to any extent, the action is apt to be one of "skinning" rather than "puttying."

An experimental mixture of oil, acids, rosin, pigments, and petroleum thinner, corresponding to the analysis of the puttied vehicle, resulted in a livered paint which, although not so hard as the samples investigated, was in every way comparable to them. Another sample, similar in composition to the mixture showing skinning, when continually shaken to prevent settling, livered in a very short time.

CONCLUSIONS

Although the use of emulsifying agents in paint grinding is quite generally recognized as necessary, their action in preventing the hard settling of the pigment has not as yet been satisfactorily explained.

Certain of the emulsifying agents hydrolyze the oil of the paint, the fatty acids subsequently forming insoluble zinc and lead soaps, which, if free to precipitate, form a skin on the surface of the settled pigment.

If, because of the presence of dissolved resinates formed from added gloss oil, or for any like reason, the viscosity of the vehicle be increased to the point where the pigments and the metallic soaps formed from the hydrolyzed oil are not free to settle, there is formed a gel or "livered" vehicle.

These conditions may be remedied by the use of a protective colloid containing no water, such as aluminum palmitate or oleate, or by the use of an emulsifier containing water, but in which the active agent exerts no saponifying action on the linseed oil.

As the probable reason why emulsified oil paints do not settle hard is that there is present in the partly settled pigment a lead or zinc linoleate, it may be advantageous to grind paints in an oil of fairly high acid content, or to add the optimum amount of lead or zinc soap to the pigments ground in a neutral oil, as a means of inhibiting the dense settling of the pigment.

Experimental formulas compounded in an effort to establish the relative values of the various emulsifying agents, while they show promise of interesting and valuable results, have not as yet been under observation for a sufficiently long time to warrant definite conclusions being drawn from them.

University of Michigan, Ann Arbor

THE USE OF BARK FOR PAPER SPECIALTIES[1]

By Otto Kress[2]

In the manufacture of paper from wood pulp, if the bark is not carefully removed preliminary to the pulping of wood by either chemical or mechanical processes, it appears in the pulp and produces small specks in the finished paper, detracting from the appearance and value of the sheet. Some kraft mills do not clean their wood preparatory to pulping, depending on the alkaline digestion to destroy the bark. This practice is followed only to a very limited extent as the high consumption of chemicals in the pulping of bark and unevenness in shade and uniformity of the resulting pulp are decided drawbacks. The loss in barking will depend on the nature and condition of the wood, and on the method of barking of the wood, and will vary from 10 to 25 per cent, based on the weight of the rough wood. According to the census of 1911 of the Department of Commerce, there were consumed in the United States 4,328,052 cords of pulpwood, of which 280,534 cords were classified as slabwood and other mill waste. Practically all of this wood was cleaned and barked before pulping. The bark, as removed at the mill, is saturated with water and even with heavy pressing can be made only about 50 per cent dry, so that it is of comparatively little value as fuel. One mill that brought this matter to our attention loaded the daily waste from the drum barking of 100 cords of spruce wood into gondola cars, and disposed of it by filling in low places around the mill. They experienced difficulties from the odors of the decomposing bark, from fires which are apt to occur and which are hard to control, while the cost of removal was estimated at from $15 to $20 a day.

Large quantities of waste bark in the tanning industry are likewise awaiting successful utilization. Waste tan bark from the leaches is about 35 per cent dry, and has an estimated fuel value of $0.60 in comparison with $3.00 for bituminous coal.[3] The latest census figures from the Department of Commerce and Labor on tan bark production for 1909 showed a production in the United States of 698,365 tons of hemlock bark and 324,070 tons of oak bark, valued at $9,968,710. The production since then, however, is reported to have diminished steadily, because of the increased use of chemical tanning agents, and accurate data as to the present amount is not available. Such minor uses for the waste bark as that in the white lead industry, runways for stables, etc., take but a very small amount of the bark, leaving the balance for fuel after the tannin extraction.

Other sources of waste bark in the United States are the lumbering of redwood, cedar, etc., where the bark is a decided detriment both in the lumbering operation and at the sawmill. The Forest Products Laboratory in attempting to utilize these wastes for pulp and paper purposes first attempted to reduce the bark by chemical pulping. A decided drawback is

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the small yield and very heavy chemical consumption. As the various waste barks such as spruce, redwood, extracted hemlock bark, etc., all have different properties, it was next attempted to reduce them to a pulp condition by simple mechanical reduction in the beater and Jordan and after mixing with various longer fibred pulps, to run them over our experimental machine into various paper products. The apparatus used in these experiments at the laboratory was a 40-lb. beater, a small Jordan, and a 15-in. experimental Pusey and Jones Fourdrinier machine.

EXPERIMENTAL

A paper was made at the laboratory on the basis of 80 per cent extracted hemlock bark and 20 per cent kraft pulp which showed such remarkable impregnation towards tars, asphalt, etc., that it appeared advisable to make further tests on a mixture of hemlock bark and rag stock to try and cheapen the felts used for roofing and shingle stock. A coöperative study was undertaken with a company manufacturing roofing felts to work this out on a commercial scale. Samples made at the laboratory on a basis of 60 per cent rag stock and 40 per cent waste hemlock bark, showed a good strength and good saturation. A factory trial was then arranged for and roofing felt was made on a 114-in. trim cylinder machine. The beaters in this trial were loaded very heavily, using 9800 lbs. of 33 per cent dry bark in the ordinary 1200-lb. beater. The bark was beaten for one-half hour with the roll down to reduce the larger pieces, and then dropped into a separate chest from which it was pumped to a Jordan and dropped into the machine stuff chest. Felt ends were used for convenience instead of rags. They were opened up in the beater, dropped into a separate beater chest, brushed lightly in a separate Jordan, and then mixed with the ground bark in the machine stuff chest. The percentages of rag and bark were controlled by regulating the amount put through the separate rag and bark Jordan, the discharges from which were mixed in the machine stuff chest. The mill in which this trial was made ordinarily makes chip and box board, and to avoid unnecessary dirtying of the machine, only the two end vats of the possible five were used. Various runs estimated up to 80 per cent bark and 20 per cent felts were made, and no difficulty was experienced in passing the paper over the machine or in drying. Using two vats, only thin felts could be made of an average calipre of 40 to 45 points. The backwater, while reddish in color from the soluble coloring matter removed from the bark, was comparatively free from fiber. In this trial 6000 lbs. of finished felts were made, and the rolls were later impregnated and finished into roofing at two different plants.

Felt made on the basis of 80 per cent bark would of course be too weak to stand up under the weakening action of the hot asphalt and would break under the tension of pulling the felt through the saturating tank. Felt carrying this high percentage of bark was made at this trial in order to bring out to the maximum extent the difficulties that might be expected in the mill production.

A coöperative study was then undertaken by the laboratory with the saturating plant, a felt mill and a tannery to develop the practical use of tan bark in the manufacture of roofing felts. At the present time, the coöperators are using at certain mills having an average daily production of 50 tons of felt, approximately 60 tons of dry bark a week, which is shipped, 40 per cent dry, from the tannery. It is reported by the coöperators that roofing felt is being successfully made and offering no undue difficulties in the saturating plant on a furnish in which tan bark is used up to 20 to 30 per cent. The average price of rags for the manufacture of felts at the present time is \$40.00 a ton, and conversion loss is estimated to average 25 per cent. The value of waste bark for fuel as already stated is \$0.60 per wet ton, 35 per cent dry, in comparison with bituminous coal at \$3.00 per ton. To this must be added the cost of handling the bark into the cars, the profit to the tannery, the expense of plant facilities necessary in changing the tanner's fuel to coal and in rearranging side tracks and loading facilities, and the freight rate to the felt mill. If this freight rate is high, it would appear to be advisable to consider the cost of drying the spent bark from a 66 per cent moisture content to about a 15 per cent content, and thus avoid the freight on the water. Modern drying apparatus has made possible the cheap drying of raw materials to a remarkable degree. This drying might offer difficulties in obtaining the necessary minimum car weight, as the spent bark is bulky.

One of the difficulties still to be overcome which, however, we feel can be easily solved, is the controlling of the percentages of bark and rag stock run onto the felt machine. At first the bark, after passing through the bark Jordan, was mixed with the beaten rags in the beater rag stuff chest, then pumped through the rag Jordan to the machine chest. This offered considerable difficulty, as any variations in pumping, in the level of the stock in the chests, etc., caused a variation in the percentage of bark in the finished felt. In order to hold the percentage of bark constant the Jordaned bark may be pumped to a separate chest with overflows arranged at 10, 20, 30 per cent, etc. The bark can then be run by gravity to the various rag beaters or the right amount can be run directly into the rag stuff chest in proportion to the amount of rags dropped. Where this development work has been done, the felt is now made on a 72-in. felt machine with a 36-in. cylinder and 46 3-ft. dryers. It has been found by experience that no beater treatment for the bark is required. The bark at the present time is screened through a screen with about a $^3/_4$-in. mesh, and is thrown into the chest. From here it is pumped to the regulating box on the Jordan and the discharge from the Jordan run to the beater rag chest. The mixture of rags and bark after passing through the rag Jordan goes to the machine chest and then onto the machine. The object of the screening of the raw bark is to prevent the choking of the inlet pipe to the Jordan by the larger pieces of bark. The larger pieces which are screened out are thrown into the beater with the rags and reduced to a proper condition in this way. A valve placed on the discharge pipe from the Jordan was found to be a convenient way to regulate the fineness of the stock, as it enables the operator to regulate the time of Jordaning. This direct Jordaning of the bark makes a decided power saving in the beating, for if a considerable replacement of rags is made by the bark, less beaters are required for the same felt output.

No difficulty is experienced in either forming or running the sheet. A little difficulty has been experienced in the proper drying of the felt, when a large percentage of bark is used. In order not to curtail the production by slowing down the machine it would appear advisable, if the mill is so arranged as to permit it, to add some extra driers or arrange for some special drying device. Due to the higher specific gravity of the bark, the finished felts are a trifle heavier, and allowance must be made for this in running the stock. The felt mills to-day are receiving a poor grade of rags, in fact only such rags as can hardly be used for any other purpose. With a more careful selection of the rags, we believe that it will be possible to raise the percentage of bark in the finished felt and still maintain the quality of the finished goods. Further, it is possible that the Jordan is not the best machine to reduce the tan bark to a proper condition; probably a special refining engine will reduce the bark without unduly cutting the fiber found in the bark. The limitation to the use of a higher percentage of bark does not appear to be in the paper mill, but in the lack of strength in the saturating tanks; this is partly due to the moral inertia and prejudice of the men handling the felt through the saturating tanks. A great deal could no doubt be done by using a better grade of rags that could be readily paid for by only a slight increase in the percentage of bark in the finished felt, as there is such a great difference in the cost of rags and bark.

Two other rather interesting and possible uses for waste hemlock and oak bark have been worked on at the laboratory. Two papers were made at the laboratory on the basis of 80 per cent extracted hemlock and 80 per cent extracted oak bark, the balance in each case being unbleached sulfite pulp. These papers were unsized and had a tendency to dust off fine particles of bark on rubbing, which we believe could be overcome by sizing. Two of the rolls were printed on a commercial 12-color wall paper printing machine, the paper taking the colors well. One of the disadvantages of a grade of paper of this type is that the high specific gravity of the bark makes the paper heavy. Hanging is ordinarily made on a furnish of 80 to 85 per cent ground wood, the balance of sulfite, and a decided saving would be made, if a wall paper made on a basis of 80 per cent bark could find application. The paper made with hemlock bark had a decided reddish color, while the oak bark paper was more of a chocolate shade. We have tried out in a preliminary way the color effect of cheap mordants, such as iron sulfate, etc., and find that there is a possibility of changing the shade with very little expense. The present price of this grade of paper was estimated by the wall paper printing concern at $60 to $80 a ton. The papers printed better than the ordinary oatmeal wall paper with which it is compared, and if no undue difficulties are experienced in running it on large and fast commercial machines, it should be decidedly cheaper than the present hanging. This paper would undoubtedly have the disadvantage of increased weight and possibly the disadvantage of dusting off small particles of the bark.

Two rolls of unsized paper were made at the laboratory on the basis of 80 per cent extracted hemlock bark and 80 per cent extracted oak bark, the balance sulfite, and tried out on a commercial machine for making fiber conduits. The paper was run at the mill in competition with their ordinary grade of paper, and impregnated thoroughly; it made a satisfactory conduit which could be machined and which showed up well under the various tests applied. The paper in which bark was used was thinner than the regular grade, and further, was softer, and impregnated more readily, which might require a slight change in the blending of the saturant. A decided drawback lies in the fact that the increased weight of the bark makes the conduit decidedly heavier, thus increasing the freight rate on the finished conduit.

Trials were made at the laboratory on the possible utilization of spruce and balsam bark obtained in the drum barking of pulpwood. These barks differ from waste tan bark in being pitchy, which would exclude their use in any product which subsequently had to be impregnated. Further, any large percentage of spruce bark makes a brittle sheet. For certain purposes such as wall board, where the finished board is usually made by plying together the individual sheets by a binder such as sodium silicate, this tendency towards brittleness is of little consequence. A coöperative study was undertaken with a wall board mill but the work to date has not progressed beyond the laboratory stage. Boards made experimentally on the basis of 80 per cent waste bark, the balance sulfite and kraft, also boards on the basis of 50 per cent bark and 50 per cent ground-wood, were favorably commented on by the mill.

Spruce bark offers some difficulty in mechanical reduction and we believe that the beater will require extra sharp tackle, and a special filling in the Jordan would be a decided help. At the laboratory no difficulty was experienced in reducing spruce bark in 45 minutes in an experimental beater, while on a commercial beater, fitted with dull tackle, a 5-hr. treatment still left the bark in an unsatisfactory condition.

Patent specifications on the use of waste bark for pulp and paper purposes have been submitted to Washington by Mr. Howard F. Weiss, of this laboratory, and myself. If patents for the United States are granted, they will be dedicated to the public. Foreign patents have also been applied for.

SUGGESTIONS

There are a great many other possible uses of the various barks which at the present time have either a limited or no value. A fair insulating board has been prepared at the laboratory from the bark of the redwood tree. Other possible uses that suggest themselves are the use of spruce or balsam bark from the drum barking of pulpwood which is to be mixed with sulfite screenings and run into car liners. Further, waste hemlock and oak bark might be used in the manufacture of sheathing, carpet liners, bottle wrappers, deadening felts, chip board and box board. A small percentage might be used for board used in stand up boxes where no great bending qualities or high test are required. For indurated fiber ware, such as pails, etc., it might be possible to substitute a large percentage of ground tan bark for the more expensive stock used at present.

The above remarks can be looked upon as only indications of what might be done, as each mill will have to determine whether they can substitute bark in part for a more inexpensive stock, and still maintain the quality and standard of their product. Waste bark can be looked on only as a filler, and must be used with a longer fibered stock to carry it over the machine. Its use will permit a decided saving in many grades of paper products.

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THE PROBLEM OF CATALYZER POISONS WITH REFERENCE TO THE HYDROGENATION OF FATTY OILS

By CARLETON ELLIS AND A. A. WELLS

Received June 19, 1916

One of the main difficulties in the hydrogenation, by the aid of nickel catalyzer, of many low-grade oils, such as some of the fish and whale oils, is that the life of the catalyzer is relatively very short. Usually the activity of the catalyzer becomes much slower after two or three batches of oil have been hardened and in some cases it is necessary to prepare fresh catalyzer for every batch of oil treated. On the other hand, when hardening a good grade of oil, such as refined, edible cottonseed oil, the life of a carefully prepared catalyzer is likely to be very long and in some cases an entirely new lot of catalyzer is not required for months in the constant operation of a hardening plant. In these cases the catalyzer is kept in a state of high activity for continued usage by adding a small amount of fresh catalyzer at intervals of one or two weeks.

The fact that in some cases a catalyzer does not last indefinitely and that its life is prolonged in proportion to the purity of the oil, indicates that there are present in some fatty oils certain substances which unfavorably affect the catalyzer, acting as a poison thereto, and sooner or later causing the catalytic agent to become inactive. It has been observed that some kinds or grades of oil may be hydrogenated to an incomplete degree but that they cannot be carried beyond this point, no matter how long the treatment is continued, without change of catalyzer. If to these semi-hardened oils a fresh quantity of catalyzer is added, the hardening will usually proceed practically to complete saturation. In some cases, a fresh quantity of oil may be treated with the seemingly spent catalyzer, when partial hardening will occur. An additional quantity of fresh catalyzer will sometimes carry the oil so treated, to completion, showing that the substance which affects the catalyzer is apparently taken up by it under these circumstances, thus leaving the oil in condition to be readily hardened. Some oils which ordinarily cannot be hardened without a preliminary purifying treatment, may first be agitated with a spent catalyzer, the catalyzer removed and the oil then incorporated with a fresh quantity of catalyzer when hardening readily occurs.

EXPERIMENTAL

From time to time we have had submitted to this laboratory various samples of low-grade oils to be treated with hydrogen. In some cases obstacles were met with in handling these oils and the observations here reported are some of the typical ones which were performed in the attempt to obviate these difficulties.

COD OIL—Apparently this oil would have a very wide use, especially in the leather industry, if some cheap method of treatment could be rendered available so that the oil could be easily hydrogenated.

A sample of crude cod oil was freed from fatty acids with a solution of sodium carbonate and after washing free from alkali and soap was treated with hydrogen, using 5 per cent catalyzer prepared from nickel oxide. In most of the laboratory work connected with this investigation, a somewhat larger proportion of catalyzer was used than is customary in commercial operations. This enabled results of a comparative nature to be more quickly obtained. The oxide was reduced in the oil at 260° C. and then subjected to the action of hydrogen at 200° C. for 2 hrs. In several trials, the oil either did not harden at all, or only to a very minor degree. Other forms of catalyzer were equally ineffective.

The oil was then agitated for 1 hr. at 200° C. with freshly prepared copper hydrate, filtered to remove the copper compound and again treated with hydrogen and catalyzer under the same conditions as above. The oil was readily hardened by this treatment. Another sample of the oil, refined as above, was treated with 5 per cent freshly prepared silver oxide at 200° C. for 1 hr. The silver compound was removed by filtration and the clear oil hydrogenated. In a short time this oil was hardened to a melting point of 46° C. on hydrogenating under the same conditions as above.

A slight discoloration of the oil due to this treatment was observed, so another portion of the oil was refined, using caustic soda in place of the sodium carbonate. The color of the oil refined with the caustic soda was better than that obtained with the carbonate.

A sample of this refined cod oil was agitated for 1 hr. with 5 per cent Fuller's earth at 150–200° C., filtered and subjected to the hydrogenation process, employing 5 per cent of catalyzer prepared from nickel oxide. The oxide was suspended in the oil and treated with hydrogen at 260° C. until black in color. The temperature was then lowered to 210° C. and maintained at this temperature for 3 hrs. The oil did not harden. A sample of the refined cod oil was treated with a great excess of catalyzer (10 per cent) prepared by soaking Fuller's earth in nickel nitrate solution in such proportions that the reduced material contained 20 per cent nickel. This material was dry-reduced in a current of hydrogen at 360° C. and immediately flooded with oil to avoid oxidation. The application of hydrogen was carried out at 200 to 210° C. for 2 hrs. but even with this excessive amount of catalyzer the oil was not hardened. A quantity of cod oil was treated with a commercial sample of copper oxide for 1 hr. at 160 to 170° C. and then hydrogenated with catalyzer prepared from nickel oxide. The catalyzer was reduced in the oil at 250° C. for 1/2 hour and hydrogenation was carried out at 200° C. for 3 hrs. The oil was slightly hardened.

A sample of cod oil (iodine No. 169) which we had attempted to hydrogenate with nickel catalyzer but which did not readily harden, was filtered from the catalyzer and again hydrogenated with a dry-reduced catalyzer on a carrier, using 1 1/2 per cent nickel. The oil hardened to a melting point of 40 to 42° C. The iodine number was 91. Continued hydrogenation for several hours raised the melting point to 44 to 45° C. and the iodine number dropped to 81. The catalyzer was unable to carry the hydrogenation further.

A series of tests were performed to determine the relative value of freshly precipitated copper hydrate as a detoxicating agent. In one test, portions of cod oil were agitated with 5 per cent of freshly prepared copper hydrate, commercial copper carbonate and lead oxide at 180 to 200° C. for 2 hrs. After filtering, these samples were treated with hydrogen using 5 per cent nickel oxide as a source of catalyzer. This was reduced in oil at 250° C. for 1/2 hr. The hydrogenation operation was carried out at 230° C. for 3 hrs. The oil treated with freshly precipitated copper hydrate hardened to a melting point of 53 to 54° C., the oil treated with copper carbonate hardened slightly, while the oil treated with lead oxide did not harden.

As the copper hydrate at times is not readily filtered from the oil after protracted agitation with the latter, the hydrate was precipitated on Fuller's earth in the proportion to give 20 per cent copper. Cod oil was agitated with 1 per cent of this material for 1 hr. at 110 to 120° C. The oil was then filtered and hydrogenated, using catalyzer prepared from nickel oxide. The catalyzer was reduced in the oil in the ordinary manner and hydrogenated at 200° C. for 2 1/2 hrs. From the results obtained the copper hydrate did not appear to be as active in this form.

To determine the most effective temperature for treating the oil with copper hydrate the following tests were performed: Cod oil was agitated with 1/2 per cent of copper hydrate for 1 hr. at room temperature, then was filtered and subjected to the hydrogenation process. Another portion of the oil was treated in a similar manner, except the temperature of treatment with copper hydrate was 50° C. Other portions were treated at 75° and at 110 to 120° C. The samples treated below 110° C. did not harden and metallic mirrors were formed on the walls of the container during the treatment with hydrogen. The sample which was agitated at room temperature exhibited the most perfect mirror. The oil treated at 110 to 120° C. hardened readily without the formation of a mirror.

The effect of refining cod oil with alkali before hydrogenation, when the copper hydrate treatment is used, is beneficial to the catalyzer as was shown by agitating crude cod oil with copper hydrate at 140 to 150° C. for 1 hr., filtering and then subjecting it to the hydrogenation process, using nickel oxide. The catalyzer was formed in the oil at 250° C. and hydrogenation was carried out at 190 to 200° C. for 4 hrs. The oil was only slightly hardened.

A sample of refined cod oil was treated with Fuller's earth to improve the color. It was then treated with copper hydrate and hydrogenated in the usual manner. As a control a portion of the same oil was treated with copper hydrate and then hydrogenated, omitting the Fuller's earth treatment. The sample which was treated with Fuller's earth hardened slightly more rapidly than the sample which had been treated only with the copper hydrate.

A quantity of the oil under examination was burned in oxygen in a combustion bomb. The contents of the bomb were washed out and examined qualitatively. Sulfates and a trace of iodine compounds were found to be present but no test was obtained for either chlorides or phosphates. Either sulfur in the sulfide form, or iodine could have been responsible for the poisoning action on the catalyzer noted.

MENHADEN OIL—A sample of Southern crude fish (menhaden) oil, without refining, was subjected to the hydrogenation process, using nickel oxide reduced in the oil at 250° C. and the hydrogen treatment was carried out at 200° C. for 4 hrs. The oil was not hardened. Another portion of the same oil was agitated with copper hydrate at 135 to 150° C. for 1 hr. and treated under the same conditions as above. The oil was hardened, without difficulty, to a melting point of 45 to 46° C. Another quantity of the same crude fish oil was refined and then treated with copper hydrate. The treated oil was hydrogenated using a catalyzer which had previously been used in cod oil that had been detoxicated with copper hydrate. The oil hardened to a melting point of 52 to 53° C. The catalyzer was apparently not affected by its previous use in cod oil which had been treated with copper hydrate.

HERRING OIL—An oil which is available in quantity and which up to the present time has had a very limited field of utility is herring oil. In general, this oil requires more careful detoxicating treatment than cod or Southern fish oil to make it adaptable to the hardening process.

A sample of herring oil which could not be hardened by the usual methods was refined to free it from fatty acids and after treating with copper hydrate for 1 hr. at 110 to 120° C. was subjected to the action of hydrogen in the presence of a catalyzer prepared by reducing nickel oxide in the oil at 250° C. for 1/2 hr.

The oil was hydrogenated at 190 to 200° C. for 5 hrs. It hardened to a melting point of 45 to 46° C.

DOGFISH OIL—A number of samples of this oil have been examined in this laboratory and have proved somewhat difficult to hydrogenate. In one case, a sample of the oil was agitated with copper hydrate for 1 hr. and then treated with hydrogen, using a catalyzer prepared by precipitating nickel hydrate on a carrier and reducing at 360° C. Hydrogenation was conducted for $5^1/_2$ hrs. at 180 to 190° C. The oil did not harden. The catalyzer was filtered out and 5 per cent of a mixture of finely-divided nickel-copper hydrate was added. A current of hydrogen was passed through the oil, the temperature of the oil being held at 250° C. for $^1/_2$ hr., then lowered to 190 to 200° C. and maintained at that point for 3 hrs. The oil hardened to a melting point of 45° C.

EFFECT OF HALOGENS, HALOGEN COMPOUNDS, SULFUR, ETC., ON HYDROGENATION OF COTTONSEED OIL

Catalyzer: Nickel Oxide (5 per cent of the weight of the oil) reduced in oil at 250° C. for $^1/_2$ hr.

Expt. No.	Substance Added	Per cent Added	Temp. ° C.	Time Hrs.	Effect on Oil
1	Bromine	1.0	200	2	No hardening
1 (CH)		1.0	200	2	
2	Iodine	1.0	200	2	
2 (CH)		1.0	200	2	
3		0.5	200	$2^1/_2$	
3 (CH)		0.5	200	$2^1/_2$	
4	Antimony Bromide	1.0	200	2	
4 (CH)		1.0	200	2	
5	Sodium Chloride	5.0	210	$2^1/_2$	Oil hardened
6	Zinc Chloride	5.0	210	$2^1/_2$	Oil polymerized
7		1.0	200	$2^1/_2$	Slight hardening
7 (CH)		1.0	200	$2^1/_2$	Oil Hardened
8		0.5	200	$2^1/_2$	
9	Tin Chloride	1.0	200	2	
10	Sulfur	0.5	200	$2^1/_2$	Slight hardening
10 (CH)		0.5	200	$2^1/_2$	Oil hardened
11		1.0	200	$2^1/_2$	No hardening
11 (CH)		1.0	200	$2^1/_2$	Oil hardened
Blank		...	200	$2^1/_2$	
12	Sulfur	0.1	210	$3^1/_2$	
13	Red Phosphorus	1.0	200	2	Slight hardening
13 (CH)		1.0	200	2	Oil hardened
14		0.5	200	2	Slight hardening
14 (CH)		0.5	200	2	Oil hardened
15	Sulfur Chloride	1.0	200	2	No hardening
15 (CH)		1.0	200	2	Oil hardened
16	(As_2O_3)	1.0	200	2	No hardening
17	Mercury	1.0	200	2	Slight hardening
Blank		...	200	$2^1/_2$	Oil hardened
18	Lead Stearate	1.0	200	$2^1/_2$	No hardening
19	Lead Oleate	1.0	200	$2^1/_2$	
19 (CH)		1.0	200	$2^1/_2$	

(CH) after an experiment number indicates treatment with copper hydrate before hydrogenation.

Probably the most difficult to handle of all the low-grade oils is that derived from city garbage. There are two methods of reclaiming this grease, one by boiling the garbage with water and allowing the oil to rise to the top when it is drawn off, the other by extracting the oil with solvents. This oil is usually denatured with or contains tar, and as it is derived from all manner of materials which would vary from day to day it is quite probable that no fixed method of treatment can be employed. Up to the present time no entirely satisfactory method has been found to refine and successfully harden this material in a manner capable of general commercial application.

EXAMINATION OF COPPER HYDRATE

The copper hydrate which had been used to detoxicate the cod and other oils was examined to determine what bodies were taken up from the oils by the treatment. Fatty material was removed from the copper hydrate by extraction with solvents and the residue was analyzed. Sulfates were found but no evidence of the presence of phosphates or chlorides was obtained. A blank test on the original copper hydrate showed no sulfates or sulfur present, indicating that sulfur compounds are removed from fatty oils containing them, by treatment with copper hydrate in the manner stated.

OTHER CATALYZER POISONS

As various bodies other than those mentioned above are known to poison hydrogenating catalysts, and as the treatment with copper hydrate has been found to remove certain of these poisons or render them non-toxic to nickel catalyzer, the accompanying table has been compiled from an extensive series of tests with such bodies and in some cases the effect of copper hydrate thereon is indicated.

NEW JERSEY TESTING LABORATORIES, MONTCLAIR

EXPERIMENTAL NOTES ON THE PREPARATION OF FIRE-PROOF WRITING PAPER

By ROLLIN G. MYERS

Received May 22, 1916

The writer made a careful study of the methods for the preparation of fire-proof writing paper, as well as of the character of the paper obtained by such processes. He extended this work to include the paper produced from crysotile fiber when this was combined, as pulp, with white or lightly tinted precipitated compounds of the metals. These pulps were prepared at about 100° C.

The method used in the preparation of the paper was identical, in many respects, to that employed by the Japanese in the preparation of their hand-made paper from the vegetable and animal fibers. Each sample prepared was tested for porosity, tensile strength and permanence to temperatures varying from 900–1000° C. during a period of about 10 hours: 80 or 90 samples of paper were prepared.

The following inferences appear to be truthful interpretations of the experimental studies:

1—The commercial varieties of crysotile fiber used as raw material in the preparation of the paper were not to be distinguished in respect to mutability at high temperature, porosity, tensile strength and flexibility.

2—Within certain limits, variations in the quantity of the chemical reagents used for a given weight of fiber produced no observable gain in tensile strength and the reduction of porosity in the paper prepared.

3—Tensile strength and closeness of texture of the paper prepared appears to be obtained best from pulps containing precipitated hydroxides, arsenites, silicates and tungstates. Perhaps the best paper prepared, in respect to the properties referred to, was that obtained from a pulp containing a considerable excess of magnesium arsenite in an alkaline mixture. This paper was far in advance of any of the commercial papers examined.

It might be well to note that most of the above precipitates are flocculent in character, and that increase in closeness of texture and tensile strength is not always concurrent.

4—Substances like kaolin or pulverized mica, when incorporated with the pulps, do not seem to add anything to the paper produced.

5—In all the pulps, there exists a certain amount of adhesion between the fiber and the precipitated substance. This attraction is greatest for the precipitated salts of the more basic metals like calcium and magnesium, and least for the more acid metals like silver or lead. This adhesive effect may be due to some chemical action between the fiber and the precipitate.

6—The degree of porosity of all samples increased rapidly when they were heated for any length of time above 100° C., the cause of the increase of porosity being undoubtedly the contraction in bulk of the precipitated substance in the paper.

7—Tensile strength, and smoothness of surface only, seem to be enhanced by pressing with a warm iron.

8—From the identity of crysotile to "true asbestos" and the general character of the foreign substances used, the indications are pretty clear that no foreign substance either acting by itself or with others can increase the chemical stability of asbestos towards fire.

9—*Under the experimental conditions set for the heat or "fire test," i. e., a temperature varying from 900–1000° C. with a time interval of 10 hours, it seems probable that no paper composed of incombustible substances containing molecular water is fire-proof or can be made fire-proof.* This inference *can be extended to "true asbestos"* on account of its general similarity in properties and composition to crysotile.

It *is true*, however, that several samples of paper prepared by the writer, were not seriously impaired when exposed to a dull red heat for an hour or so. These samples still possessed considerable flexibility and could be handled, if a certain degree of care was used. There are some varieties of "true asbestos" which cling to their zeolitic(?) water with a great deal more persistence than crysotile. Paper made from asbestos of this sort would of course be quite well adapted for the preparation of, *e. g.*, fire-proof records. In general then, when lower temperatures and shorter time limits are considered, it is very probable that an entirely satisfactory fire proof paper can be prepared.

10—In respect to fire-proof inks, solutions of ferric, chromic and cobaltous nitrates and chlorides were used. They stood the "fire test" well. According to Franz Cirkel in the Canadian Government bulletin "*Asbestos—Its Exploitation and Uses*" no inks up to that time prepared would stand a red heat—excepting perhaps those produced from platinum. For inks other than those prepared from platinum, one condition seems to be necessary, that the acid oxides in the paper should be kept in excess.

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A HIGHLY UNSATURATED HYDROCARBON IN SHARK LIVER OIL

By Mitsumaru Tsujimoto

Received March 21, 1916

Although usually small in their quantities, hydrocarbons seem to occur in fatty oils more frequently than hitherto considered. Some of them may possibly be utilized for the identification of individual fats and oils.

P. Matthes and O. Rohdeck[1] isolated a hydrocarbon of the composition $C_{30}H_{48}$ from cacao butter. It was considered most likely identical with amyrilene. The former chemist, together with H. Sander,[2] obtained a hydrocarbon from laurel oil and named it laurane. It had the composition $C_{20}H_{42}$ and formed a fine needle crystal of m. p. 69° C. from its alcoholic solution. According to another investigation of Matthes and W. Heintz,[3] a hydrocarbon of the composition $C_{20}H_{42}$ (m. p. 69° C.) occurs in parsley seed oil and was named by them petrosilene. A hydrocarbon, $C_{31}H_{64}$ (m. p. 67–68° C.), is stated to occur in kôsam seed oil (Power and Lees).

In the domain of animal oils, especially in insect oils, hydrocarbons occur in considerable amounts and are characteristic of them. So, from chrysalis oil, Menozzi and Moreschi[4] isolated two hydrocarbons: one of them had the composition $C_{28}H_{58}$, melted at 62.5° C. and was optically active, while the other melted at 41–42° C. Further, hydrocarbons were obtained from cantharide and Melolontha oils.[5]

The study of substances, beside sterols, in the unsaponifiable matter of oils and fats, so-called "stearol-free unsaponifiable matter," has lately much attracted the interest of the oil chemist. These substances consist mainly of hydrocarbons, alcohols and ketones. Thanks to the classical researches of Windaus, an effectual means for the separation of sterols from these substances was introduced into fat analysis by the use of digitonin.

The reports of J. Marcusson and G. Meyerheim,[6] as well as P. Berg and J. Angerhausen,[7] have satisfactorily confirmed the importance of the investigation of a stearol-free unsaponifiable matter. The latter chemists have devised, on the ground of the examination of this matter, a differentiation method of mowrah and shea butters, the distinction of which is not feasible by ordinary fat analysis.

Of marine animal oils, shark liver oil contains, as is well known, a high percentage of unsaponifiable matter, and appears to furnish a very suitable material for the above-mentioned investigation. In the literature of fats, however, we find but meagre descriptions of the oil; some statements even appear to be conflicting at a glance.

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[1] *Ber.*, **1908**, 41.

[2] *Arch. d. Pharm.*, **1908**, 165.

[3] *Ber.*, **1909**, 325.

[4] *Rend. accad. dei Lincei*, **1908**, 95.

[5] Mosquito fat is likely to contain hydrocarbon (W. Normann, *Chem. Rev.*, **1913**, 187).

[6] *Z. angew. Chem.*, **1914**, 201.

[7] *Z. Nahr. Genussm.*, **1914**, Bd. 27, 723; Bd. 28, 73, 145.

C. Schaedler[1] and also L. E. Andes[2] described the sp. gr. of shark liver oils to be 0.870–0.875 (highest 0.880) at 15° C., and took oils of higher sp. gr. to be adulterated. G. Hefter,[3] on the other hand, rejected the above statement as incorrect, and assigned the values 0.910–0.916 at 15° C. Both statements are correct, however, as, according to the author's experience, shark liver oils of sp. gr. 0.8644 to 0.9323 at 15° C. were met with, the value varying according to the difference of the genus and species of sharks. The great variation on the other characteristics of the oil recorded in the literature may easily be understood as well.[4] Of the nature of the fatty acids of shark liver oil, no description is found even in the standard works on oils and fats, such as "Lewkowitsch" and "Benedikt-Ulzer."

The unsaponifiable matter of shark liver oil is usually stated to consist of cholesterol. Though cholesterol is invariably found in the oil, this statement is not valid, since substances besides cholesterol, notably hydrocarbons, are found in very large quantities in some shark liver oils.

It should be mentioned that the occurrence of hydrocarbons in shark liver oil has not yet been recognized by the authorities: but in Allen's "Commercial Organic Analysis," Vol. II, Part I (1899), p. 201, the following interesting note is found: The author examined four samples of presumably adulterated shark liver oil (sp. gr. 0.8661–0.8746 at 15.5° C.) and obtained 69.9–83.5 per cent of the ether-extraction residue (unsaponifiable matter). The residue was found to be a bright yellow color like the original oil. It was free from nitrogen and nearly free from oxygen, and gave when heated an unmistakable odor of pine resin. Allen took it, apparently erroneously, to be a mixture of light rosin oil with shale or petroleum lubricating oil, which have been added to the oil as an adulterant. In my opinion, the substances must have hydrocarbons, normally present.

The first report on the occurrence of hydrocarbons in shark liver oil is, so far as I know, the one published by the author some ten years ago.[5] The sample of shark liver oil used for examination was so-called "Kurokozamé" oil,[6] obtained from the liver of a shark caught in the Sagami Sea. The oil had the sp. gr. 0.8806 at 15.5° C.; saponification value 66.85, iodine value (Wijs) 281.47, and contained 56.13 per cent of unsaponifiable matter. The unsaponifiable matter was a light yellow oil of iodine value 381, which on brominating in an ethereal solution yielded a white precipitate of bromine addition compound. By elementary analysis, the latter substance was found to consist of 26.93 per cent C, 3.94 per cent H and 69.28 per cent Br, corresponding approximately to an empirical formula, $C_{10}H_{18}Br_4$. From this result the author inferred the existence of a highly unsaturated hydrocarbon of the composition $C_{10}H_{18}$ or $(C_5H_9)_n$.

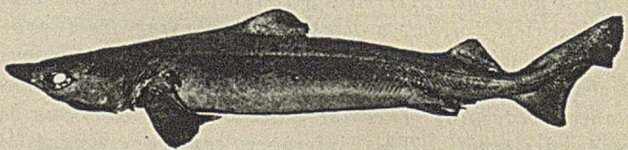
Lately, while engaging in the examination of marine animal oils, the author has often met with shark liver oils of high content of unsaponifiable matter. Hence the previous work was again taken up and has shown that hydrocarbons are important and characteristic constituents of some shark liver oils.

In the present preliminary report, the author describes two remarkable Japanese shark liver oils ("Ai-zamé" and "Heratsuno-zamé") whose contents of unsaponifiable matter amount to about 70–90 per cent. By the present investigation, the unsaponifiable matter of the oils has been confirmed to consist chiefly of hydrocarbons. The oils are therefore not fatty oils, but hydrocarbon oil, in which a comparatively small quantity of glycerides is present.

EXPERIMENTAL

SAMPLES OF SHARK LIVER OIL USED FOR EXAMINATION

Shark liver oil (Japanese: "Samé-abura") is obtained from the liver of sharks, fish belonging to *Selachoidei*. There are a great number of species of shark, but those which are caught for oil-yielding purposes are comparatively limited. The more common oil-sharks of Japan are as follows: Cat shark, Dog shark, Porbeagle, Basking shark, the Squaloid sharks (the most important shark belonging to this class is "Ai-zamé," *Squalus mitsukurii*) and the so-called "Black sharks" (Genii *Zameus*, *Lepidorhinus*, etc.).



AI-ZAMÉ (*Squalus mitsukurii*, JORDAN AND SNYDER)
Scale about 1/10

As a result of the author's experiments, it has been observed that more or less hydrocarbons occur in shark liver oils of specific gravity lighter than 0.900 at 15° C., the content increasing as the specific gravity becomes lighter. Ai-zamé and Heratsuno-zamé oils are the lightest shark liver oils examined; hence, they contain the highest proportions of hydrocarbons.

AI-ZAMÉ OIL is obtained from the liver of "Ai-zamé,"[1] *Squalus mitsukurii* (*Squalidae*), Jordan and Snyder, one of the common squaloid sharks of Japan. The liver of this shark is very rich in oil; hence, the fish is often called simply "Abura-zamé" (Abura = oil, Zamé = shark). There are two or more varieties of *Squalus mitsukurii*. "Ai-zamé" is the name given to a variety which lives in the sea near Tokyo, notably in the Sagami and Suruga Seas. The following samples of the oil were procured:

(1) This oil was prepared in the laboratory (May 7, 1915), from the fresh liver of an "Ai-zamé," caught

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[1] "Technologie der Fette und Oele," **1883**.

[2] "Animal Fats and Oils," **1904**.

[3] "Technologie der Fette und Oele, "Bd. II (1908).

[4] The variation may even be caused by the age and habit of fish, and also by local conditions. Cp. O. Polimanti, *Biochem. Z.*, **1915**, 145.

[5] Kôgyô-Kwagaku Zasshi, *J. Chem. Ind., Tokyo*, **1906**, 953. The report was published in Japanese only.

[6] "Kuroko-zamé" is probably a kind of "Kuro-zamé" (Black shark) of the genii *Zameus* and *Lepidorhinus*. But neither the exact genus nor species is known. (Japanese: "Samé" or "Zamé" = Shark.)

[1] The meaning of "Ai" in Japanese is not exactly known. The shark is known as "Tokyo dogfish."

in the Suruga Sea.[1] The fish (male) was 92 cm. in length (measured from tip of snout to root of upper lobe of caudal) and weighed 8.5 kg. The color of the body of the fish was pinkish gray, becoming lighter on the underside. The snout was pointed, the spiracles large, the spines in the two dorsals rather small. The grayish white-colored liver was found to occupy the greater part of the internal cavity, the weight reaching 2120 g., *i. e.*, about 25 per cent of the total body weight. The oil was prepared by carefully heating the chopped material in a porcelain basin on a sand bath, until the moisture had been nearly expelled. The yield of the oil was about 1615 g. The oil is a pale orange-yellow liquid of a peculiar, not unpleasant odor. When spread on the skin, a fishy smell was noticed in a little while. When stirred with a drop of concentrated sulfuric acid, a fine reddish violet coloration was developed.

(2) This oil was a commercial oil, procured from a fish oil factory at Yui-chô, Suruga (Shizuoka Prefecture). It was a pale orange-yellow oil of properties very similar to Sample 1. The coloration with concentrated sulfuric acid was yellowish brown.

The following values were determined with the above two samples:

AI-ZAMÉ OIL	(1)	(2)
Sp. gr. (15° C./4° C.)	0.8644	0.8662
Solidifying pt.	Below —20° C.	Below — 20° C.
Acid value	0.00	0.13
Saponification value	22.98	28.15
Iodine value (Wijs)(*a*)	344.63	330.35
Iodine value (Hübl)(*a*)	352.00	333.45
Refractive index (20° C.)	1.4930	1.4925
Fatty acids	10.62%	....
Neutralization value	168.52	....
Iodine value (Wijs)	119.25	....
Glycerol	0.52%	....
Unsaponifiable matter	90.17%	87.32%

(*a*) The time of standing was 2 and 24 hrs. with Wijs's and Hübl's solutions, respectively.

The mixed fatty acids gave, in ether solution, 16.55 per cent of polybromides, which turned black without melting at above 200° C. Glycerol was determined by the bichromate method; it was also qualitatively isolated by the acetone extraction method (Schukoff and Schestakoff). Since its percentage is a little less than the half of that calculated from the saponification value, a small quantity of some esteric compounds besides glycerides is doubtless present in the oil.

HERATSUNO-ZAMÉ OIL—"Heratsuno-zamé,"[2] *Deania eglantina* (Jordan and Snyder), is another squaloid shark which contains a large quantity of liver oil. The sample of the oil used for experiment was obtained from a "Heratsuno-zamé" caught also in the Suruga Sea. The fish (male) had a gray skin and a peculiar flattened head. The spine in the second dorsal was large and curved backward. It had a body length of 71.2 cm. and weighed 1.88 kg. The liver was of a grayish pink color and weighed 407 g. The oil was prepared in the same way as Ai-zamé oil. The yield was 338 g. (Nov. 29, 1915). The oil was a light yellow liquid. Its odor resembled that of Ai-zamé oil. Stirred with a drop of concentrated sulfuric acid, a violet-red coloration was developed. It had the following properties:

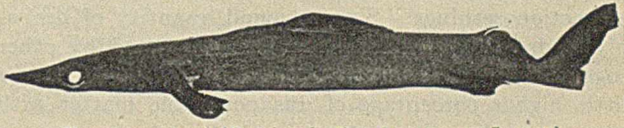
Sp. gr. (15° C./4° C.)	0.8721	Refractive index (20° C.)	1.4850
Solidifying pt.	At 20° C., solidified to a viscous mass	Fatty acids	26.59%
Acid value	0.49	Neutralization value	168.39
Saponification value	52.46	Iodine value (Wijs)	73.35
Iodine value (Wijs)	261.72	Glycerol	0.39%
Iodine value (Hübl)	259.16	Unsaponifiable matter	72.88%

The mixed fatty acids gave a very small quantity of ether-insoluble bromine additive compounds which turned black on heating. The glycerol was far less than calculated from the saponification value.

DETERMINATION OF UNSAPONIFIABLE MATTER

It is difficult and not in all cases possible to determine quantitatively the content of hydrocarbons in shark liver oils. But in the cases when no other substances besides cholesterol are present in the unsaponifiable matter together with hydrocarbons, the latter may be indirectly determined by deducting the amount of cholesterol from the total unsaponifiable matter. So far as the present shark liver oils are concerned, as will be seen later, the so-called stearol-free unsaponifiable matter may be taken to be practically identical with hydrocarbons.

(*a*) DETECTION OF HYDROCARBONS—The following method, essentially a combination of the well-known Spitz-Hönig's and Bömer's methods of determination of the unsaponifiable matter in fatty oil, has been tried with success to decide whether a given sample of shark liver oil contains hydrocarbons or not, and to determine their contents approximately. As cholesterol is very incompletely extracted by petroleum ether from soap solution, the residue of the extraction consists chiefly of hydrocarbons. When the residue has been found to be an oil, the presence of hydrocarbons may be stated with a possible certainty. The absence of hydrocarbons may be usually confirmed by a residue of a small quantity of crystals of melting point above 100° C.



HERATSUNO-ZAMÉ (*Deania eglantina*, JORDAN AND SNYDER)
Scale about 1/9

The operation adopted was as follows:

5–10 g. of the sample were saponified with 50 cc. of about normal (96 per cent) alcoholic KOH in a flask with a reflux condenser on a water bath for about 30 minutes to 1 hour. On cooling, the contents of the flask were washed out into a separating funnel with 50 cc. of distilled water and shaken with 100 cc. of petroleum ether (boiling point below 65° C.) for 1 minute.

The emulsion separated quickly into two layers. After standing for about one hour, the lower layer of the soap solution was drawn off into a beaker. The petroleum ether layer was washed successively with 20 cc. of 50 per cent alcohol and distilled water, each two times, and the alcohol washings added to

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[1] The date has been mentioned, because the season appears to influence the properties of fish oils.

[2] "Hera" = spatula, in allusion to the flat head of the fish. "Tsuno" = spine; "Zamé" = shark.

the soap solution; then the petroleum ether layer drawn off into a small tared flask, the ether distilled off and the residue dried to a constant weight at 105° C. in a current of dry carbon dioxide gas. This residue consisted mainly of hydrocarbons.

The soap solution in the beaker was heated on a water bath (to expel the greater part of alcohol), then transferred into a separating funnel and extracted with each 100 cc. of ether three times. If an emulsion forms, it may be easily subsided by the addition of alcohol. The ether extracts were united and washed with distilled water; the ether was then distilled off in a tared flask, the residue dried and weighed as above.

As already stated, since cholesterol is extracted only to a small extent by petroleum ether from the soap solution, the residue of the second extraction by ether contains the main part of cholesterol. As a matter of fact, hydrocarbons are not completely extracted by a single extraction with petroleum ether, as may be expected from the distribution law. In the case of the oil of low saponification value, the petroleum ether extract gives the rough content of hydrocarbons. But if the quantity of saponifiable matter is large, considerable proportions of hydrocarbons are retained in the soap solution, so that the above number is not exact even approximately. The total unsaponifiable matter is the sum of the two extraction residues. Since a small quantity of probably hydrolyzed soap is sometimes extracted by ether together with cholesterol, the result is liable to give a little higher percentage of unsaponifiable matter with respect to the ether extract.

The following results (percentages) were obtained with the samples of shark liver oil:

OIL	Petroleum ether extract	Ether extract	Total unsaponifiable matter
Ai-zamé (1)	87.20	2.97	90.17
Ai-zamé (2)	83.06	4.26	87.32
Heratsuno-zamé	58.20	14.68	72.88

The petroleum ether extracts were faintly yellow to nearly colorless liquid, sometimes with a small deposit of apparently cholesterol crystals. The ether extracts were a pale yellow crystalline mass admixed with more or less liquid constituents (hydrocarbons). A few properties of these extracts were as follows:

OIL	PETROLEUM ETHER EXTRACTS Iodine value (Hübl)	LIEBERMANN'S TEST	MIXED WITH ALCOHOLIC DIGITONIN SOLUTION
Ai-zamé (1)	370.80	Bluish gray, finally dirty yellowish orange	Almost no ppt.
Ai-zamé (2)	378.17	......	Almost no ppt.
Heratsuno-zamé	360.82	Bluish violet, finally dirty orange	Ppt. formed
		ETHER EXTRACTS	
Ai-zamé (1)	....	Reddish violet, finally dark green	Ppt. formed
Ai-zamé (2)	187.95	......	Ppt. formed
Heratsuno-zamé	119.80	Violet-red, finally bluish green	Ppt. formed

The exceptionally high iodine value of the petroleum ether extracts is very characteristic. It indicates the occurrence, in these oils, of a hydrocarbon found by the author in "Kuroko-zamé" oil for the first time (*Loc. cit.*). As may be seen below, this was actually the case with the samples of these shark liver oils. The presence of stearol in the ether extracts has been confirmed by the Liebermann and digitonin tests.

DETERMINATION OF CHOLESTEROL—Cholesterol was determined by the digitonin method. It has been shown by M. Klostermann and H. Opitz[1] that a part of the cholesterol in cod liver oil occurs in the form of esters; this was also found to be the case with shark liver oil.

For the determination of the total content of cholesterol, 10 g. of Ai-zamé oil, or 5 g. of Heratsuno-zamé oil were saponified with alcoholic KOH, the soap decomposed with dilute sulfuric acid and shaken with ether. The ether layer was well washed with water and then dehydrated by means of anhydrous sodium sulfate. The residue left in a flask by evaporating off the ether was mixed with 50 cc. of 1 per cent digitonin solution in 90 per cent alcohol and vigorously shaken while hot for several minutes. After standing for two or more hours, the content of the flask was filtered in a tared Gooch crucible containing layers of filter paper and cotton. As the digitonide formed an emulsion-like mixture with the hydrocarbons, about 10 cc. of chloroform were next added to dissolve the latter substances. When the precipitate had been transferred into the crucible, it was washed with 90 per cent alcohol and finally with ether. The whole was dried at 105° C. and weighed. Free cholesterol was determined by a similar method by directly treating the original oils with digitonin solution. The weight of cholesterol was calculated from the weight of the digitonide by multiplying by the factor 0.2431. The results obtained were as follows:

PER CENT CHOLESTEROL:	Free	Combined	Total
Ai-zamé oil (1)	0.09	0.46	0.55
Heratsuno-zamé oil	0.61	0.63	1.24

Cholesterol acetate obtained by treating the digitonide with acetic anhydride melted at 112–113° C.

If we assume the unsaponifiable matter of the shark liver oils to consist of cholesterol and hydrocarbons only, then the content of the hydrocarbons is obtained by deducting the content of cholesterol from the total unsaponifiable matter, as follows:

Ai-zamé oil (1), 89.62 per cent	Heratsuno-zamé oil, 71.64 per cent

SEPARATION OF HYDROCARBONS

The petroleum ether extracts obtained in the previous experiments were presupposed to be a hydrocarbon or hydrocarbons. In order to determine whether they really consisted of a hydrocarbon or a mixture of hydrocarbons, and if any other constituents are contained in them, the following experiments were performed. Essentially, the volatility of the substances under a reduced pressure was utilized for their isolation and identification.

AI-ZAMÉ OIL (1)

FRACTIONAL DISTILLATION OF STEROL-FREE UNSAPONIFIABLE MATTER—One hundred g. of the oil were saponified with 10 g. of KOH in 10 cc. of water and 90 cc. of 96 per cent alcohol in a flask. The saponified solution, consisting of two layers (the upper hydrocarbon and the lower, chiefly soap solution), was

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[1] *Z. Nahr. Genussm.*, Bd. 27, Heft 10.

transferred into a separating funnel by washing the flask with 100 cc. of distilled water. It was then extracted with 200 cc. of light petroleum ether. The lower soap solution was drawn off, the ether layer well washed with 50 per cent alcohol and water, and then the petroleum ether distilled off.

The crude hydrocarbon thus obtained was mixed with 20 cc. of 1 per cent digitonin solution in 95 per cent alcohol and allowed to stand over night. The lower layer of hydrocarbon was then drawn off; from the upper alcoholic layer, in which the separated digitonide was chiefly suspended, the alcohol was evaporated; the residue was treated with 200 cc. of ether and mixed with the previously drawn hydrocarbon. Since digitonide and digitonin are insoluble in ether, they were deposited from the ether solution as white precipitates; these were filtered off. Finally, the ether was evaporated from the clear ethereal solution, and the stearol-free hydrocarbon, a pale yellow oily liquid of faint peculiar odor, was left. The yield from 100 g. of the oil was 79 g. (79 per cent by weight) of a colorless liquid.

Fifty grams of the hydrocarbon thus obtained were put in a distillation flask of about 100 cc. capacity, and fractionally distilled under 8 mm. pressure.

The first drop of the distillate was observed at 280° C. bath temperature; the continuous distillation began at 240° C. (temperature of the bath, 288° C.), the thermometer soon rising to 256° C. The specific gravities and refractive indices of the original substance, as well as these fractions, were determined:

FRACTION	1	2	3	4	5	TOTAL
Temperature Oil Bath..........	291	289	289	288	286–7° C.	
Temperature Distillation.......	256	256	256	256	256° C.	
Yield, grams.....	8.0	9.7	9.7	10.4	11.5	49.3
Specific gravity (15/4° C.).....	0.8540	0.8580	0.8589	0.8584	0.8589	(Original) 0.8570
Refractive Index (20° C.).......	1.4925	1.4963	1.4963	1.4962	1.4962	1.4955

Thus, the substance had a constant boiling point and its fractions showed nearly concordant values with respect to specific gravities and refractive indices. It appears, therefore, to consist mainly of a single chemical compound, although a small quantity of a substance of lower boiling point is likely to be present in the first fraction.

The elementary analysis of the substance and of Fraction 3 gave the following results:

0.1785 g. original substance gave 0.5741 CO_2, 0.1972 H_2O; C = 87.71 per cent, H = 12.36 per cent.

0.1816 g. Fraction 3 gave 0.5817 CO_2, 0.1979 H_2O; C = 87.36 per cent, H = 12.19 per cent.

Molecular weight of Fraction 3 (freezing point method, benzene as solvent) = 413.

$C_{30}H_{50}$ requires C = 87.72 per cent, H = 12.28 per cent, mol. wt. = 410.40.

$C_{30}H_{48}$ requires C = 88.17 per cent, H = 11.83 per cent, mol. wt. = 408.38.

The above results agree more closely with the formula $C_{30}H_{50}$.

FRACTIONAL DISTILLATION OF THE OIL—By the later experiments, it has been found that in order to obtain the hydrocarbon in pure state, the previous separation of stearol-free unsaponifiable matter is not necessary, and the original oil or crude unsaponifiable matter may be directly distilled for this purpose, since cholesterol is nonvolatile at the temperature and pressure at which the hydrocarbon distils over. Hence the following experiment was tried: 50 g. of Ai-zamé oil (1) were fractionally distilled under 10 mm. pressure. The distillates were colorless and contained a small quantity of free fatty acids, as may obviously be expected; the later fractions were of fairly pure quality.

FRACTION	1	2	3	4	5	TOTAL
Temperature Oil Bath..........	290	292	292.5	295–8	293–303° C	
Temperature Distillation.......	262–4	264	264–5	265	265° C.	
Yield, grams.....	7.6	8.0	9.0	9.0	7.2	40.8
Acid value.......	0.99	0.21	....	....	....	
Refractive Index (20° C.).......	1.4940	1.4963	1.4965	1.4965	1.4965	

ELEMENTARY ANALYSIS OF THE FRACTION (4). 0.1622 g. gave 0.5183 CO_2 and 0.1765 H_2O: ∴C = 87.15 per cent, H = 12.18 per cent.

The above composition corresponds to the formula $C_{30}H_{50}$.

AI-ZAMÉ OIL (2)

The stearol-free substance was prepared by the same method as from Ai-zamé oil (1). Fifty grams of the pale yellow substance were fractionally distilled at 11 mm. pressure. The first drop was observed at 256° C. (bath 294° C.); then the thermometer rapidly rose to above 260° C. The distillates were colorless.

FRACTION	1	2	3	4	5	TOTAL
Temperature Oil Bath..........	304	300	294	294	295–306° C.	
Temperature Distillation.......	265–268	268	368	268	268° C.	
Yield, Grams....	10.6	10.6	10.5	10.8	6.5	49.0
Specific gravity (15/4° C.).....	0.8574	0.8584	0.8586	0.8587	0.8546	(Original) 0.8586
Refractive Index (20° C.).......	1.4955	1.4965	1.4965	1.4965	1.4968	1.4960

The elementary analysis gave the following results:

0.1943 g. original substance gave 0.6258 CO_2, 0.2121 H_2O: ∴ C = 87.84 per cent, H = 12.21 per cent;

0.1932 g. of fraction 3 gave 0.6230 CO_2, 0.2079 H_2O: ∴ C = 87.94 per cent, H = 12.14 per cent.

Hence, the substance consists of the hydrocarbon $C_{30}H_{50}$.

HERATSUNO-ZAMÉ OIL

The direct distillation method was adopted with this oil. But, since Heratsuno-zamé oil contains a far higher percentage of esteric compound than Ai-zamé oil, the separation of hydrocarbon was better accomplished by resorting to redistillation: 100 g. of the oil were distilled under 4.5 to 5 mm. pressure: the yield of the distillate was 58 g. The main part distilled at 250–260° C., but it was found that a small fraction distilling at a temperature below 250° C. at 5 mm. was also present. Then, the distillate was well washed with alkali to remove the admixed fatty acids: 40 g. of this refined substance were fractionally distilled under 5 mm. pressure. The distillates were colorless.

FRACTION	1	2	3	4	5	6	TOTAL
Temp. Oil Bath.....	285	288	286	284	285	287° C.	
Temp. Distillation to	248	248–52	252	252	252	252	
Yield, grams........	1.4	6.6	7.2	7.2	7.2	7.5	37.1
Sp. gr. (15/4° C.)...	0.8189	0.8581	0.8589	0.8589	0.8589	0.8590	
Ref. Index (20° C.).	1.4633	1.4950	1.4955	1.4962	1.4961	1.4960	

Fraction 1 had a lower boiling point and considerably lower specific gravity and refractive index. The properties of the other fractions nearly coincided with those of the hydrocarbon $C_{30}H_{50}$, isolated from Ai-zamé oil.

The elementary analysis and molecular weight determination of Fractions 1 and 4 gave the following results: 0.1565 g. Fraction 1 gave 0.4925 CO_2, 0.1928 H_2O: ∴ C = 85.82 per cent, H = 13.78 per cent; Mol. wt. = 288.

$C_{28}H_{38}$ requires C = 86.24 per cent, H = 13.76 per cent; Mol. wt. = 278.3.

Fraction 1 was thus confirmed to be a hydrocarbon, but that it really consists of a single compound requires further confirmation.

0.1880 g. Fraction 4 gave 0.6024 CO_2, 0.2066 H_2O: ∴ C = 87.39 per cent; H = 12.31 per cent.

This fraction was thus confirmed to be the hydrocarbon $C_{30}H_{50}$.

As the result of the above-described experiments, it has been concluded that the stearol-free unsaponifiable matter of Ai-zamé and Heratsuno-zamé oils mainly consists of a new hydrocarbon of the empirical formula $C_{30}H_{50}$. Besides this hydrocarbon, a small quantity of a hydrocarbon or hydrocarbons of lower boiling point is also present in these oils, especially in Heratsuno-zamé oil.

PROPERTIES OF THE HIGHLY UNSATURATED HYDROCARBON

So far, it has been shown that a highly unsaturated hydrocarbon, $C_{30}H_{50}$, occurs in Ai-zamé and Heratsuno-zamé oils in high proportion. Since the oils consist mainly of unsaponifiable matter, the hydrocarbon is in reality the chief constituent of these oils. A closer study of this interesting hydrocarbon will be very important from technical, and particularly from physiological points of view, as the occurrence of a large quantity of a hydrocarbon in animal oils is a matter of rarity. The experiments with this hydrocarbon, imperfect as they are, are described below:

The sample of the hydrocarbon was obtained from Ai-zamé oil (1): 100 g. of the oil were saponified and the crude hydrocarbon extracted by petroleum ether (yield, 117 g.); 108 g. of this substance were treated with 0.5 g. of digitonin, and 101 g. of the stearol-free substance were obtained; 100 g. of the latter substance were distilled under 10 mm. pressure. Discarding this first fraction, the distillates of boiling points of 262–264° C. (temperature of the oil bath, 294–296° C.) were collected (yield, 83.5 g.): 80 g. of this distillate were redistilled under 9.5 mm. pressure. Discarding again the first fraction, the distillates of boiling points of 259–264° C. (temperature of the bath, about 300° C.) were collected (yield, 70.3 g.). This substance was used as the sample for investigation. The discrepancy of the boiling points is probably due to the rapid heating of the oil bath.

To confirm the correctness of the formula $C_{30}H_{50}$, the following elementary analysis and molecular weight determination were repeated.

(1) 0.1886 substance gave 0.6033 CO_2, 0.2093 H_2O.
(2) 0.1553 substance gave 0.4994 CO_2, 0.1709 H_2O.

C = 87.43 per cent, 87.70 per cent; H = 12.41 per cent, 12.30 per cent.

$C_{30}H_{50}$ requires C = 87.72 per cent, H = 12.28 per cent.

0.4020 substance in 11.7470 benzol gave d = 0.42° C.

Mol. wt. = 408. Mol. wt. of $C_{30}H_{50}$ = 410.4.

The hydrocarbon is a colorless, oily liquid which refracts light somewhat strongly. In the pure state, it is nearly odorless; but the distilled sample possesses a faint odor, apparently of decomposition products, which can be removed by washing with alkali. On keeping, it involves an odor which recalls some terpenes. Its taste is peculiar, but not so unpleasant. It is readily soluble in ether, petroleum ether, carbon tetrachloride and acetone; in cold alcohol and glacial acetic acid, it is sparingly soluble. When heated over a flame, the hydrocarbon burns with a smoky, luminous flame, emitting a resinous smell.

BOILING POINT—Under ordinary pressure, the hydrocarbon cannot be distilled without decomposition. Boiling point (10 mm. pressure), 262–264° C.; (5 mm. pressure) 252–254° C.

SOLIDIFYING POINT—Kept at —20° C. for one hour, it remained clear; at —75° C., it solidified to a white wax-like mass.

SPECIFIC GRAVITY—At 15°/4° C., 0.8587.

IODINE VALUE—388.12 (Wijs), 398.70 (Hübl).

Theory requires for $C_{30}H_{50}I_{12}$, iodine value = 371.10.

REFRACTIVE INDEX—(20° C.) 1.4965.

OPTICAL ROTATION—inactive.

HEAT OF COMBUSTION—(Hempel's calorimeter), 10,773 cal. per g.

COLOR REACTION—By Liebermann's test (solution in acetic anhydride and addition of a drop of concentrated sulfuric acid), the fresh hydrocarbon gave only a faint pink coloration in the lower (acetic anhydride) layer.

DRYING PROPERTY—The hydrocarbon dries like the vegetable drying oils. The pure hydrocarbon requires a long time to dry at the ordinary temperatures. That which had been treated with 1 per cent of cobalt resinate, dried in about 10 days (in winter) to a colorless, smooth film which possessed a firmness superior to those of the fatty oils. At 100° C., a thin layer of the hydrocarbon dried in about 2 hours.

ACTION OF ACIDS—Concentrated sulfuric acid attacked the hydrocarbon violently with evolution of heat, changing it to a dark reddish brown mass. Concentrated nitric acid acted not so violently. A very violent reaction was observed by a mixture of concentrated nitric and sulfuric acids.

ACTION OF ALKALIES—Even caustic alkalies had practically no action at 100° C.

ACTION OF SULFUR CHLORIDE—A yellow solid mass was obtained.

PICRATE COMPOUND—No definite compound was obtained.

BROMIDE ADDITIVE COMPOUND—0.6326 g. of the hydrocarbon was dissolved in 10 cc. of ether in a flask, the solution cooled with ice, and 0.55 cc. of bromine was added drop by drop. After standing for 2 hours, the precipitate was filtered on a tared filter paper, washed with about 70 cc. of ether and dried *in vacuo*, over sulfuric acid, until the weight became constant.

The yield of the insoluble bromide was 0.5630 g., *i. e.*, 89.00 per cent of the sample.

0.1467 substance gave 0.1413 CO_2, 0.0496 H_2O.

0.1587 substance gave 0.2600 AgBr (Carius method).

C = 26.27 per cent, H = 3.78 per cent, Br = 69.75 per cent.

$C_{30}H_{50}Br_{12}$ requires C = 26.78 per cent, H = 3.72 per cent, Br = 69.50 per cent.

The filtrate from the above precipitate was treated with sodium thiosulfate solution, in order to remove the excess of bromine, washed with water and dried with anhydrous sodium sulfate. On evaporating off the ether, a viscous solid was left, which became a white powder on grinding. The yield was 1.6070 g., *i. e.*, 254.00 per cent of the original sample. The soluble bromide was then treated with a few cc. of ether to remove admixed impurities, and analyzed.

0.1157 substance gave 0.1117 CO_2, 0.0391 H_2O.

0.1664 substance gave 0.2710 AgBr.

C = 26.33 per cent, H = 3.78 per cent, Br = 69.30 per cent.

This substance is, therefore, identical with the insoluble portion.

The total yield of the bromide is thus 333 per cent. Theory requires 327.60 per cent, nearly a good accord. The bromine additive compound is a white powder, turning black at about 170° C. and decomposing at 176–177° C. It is sparingly soluble in organic solvents, especially when dried.

The bromide obtained from "Kuroko-zamé" oil described in the introductory note, is the same substance as this brominated hydrocarbon. The analytical results given there correspond more closely with $C_{30}H_{50}Br_{12}$ than $C_{10}H_{18}Br_4$. Therefore, the hydrocarbon in the above-named shark liver oil must have been the hydrocarbon $C_{30}H_{50}$.

HYDROGENATION COMPOUND—3.3115 g. of the hydrocarbon were dissolved in 30 cc. of ether in a shaking bottle. To this solution, 0.5 g. of Loew's platinum black was added. The bottle was then connected to a gas burette, which in turn was connected with a hydrogen holder. Hydrogen was prepared from pure zinc (Merck) and dilute sulfuric acid, and before entering into the burette, it was washed and dried by bottles containing a solution of potassium permanganate and concentrated sulfuric acid. By vigorously shaking the bottle, hydrogen was conducted into it under the mercury pressure. After 2 hrs. 40 mins., the absorption ended; the volume of hydrogen absorbed, together with a little leakage, was 1120 cc. The hydrogenated compound, left on evaporating off ether, was found to be a colorless oil, resembling in its appearance the so-called liquid paraffin. It had the following properties: Sp. gr. at 15/4° C., 0.8125; b. p. (10 mm. pressure), 274° C.; solidifying pt.: at —20° C. it remained clear and mobile; at —80° C., solidified to a transparent jelly which at —35° C. regained its mobility; ref. index at 20° C., 1.4525. It was not readily acted on by concentrated sulfuric acid, even at 100° C.

ELEMENTARY ANALYSIS: (1) 0.1610 substance gave 0.5022 CO_2, 0.2114 H_2O.

(2) 0.1910 substance gave 0.5959 CO_2, 0.2523 H_2O.

C = 85.07, 85.09 per cent; H = 14.69 per cent, 14.78 per cent.

$C_{30}H_{62}$ requires C = 85.21 per cent, H = 14.79 per cent.

Molecular weight determination, by freezing point method, 0.2982 substance in 11.1030 benzol, d = 0.31° C. Mol. wt. = 433.

$C_{30}H_{62}$ requires mol. wt. = 422.5.

The substance has therefore been confirmed to be a compound of the empirical formula $C_{30}H_{62}$. As $C_{30}H_{62}$ is of a type of the general formula C_nH_{2n+2}, it appears that the hydrocarbon $C_{30}H_{50}$ belongs to the aliphatic compounds.

PREPARATION AND APPLICATION OF THE HYDROCARBON

Ai-zamé and Heratsuno-zamé oils are produced in somewhat large quantities in certain districts of Japan, especially in Shizuoka Prefecture. So the preparation of the hydrocarbon is practicable even for commercial purposes; all the more so, as the author has lately ascertained the presence of the hydrocarbon in other shark liver oils besides the above mentioned ones. (See below.)

The preparation of the hydrocarbon is, according to the author's experience, best conducted by distilling the oil under reduced pressure, or by means of superheated steam.[1] Since cholesterol is comparatively nonvolatile, the distilled hydrocarbon contains more or less admixed fatty acids. Therefore, by subsequent washing with alkali, it can be obtained in nearly pure state.

As to the use of the hydrocarbon, only a few experiments have been tried as yet, and exact descriptions cannot be given here. It may be mentioned, however, that for technical purposes, the hydrocarbon may be used for paints, varnishes, lithographic inks, and oil colors. The hydrogenated product, which in its appearance is very similar to so-called liquid paraffins and, at the same time, far more stable for cold, will be a useful material for lubrication of machines.

The medicinal use of the hydrocarbon, possible for the same purpose as cod liver oil, will perhaps be most interesting, but careful researches are necessary to settle this question.

CONCLUSIONS

The results of the present investigation have confirmed that two Japanese shark liver oils, Ai-zamé and Heratsuno-zamé oils, contain very high proportions of unsaponifiable matter which mainly consist of a new highly unsaturated hydrocarbon of the formula $C_{30}H_{50}$. It will be rather premature to make any further statement, but certainly a remarkable quantity of a hydrocarbon which in reality is the essential constituent of the oil itself, occurs in oils of such vital organs as the liver of the fish. It may be added here from the author's latest experiments that the hydrocarbon also occurs in the liver oils of so-called "Black sharks," basking sharks and another

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[1] Japanese Patent, No. 28,143, Aug. 4, 1915.

shark (probably *Triakis scyllium*—Japanese; "Korozamé"). Sharks belonging to Squalidae appear to contain the hydrocarbon more frequently. But, the data obtained hitherto are yet too scanty to allow a generalization as to the genus and species of sharks.[1]

To solve the question, why such a hydrocarbon is present in the liver of some fish, is probably very difficult, and presents an important problem for physiological chemistry. It is interesting to note that the bromine content of the bromine additive compound of the hydrocarbon is nearly identical with those of the polybromides of the highly unsaturated fatty acids[2] in marine animal oils, *viz.*, about 70 per cent.

In the case of the present shark liver oils, the place of the highly unsaturated fatty acids is taken, as it were, by the hydrocarbon of a nearly equally high unsaturation. The liver is a storage organ for fat and consequently a source of energy of the fish. If a speculation may be allowed, the hydrocarbon, which evolves far more heat of oxidation than the glycerides, must have been formed in the liver of the fish from the necessity of local conditions. Little as the habit of the sharks is known, it is pretty certain that they are comparatively deep sea dwellers.

For technologists, the hydrocarbon is not less important. The "drying" properties of glycerides (vegetable drying oils) and certain phenols, such as Urushiol, $C_{20}H_{30}O_2$, the chief constituent of Japanese lacquer, are well known, but yet those of the hydrocarbons have not been investigated.

In a second paper on this subject, the author hopes to publish the results of the latter experiments, performed on other shark liver oils, and an examination of the further properties of the hydrocarbon.

ADDENDUM—After the foregoing report had been written, the author read a paper by H. Mastbaum (Lisbon), entitled "Hydrocarbon in Fish Liver Oils," through *Chemical Abstracts*, **10**, No. 2, just arrived. The author has examined two liver oils from *Centrophorus granulosus* and *Scymnus lichia*, and found 80–90 per cent of oil with the characteristic of mineral oil. The unsaponifiable portion of the oil from *Scymnus lichia* is said to have boiled at 205–330° C. (under the ordinary pressure?). As no analytical result of the unsaponifiable matter is given, it is not possible to decide whether they contained the hydrocarbon $C_{30}H_{50}$ or not. But, as the former shark belongs to *Squalidae*, the hydrocarbon in the oil is doubtless the same. From this report, it may be seen that the liver oil of foreign squaloid shark also contains hydrocarbon. Although not the only one of the kind, the family *Squalidae* seems to have a more important relation to the hydrocarbon than other families. From such reasons, and particularly from the fact that the author has discovered the hydrocarbon first in the liver oils of the squaloid sharks, he proposes the name "*Squalene*" for the hydrocarbon.

IMPERIAL INDUSTRIAL LABORATORY
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February, 1916

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[1] Oils prepared from the following sharks have been found not to contain the hydrocarbon. Cat shark (*Heterodontus japonicus*), Blue shark (*Isuropsis glauca*), Porbeagle (*Lamna cornubica*), Saw shark (*Pristiophorus japonicus*), Hammer-headed shark (*Sphyrna zygaena*), and Angel-fish (*Squatina japonica*). Nor has the hydrocarbon been found in the liver oils from the following rays: Ray (*Raja kenojei*), Sting-ray (*Dasyatis akajei*), Eagle-ray (*Myliobatis tobiei*), and *Discobatus sinensis* (Japanese; "Uchiwa-zamé").

Shark liver oils from probably *Squalus sucklii* contained 12.00 to 21.64 per cent of unsaponifiable matter, not volatile at 300° C. under 10 mm. pressure. The nature of the substance has not yet been ascertained. Details will be published in a next report.

[2] Acids of the series $C_nH_{2n-8}O_2$ and $C_nH_{2n-10}O_2$.

AERATION METHOD FOR AMMONIA

By B. S. DAVISSON, E. R. ALLEN AND B. M. STUBBLEFIELD

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Investigations in soil biology require frequent exact determinations of ammonia in the presence of organic nitrogenous compounds. The problem is therefore the same as that encountered in general biological chemistry with the additional difficulty that large amounts of solutions must be used in soil biological work because of the smaller percentage of ammonia in the material under examination. For instance, in biological chemistry, in the determination of ammonia in urine, 25 to 50 cc. portions of urine are taken, whereas in soil biology 250 cc. of soil extract or of physiological solution are frequently necessary to give a measurable amount of ammonia nitrogen.

The matter of the separation of ammonia from organic nitrogen has been the subject of a very large amount of study by biological chemists. The tendency of all recent work has been toward the use of an air current to transfer the ammonia from cold alkaline solution into acid receivers and determination of the ammonia by titration (or Nesslerization) of the receiver contents. The use of larger amounts of solutions naturally renders the removal by the air current slower. Moreover the matter of the kind and concentration of alkali is still a matter of controversy among workers in this field. Obviously, the lowest hydroxyl ion concentration compatible with complete removal of ammonia under workable conditions is desirable since decomposition of the organic nitrogenous material is roughly proportional to the concentration of hydroxyl as ion.

The use of different alkalies, and their effect on the rapid removal of ammonia from large amounts (250 cc.) of solution by means of a vigorous air current, and its subsequent quantitative collection and measurement constitutes the experimental work reported in this paper. It was desired to obtain a method by which the ammonia can be recovered in a period of $2^1/_2$ to 3 hrs. and, if possible, the use of an alkali imparting a low concentration of hydroxyl as ion to the solution.

HISTORICAL

Folin[1] outlined a method for determining ammonia in urine: 25 cc. of urine were aerated for 1 to $1^1/_2$ hrs. over 1 g. of sodium carbonate and 8 to 10 g. of sodium chloride. The rate of air used was 600 to 700 liters per hour. The ammonia was absorbed in standard acid and titrated with standard alkali. He devised the well-known Folin absorption tube by which he was able to get complete absorption of the ammonia. He used MgO for some determinations

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[1] Folin, *Z. physiol. Chem.*, **37** (1912), 161.

of ammonia in pure solutions and complete recovery was obtained. However, no data are reported for aeration of urine over MgO. Steel[1] proposed the use of sodium hydroxide and saturation of the solution with sodium chloride, but this alkali has been subsequently shown to be stronger in its action on organic nitrogenous compounds than the sodium carbonate.

Kober[2] recommended the use of the air current for the transfer of ammonia from the strongly alkaline solution of the Kjeldahl method, to the standard acid. He does not report the rate of aeration but states that the rate is increased as much as possible without losing any of the absorbing acid in the cylinder. The distillation is complete in one hour. After the aeration is complete the acid is titrated with standard alkali. Kober and Graves[3] report further work on this same point. The rate of aeration used was 500 liters per hour. The rate was measured by displacement of a known volume of water by the air current drawn by the pump. They were able to remove large quantities of ammonia in one hour.

Pennington and Greenlee[4] report some determinations on chicken meats. They determined the loosely bound nitrogen in protein-rich tissues of meats. The work reported was done on chicken meats which had undergone some bacterial and enzyme decomposition. Twenty-five grams of chicken meat were suspended in 250 cc. water and 5 g. of MgO added. The suspension was aerated and the ammonia absorbed in standard acid. The rate of aeration was about 1,250 liters of air per hour through each aeration flask.

Potter and Snyder[5] report on the determination of ammonia in soils by aeration over sodium carbonate. They show conclusively that the alkali as recommended by Steel[6] for determining ammonia in urine, decomposes organic nitrogenous compounds of the soil and give ammonia. They ascribe this largely to the decomposition of acid amides. Acetamide failed to give a very appreciable amount of ammonia when aerated with sodium carbonate. They conclude that sodium carbonate will not decompose acid amides to yield ammonia as does sodium hydroxide. They aerated 25 g. of soil in 50 cc. of ammonia-free water and about 2 g. of sodium carbonate for a period of 19 hrs. The rate reported in this work was 250 liters per hour. At the end of the aeration period the acid solutions were titrated with standard alkali. The results are reported for 100-g. samples of soil. The average amount of ammonia found was about 1 to 1.4 mg. per 100 g. of soil. They added quantities of ammonia to soil and in most cases they were able to recover better than 99 per cent of the added ammonia. The addition of the salts NaCl and $K_2C_2O_4$ did not aid in the recovery of the ammonia of the soil.

We find very little attention has been given to the liberating of ammonia from solutions by MgO. Other alkalies have been used and it is well established that large quantities of ammonia can be determined by aeration and in a comparatively short time when the rate of aeration is high. The rate of aeration has been slow in most cases and the quantity of solution aerated has been small except in Kjeldahl determinations. The lack of a uniform method of measuring the rate of aeration makes any correlation of the work from different laboratories hard.

EXPERIMENTAL

AMMONIA-FREE WATER—The distilled water used in this work was prepared by double distillation of live steam through dilute $CuSO_4$, and this then passed through a scrubber before condensation. The water showed no traces whatever of ammonia with Nessler's reagent, and was neutral to methyl red.

AMMONIA-FREE MAGNESIA—The magnesium oxide was calcined before being used.

AMMONIA SOLUTIONS—The ammonia solutions were prepared from ammonium sulfate and standardized by distilling over MgO. For small quantities of ammonia $N/50$ H_2SO_4 was used and for larger quantities $N/10$ H_2SO_4 was used.

INDICATOR—Methyl red was used as the indicator in all titrations. The CO_2 was expelled from all solutions before titrating.

The method of measuring the rate of aeration is that suggested by Kober.[1] Attention is called to the fact that the tube through which the water passes should be sufficiently large to prevent the speed of the pump being checked at any time. Theoretically, the friction of the water passing through any tube would retard the rate of flow. However, in the apparatus used in this work tubes of 11 mm. internal diameter were employed, and when this apparatus operated in series with the aeration flasks, there was no perceptible decrease in the rate of bubbling in the latter.

The measurement of the air should give the amount which actually passes through the apparatus and not that amount which the pump is capable of pulling when there is no load. The rate as measured by some workers does not give the amount of air which passes through the apparatus. They measure the capacity of the pump and take this value for the rate of aeration used. Measured through the apparatus, the rate would be found very much lower. This important point has been overlooked by workers in this field and renders impossible the comparison of results from different laboratories.

The rate of aeration reported in this work gives the amount of air which passed through the apparatus. The Crowell pump, which was used, was capable of handling 2100 liters of air per hour, with no load. However, when drawing air through the apparatus, the rate was reduced to 1080 liters per hour, because of the resistance of the solutions in the ten flasks.

The first work was carried on with sodium carbonate as the alkali. Five hundred cc. Kjeldahl flasks were used as aeration flasks and the regular Folin tubes

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[1] Steel, *J. Biol. Chem.*, **8** (1910), 365.

[2] Kober, *J. Am. Chem. Soc.*, **30** (1908), 1131.

[3] Kober and Graves, *Ibid.*, **35** (1913), 1594.

[4] Pennington and Greenlee, *Ibid.*, **32** (1910), 561.

[5] Potter and Snyder, THIS JOURNAL, **7** (1915), 221.

[6] *Loc. cit.*

[1] *Loc. cit.*

and cylinders as receivers. The results were highly unsatisfactory. Mr. J. J. Kennedy, working in this laboratory, obtained results which lead him to believe entrained alkali was being carried over into the receiving flasks. This point was confirmed by later work. The results appear in Table I. After aeration was complete and the excess acid titrated the titer solutions were then distilled over MgO into standard acid and the excess acid again titrated.

TABLE I

Nitrogen by:	Direct Titration Mg.	Distillation over MgO Mg.
1	24.12	24.44
2	25.00	24.48
3	24.69	24.45
4	24.77	24.40

An attempt was made to prevent the carrying over of the alkali. Many different kinds of traps were used but none sufficed to cause the complete deposition of the alkali. Further work with sodium carbonate was abandoned and attention was then paid to the use of MgO. By using MgO we hoped to remove dangers from entrained alkali, at the same time reduce the hydroxyl ion concentration, and thus reduce the danger of decomposition of organic nitrogenous compounds of the soil.

Trouble was experienced from incomplete absorption. The Folin tube was found to be of no value for such a rapid rate of aeration as was used in this investigation The air passed from the bottom of the bell in large bubbles and escaped from the solution without complete washing.

A $^5/_8$ in. bulb perforated with $^1/_2$ mm. holes, the use of 225 cc. of approximately $N/10$ H_2SO_4 contained in a 500 cc. Kjeldahl flask and the distillation of the receiver contents over MgO gave far better results, but absorption was as yet not quite complete.

This showed that complete absorption could not be obtained without thorough scrubbing of the air as it passed through the acid solution, and this can not be obtained without the use of a tower. Carbon dioxide towers, both the Reiset and Camp forms, were tried but the diameter of these towers was too small. The rapid air current jerked the absorbing liquid out at the top. Larger towers, $1^1/_2$ in. in diameter, were prepared and used. The acid solution was drawn up on top of the column of beads where it spattered badly. The absorption was complete but the spattering caused a loss in some cases. Glass rods about $1^1/_2$ in. in length were then substituted for the beads. The acid did not draw up on top of this coarse material.

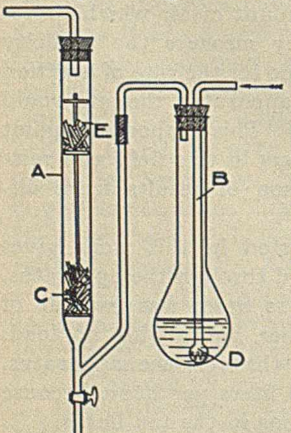

FIG. I

The tower finally adopted for the work is shown in Fig. I. The main part of the tube is $1^1/_2$ in. in diameter and 15 in. long. It is closed at the bottom with a glass stopcock of 3 mm. bore. The side arm has a bore of 8 mm. *C* and *E* are glass rods held in place by baffles made from rubber gasket. The purpose of the baffle at *E* is to stop any acid which spatters from the lower part of the tower. The tower is connected with the aeration flask as shown in the figure. The aeration bulb *D* should be well perforated so that complete stirring of the solution will be obtained, and should extend well to the bottom of the flask. The tubes connecting the flask are 5 mm. bore.

PROCEDURE—In the tower are placed 15 cc. of approximately $N/10$ H_2SO_4 and 15 cc. distilled water. The ammonia solution is placed in the Kjeldahl flask and made to a volume of 250 cc. A few drops of oil and the MgO are then added. Determinations are run in a series of four. The rate of aeration is measured at the beginning of each determination.

The air was washed through 25 per cent H_2SO_4. Trouble was experienced in securing complete recovery of the ammonia from the first flask which the air entered. It seemed this might be due to the CO_2 of the air since it would react with the magnesium oxide in solution and the rapidity of ammonia liberation would be thus greatly checked. During the aeration enough CO_2 would be drawn into the solution to react with about 1 g. of MgO. When 30 per cent solution of NaOH was used to remove the CO_2 from the air no further trouble was experienced. The air is washed with the NaOH before washing with acid.

Several determinations showed the best period of aeration to be $2^1/_2$ hrs. When the aeration is complete the air current is reduced and the stoppers loosened, beginning at the flasks farthest from the pump.

A Kjeldahl flask is placed under the tube of the tower and the acid solution is emptied into it. The tower is then washed with about 150 cc. distilled water, using about 50 cc. portions. The stopcock is closed before each washing in order to allow the water to run back into the side arm. Three such washings were found to remove all traces of ammonia, a fourth showing no ammonia with Nessler's reagent.

The solution is then distilled over MgO into standard acid and the excess acid titrated. The boiling should be continued for 30 mins. The liquid in the titration flask, which becomes hot from the steam, is cooled under running water before titration. In making this distillation over MgO it has been found that direct distillation into the acid without the use of a condenser is more satisfactory than using the Kjeldahl distilling apparatus provided with block-tin condensing tubes. Quartz[1] tubes were used in this work. Hard glass tubes well seasoned will suffice for many determinations. It is only where one works with small quantities of ammonia and the use of $N/50$ acid that the very insoluble quartz tubes are necessary.

Some determinations were made to ascertain the amount of MgO necessary to liberate all the ammonia. It was found that 0.2 g. of MgO was sufficient to liberate 25 mg. ammonia nitrogen when the CO_2 is removed from the air before entering the flasks. It

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[1] Allen, THIS JOURNAL, 7 (1915), 251.

is not necessary that an exact amount of MgO be added and for most determinations 0.5 of a gram is entirely sufficient. Large quantities, as 10 g., which are often used in distillation over MgO, are not necessary and should be avoided.

The results obtained from a number of determinations are reported in Table II. For quantities of 5 mg. or less, $N/50$ H_2SO_4 was used and for quantities above 5 mg., $N/10$ H_2SO_4 was used. The results need no discussion and they show the accuracy of the method. The ammonia in 250 cc. of the soil extract was first determined and then a known quantity of ammonia added and the total ammonia determined.

TABLE II—MILLIGRAMS AMMONIA NITROGEN FOUND, AND ERRORS

	TAKEN, 23.92		TAKEN, 5.045		In soil, 12.84 } Added, 5.040 } 17.880	
	Found	Error	Found	Error	Found	Error
	23.91	—0.01	5.001	—0.044	17.88	0.00
	23.88	—0.04	5.010	—0.035	17.89	+0.01
	23.88	—0.04	5.048	+0.003	17.85	—0.03
	23.91	—0.01	5.035	—0.010	17.89	+0.01
	23.90	—0.02	5.080	+0.035	17.85	—0.03
	23.93	+0.01	5.054	+0.009	17.85	—0.03
	23.90	—0.02	5.045	—0.000	17.91	+0.03
	23.89	—0.03	5.054	+0.009	17.92	+0.04
	23.90	—0.02	5.001	—0.044	17.84	—0.04
	23.95	—0.03	5.015	—0.030	17.92	+0.04
Deviation....		—0.013		—0.0117		0.000
Probable error		±0.018		±0.0195		±0.02

SUMMARY

I—Ammonia can be determined by aeration over MgO.

II—A standard method of measuring the rate of aeration should be adopted.

III—The Folin tubes are of no value for aeration work when the rate is as rapid as was used in this work.

IV—Complete absorption cannot be obtained unless the air is scrubbed well as it passes through the absorbing liquid.

V—The absorbing tower as used in this work gives complete absorption.

VI—One-half gram of MgO gives as satisfactory results as larger quantities.

VII—Two and one-half hours is sufficient to recover large quantities of ammonia from 250 cc. portions of solution when 1080 liters of air per hour are used.

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NITRATES AND OXYGEN DEMAND

By F. W. BRUCKMILLER

Received June 9, 1916

The determination of oxygen demand in sewages by the so-called saltpeter method depends upon the oxygen value ascribed to the nitrogen in the nitrate radical. Two values have so far been proposed, one by Lederer[1] and one by Hale.[2] The former assumes that 1 nitrate nitrogen is equivalent to 2.5 atoms of oxygen, while the latter assumes that 1 nitrate nitrogen is equivalent to 4 atoms of oxygen.

The process of nitrate reduction is a biologic one, and in order for it to go on successfully three conditions must prevail: namely, presence of organic matter, nitrates and bacteria. The products of reduction depend upon the kind of bacteria present. The reduction may be such that (1) the nitrates are reduced to nitrites only; or (2) the oxygen is taken from the nitrates and nitrites for the formation of ammonia; or (3) the nitrates and nitrites are reduced with evolution of NO and N_2O; or (4) the nitrates and nitrites are reduced to gaseous nitrogen.

The energy for carrying on the reduction is obtained from easily assimilated carbon compounds and the amount of reduction is directly proportional to the organic matter present. A number of such compounds so readily utilized by denitrifiers are produced by the action of putrefactive organisms upon the complex insoluble compounds in animal and vegetable tissues, humus and undigested material in feces.

Any equations, therefore, devised to explain the reduction of nitrates must necessarily consider carbonaceous matter. Such equations, therefore, as the following[1] hardly represent the true course of the reaction since they do not take into consideration the reducing action of the carbon compounds:

$$(1)\quad HNO_3 + H_2O = NH_3 + 2O_2$$

$$(2)\quad 2KNO_3 + H_2CO_3 + 2H_2O = K_2CO_3 + 2NH_3 + 4O_2$$

These equations might possibly represent the part nitrates play in the electrolytic action in the corrosion of iron, but they hardly apply to the biologic reduction of nitrates in sewages.

If it is necessary to represent the biologic reduction by a chemical equation the following[2] can be used to picture the facts in the case, although the exact nature of the reaction in actual conditions might be altogether different.

$$(3)\quad 5C + 4KNO_3 + 2H_2O = 4KHCO_3 + 2N_2 + CO_2$$

$$(4)\quad 4C + 2KNO_3 + 3H_2O = 2NH_3 + 3CO_2 + K_2CO_3$$

Analyzing this last equation by splitting it into its supposed successive reactions as they might occur we get the following:

$$(5)\quad 2KNO_3 + C = 2KNO_2 + CO_2$$

$$(6)\quad 2KNO_2 + 3C + 3H_2O = 2NH_3 + 2CO_2 + K_2CO_3$$

In Equation 5, 2 nitrogens give up 2 oxygens. In Equation 6, 2 nitrogens give up only 3 oxygens (one of them staying with the potassium to form the K_2CO_3), and 3 oxygens are taken from the water in order to carry the reaction to completion. In the complete reduction, therefore, 8 oxygens are required; that is, 1 nitrogen is equivalent to 4 oxygens.

The same conclusion can be obtained without the aid of equations and without recourse to the idea that oxygen must always be associated with oxidation and reduction. Oxidation can be defined as an increase in positive valence or a decrease in negative valence on the element oxidized; reduction as the converse.[3] In going from NO_3 to NO_2 or NH_3, nitrogen changes in valency. The nitrogen in nitrate has 5 positive valences; in ammonia 3 negative; in nitrite 4 positive; and in nitrogen gas no valence. The change from nitrate to ammonia is 8, to nitrite is 2, and to nitrogen 5, which being interpreted in terms of oxygen with 2

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[1] *J. Infect. Dis.*, **14**, 488.

[2] THIS JOURNAL, **7** (1915), 762.

[1] Hale, THIS JOURNAL, **7** (1915), 763.

[2] Marshall, "Microbiology," **1912**, 264.

[3] Cady, "Inorganic Chemistry," **1912**, 255.

valences means 4, 1 and 2$^1/_2$; that is, if the reduction all proceeded to gaseous nitrogen the equivalents of oxygen available for each nitrogen in nitrate is 2$^1/_2$; if only ammonia was formed, 4 equivalents would be available; and if only nitrites 1 equivalent.

Assuming that the reduction goes to nitrites and ammonia, the oxygen available will be dependent upon the quantity of nitrites and of ammonia produced. If we start with one equivalent of nitrogen as nitrate, and assume varying percentages of NO_2 formed we can get the oxygen value for the different percentage combinations of NO_2 and NH_3 present.

TABLE I

Eqvt. NO_2 formed	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Eqvt. NH_3 formed	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
Eqvt. O available	4.0	3.7	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.3	1.0

If 50 per cent of the nitrogen goes to NH_3, the oxygen equivalent is 2.5.

Since bacteria in sewage vary, the percentages of reduction products obtained will not only vary with different sewages but will vary from day to day with the same sewage. That this is true is shown by the experiments of various investigators. Letts, Blake, and Totton[1] found that nitrogen is evolved, sometimes free and sometimes as nitric oxide. Guth and Keim[2] report the same products. Both of these investigators were unable to demonstrate an increase in free ammonia. Hoover[3] reports an increase of free ammonia and nitrites. Lederer[4] reports an increase of nitrites and free ammonia, the latter varying from 20 to 50 per cent.

TABLE II—FORMATION OF FREE AMMONIA DURING SALTPETER OXYGEN CONSUMPTION (*a*)

No.	Temp. of Incubation	Time of Incubation	N as free NH_3 Before	After	Per cent Increase
1	37° C.	3	7.2	9.2	30
2	37	3	8.8	12.4	41
3	37	3	12.4	14.4	16
4	37	3	10.8	15.2	40
5	37	3	14.0	16.4	15
6	37	3	12.0	14.8	23
7	20	5	7.2	10.0	40
8	20	5	8.8	11.6	24
9	20	5	12.4	12.8	3
10	20	5	10.8	15.2	50
11	20	5	14.0	18.0	29
12	20	5	12.0	17.6	47

(*a*) Lederer, *Am. J. Pub. Health*, **5**, 358.

Unfortunately, the quantity of nitrites and initial nitrates were not given, so the value of the nitrogen in terms of oxygen could not be calculated from these products.

In our laboratory, we have been unable to demonstrate the presence of any free nitrogen or nitric oxide. Nitrites and ammonia were found to be the only products of reduction.

TABLE III—REDUCTION PRODUCTS OF SALTPETER TREATMENT

SERIAL NO.	1	2	3	4	5	6	7	8	9	10
Incubation Temp.	37	37	37	37	37	20	20	20	20	20° C.
Incubation Time	5	5	5	5	5	0	10	10	10	10
PER CENT INCREASE: Nitrogen	0	0	0	0	0	0	0	0	0	0
Ammonia	40	51	47	46	52	49	45	42	51	47

The increase in ammonia, however, may come from the hydrolysis of proteins and other complex nitrogenous organic compounds present in sewages, so that any calculations based on the increase in free ammonia are not very dependable. If, however, we can get comparable results on the reduction of nitrates and the reduction of available oxygen in absence of nitrates, we will have dependable data from which the oxygen equivalent of nitrogen in nitrates can be calculated. Such comparisons have been made by Hale and Melia,[1] by Lederer[2] and by the writer.[3]

Hale and Melia could get consistent results with the sewage on which they were working only by assuming that one nitrogen was equivalent to 4 oxygens, basing their assumptions on Equations 1 and 2 above. From the considerations herewith presented, the nitrate must have been all reduced to NH_3, no nitrites being formed, in order for this value to be true.

Lederer, however, could get checking results with the dilution and nitrates method, by assuming that 1 nitrate nitrogen was equivalent to 2.5 oxygens. This is strictly in accord with his observations that both nitrites and ammonia are formed in the nitrate reduction. He further assumed that one nitrite nitrogen was equivalent to 1$^1/_2$ atoms of oxygens. According to the consideration that the nitrogen is the oxidizing agent, one nitrite nitrogen is equivalent to one oxygen.

Rideal[4] in his text book allows 2.5 atoms of oxygen for one atom of nitrogen, and Hoover at the Columbus Sewage Testing Station has employed the same value.

The weight of evidence, therefore, seems to be in favor of 2.5 atoms of oxygen for every nitrate nitrogen. The conclusion, however, can not be drawn that this value is applicable to all sewages. The most that can be said is that the percentages of reduction products in each of the sewages so far worked on were about the same, namely, about a 50 per cent increase in free NH_3. Other investigators might find a different oxygen value for nitrogen.

That is, each sewage, depending upon the bacteria and organic matter present, will reduce nitrates differently. The safest thing, therefore, in oxygen demand work is to determine experimentally the oxygen value for the nitrogen in nitrates for the sewage in question. This can be done best by conducting very carefully parallel determinations, using nitrates in one and oxygen in the other, as the oxidizing agent. All the precautions mentioned by Lederer[5] and others[6] should be followed in running the "Dilution" method.

From the data thus obtained, the oxygen equivalent of nitrogen in nitrate can be readily determined, and from the evidence so far presented the value obtained should not differ far from 2.5.

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[1] *Chem. News*, **88** (1903), 182.
[2] *Gesundh. Ing.*, **35** (1912), 52.
[3] *Engineering News*, **68**, 192, 452.
[4] *Amer. J. Pub. Health*, **5**, p. 357.

[1] THIS JOURNAL, **7** (1915), 763.
[2] *J. Infect. Dis.*, **14** 487.
[3] THIS JOURNAL, **8** (1916), 403.
[4] "Sewage," 3rd Ed., **1906**, 131.
[5] THIS JOURNAL, **6** (1914), 882.
[6] Bruckmiller, *Ibid.*, **8** (1916), 403; **7** (1915), 762.

A NEW VOLUMETRIC METHOD FOR THE DETERMINATION OF COBALT

By W. D. Engle and R. G. Gustavson

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As the quantitative determination of nickel and cobalt in the presence of one another is difficult, this investigation was undertaken to find, if possible, simpler methods than those commonly used. It was hoped that volumetric methods might be found whereby either of these metals might be easily determined in the presence of the other. A very satisfactory method for cobalt has been found, but in the case of nickel nothing better than the methods already in use has so far been discovered.

In the presence of sodium or potassium hydroxide both nickel and cobalt are oxidized to trivalent oxides or hydroxides by various oxidizing agents, but neither trivalent nickel nor cobalt forms stable salts with acids. Both nickelic and cobaltic hydroxides, when treated with acids and potassium iodide, liberate iodine and form the nickelous or cobaltous salts, *e. g.*,

$$Co(OH)_3 + KI + 3HCl = CoCl_2 + I + KCl + 3H_2O.$$

Of these two metals, cobalt is the more easily oxidized, and when oxidized, forms the more stable compounds. For example, cobalt sulfate treated with potassium hydroxide and hydrogen peroxide gives cobaltic hydroxide, while nickel under the same treatment is not changed even at the boiling point. A. Metz[1] uses this fact as a basis for the determination of cobalt. The difficulty in completely removing the excess of hydrogen peroxide either by boiling or filtering and washing, is an objection to this method. After trial of a number of oxidizing agents, sodium perborate proved to be the best, both because it completely oxidizes the cobalt without affecting the nickel and also because any excess of the reagent is readily decomposed by boiling.

The method recommended is as follows: The ore, or other material, may be dissolved with acids and the metals of the copper and iron groups and also manganese removed by standard methods. The solution so obtained may contain nickel and cobalt, zinc, and the metals of the alkalies and the alkaline earths, but must be free from any substances capable of liberating iodine from an acid solution of potassium iodide. This solution, with a volume of about 100 cc., is made acid with dilute sulfuric acid, using about 5 cc. in excess, and 1 or 2 g. of dry sodium perborate added. After agitation and solution of the perborate, sodium hydroxide is added to strong alkaline reaction and the mixture boiled for 10 min. to decompose the excess of perborate. The solution is now cooled to room temperature and, after 1 g. potassium iodide has been added, acidified with dilute sulfuric acid. After solution of the precipitate, the liberated iodine is titrated with a standard solution of sodium thiosulfate, using starch paste as an indicator.

As it is difficult to secure a cobalt compound of known cobalt content, it is recommended that the sodium thiosulfate solution be standardized by means of potassium dichromate in the usual manner. Since $1K_2Cr_2O_7 = 6I = 6Co$, the $K_2Cr_2O_7$ factor of the thiosulfate solution multiplied by 1.2027 gives its cobalt factor.

If a cobalt compound of known purity is available, it may be used to standardize the sodium thiosulfate solution by taking a weighed quantity and treating, as in the regular method, with sodium perborate and sodium hydroxide. After boiling for 10 mins., cool, add potassium iodide and acidify with dilute sulfuric acid; titrate the free iodine with the thiosulfate solution and compute its factor. By this method 0.1613 g. of cobalt as cobalt sulfate required 35.25 cc. of the sodium thiosulfate solution, making its factor 0.004575 while its factor as determined by the potassium dichromate method was 0.004568.

The results of a few of the analyses of mixtures of cobalt and nickel are given in Table I. The cobalt used was a solution of pure cobalt sulfate containing 0.00978 g. of cobalt per cc. The nickel used was a solution of nickel sulfate free from cobalt and contained 0.00908 g. of nickel per cc. The titrations checked one another within a 0.1 cc. and wide variations in the amounts of the sulfuric acid, sodium perborate, etc., used did not affect the results. It may be noted that the process is accurate for widely different amounts of cobalt and also in the presence of large quantities of nickel.

Table I—Determination of Cobalt in the Presence of Nickel

Expt. No.	Gram Nickel Present	Gram Cobalt Present	Gram Cobalt Found
1	0.0454	0.000	0.000
2	0.0908	0.000	0.000
3	0.0000	0.0489	0.0492
4	0.0000	0.0489	0.0487
5	0.0908	0.0489	0.0490
6	0.0454	0.0489	0.0491
7	0.4540	0.0489	0.0491
8	0.4540	0.0489	0.0495
9	0.0908	0.0978	0.0977
10	0.0908	0.0978	0.0982
11	0.0000	0.1467	0.1470
12	0.0908	0.1467	0.1466
13	0.0000	0.1956	0.1950
14	0.2270	0.1956	0.1955
15	0.0000	0.2445	0.2439

The following points in this analysis must be carefully observed to obtain accurate results: It is necessary to add the sodium perborate to the acid solution and then make alkaline. Attempts to add the perborate to the alkaline solution resulted in incomplete oxidation of the cobalt when the amount present was more than 0.050 g. It is necessary to add the potassium iodide before adding the dilute sulfuric acid for the solution of the cobaltic hydroxide, otherwise the results will be low. This method does not require the filtration of the cobaltic hydroxide, which is important not only in saving time, but in increasing the accuracy, as this compound tends to pass through the filter during the last part of the washing.

It was attempted to determine nickel and cobalt together by an analogous method using more powerful oxidizing agents such as bromine water and sodium persulfate. These experiments were not successful, due to the difficulty of completely removing the excess of the oxidizing agent. The nickelic and cobaltic hydroxides, which are readily formed, require filtra-

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[1] *Z. anal. Chem.*, **53** (1914), 537.

tion and excessive washing and even after prolonged washing the results were usually high. Cobalt free from nickel gave good results when oxidized with bromine water, but even here the washing required was excessive and the method is much inferior to the one given above using sodium perborate.

In conclusion we would state that cobalt may be determined in the presence of nickel by oxidation in alkaline solution with sodium perborate, removing the excess of the perborate by boiling, and after the addition of potassium iodide and dilute sulfuric acid, titrating with a standard sodium thiosulfate solution.

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THE COMPOSITION OF SOUND AND FROZEN LEMONS WITH SPECIAL REFERENCE TO THE EFFECT OF SLOW THAWING ON FROZEN LEMONS

By H. S. BAILEY AND C. P. WILSON

Received May 29, 1916

INTRODUCTORY

The work described below was undertaken as a result of the freeze of January 6, 1913, which destroyed a portion of the citrus crop of Southern California and was especially severe on lemons.

While no temperature charts were made at San Dimas, the district from which the material was collected, Mr. Woods, foreman of the San Dimas lemon house, says: "On the 6th of January, the day preceding the freeze, there was a very high wind and the temperature went below the freezing point early in the evening. A low temperature was maintained until 6.30 next morning, when it began to move up."

That the injury to lemons, which almost always follows a heavy freeze, is due to a rapid thawing of the frozen fruit, rather than to the low temperature to which they have been subjected, seems to be the general opinion of citrus growers. This assumption is apparently substantiated by the fact that in groves where a night of frost is followed by a warm, bright day, the damage is greater than in orchards which have suffered an equally low temperature during the night but warmed up more slowly the following day. In other words, when a cloudy morning or a heavy smudge blanket keeps the groves cool until toward noon, the fruit is less injured by a freezing night than if the sun comes out hot early in the day. This is in harmony with the well-known fact that living animal tissues suffer greater injury from freezing if the thawing out be rapid than when it takes place gradually.

In the hope of obtaining further data upon the effect of gradual thawing upon frosted citrus fruit, Mr. Horsford, Manager of the San Dimas Lemon Association, had a quantity of the fruit which was frozen on the night of January 6, 1913, picked, beginning at 7 o'clock the following morning and continuing nearly all that day. This was stored as fast as gathered in the packing house at a temperature of 45 to 50° F., where it would thaw slowly. At the time the freeze occurred there was already in storage in his house a quantity of sound lemons picked two days previously and several boxes of these were set aside for comparison later with frozen fruit. To supply the third set of samples, that of frozen fruit thawed rapidly, several trees were left unpicked in the orchard, from which were gathered the frosted lemons for storage. An opportunity was thus afforded to make a comparative study of fruit picked before the frost, and therefore, normal; fruit picked and stored immediately after the frost; and frozen fruit remaining on the trees. All this fruit came from the same grove of Eureka lemons.

DESCRIPTION OF SAMPLES ANALYZED

One packing box of fruit picked January 4, two days before the freeze, and one box picked January 7, the day after the freeze, were selected and placed side by side in storage at a temperature of 45 to 50° F. Beginning January 16, a sample of a dozen or more lemons was taken at random from each box and another dozen picked fresh from the grove. These were wrapped in the regular tissue paper wrappers, packed in a wooden box, and sent by express to the Citrus By-Products Laboratory in Los Angeles, and analyzed as soon as possible after being received. Similar series of samples were taken at intervals of about a week until the first of May following.

METHODS OF ANALYSIS

SPECIFIC GRAVITY OF FRUIT—When received, the lemons were weighed on a torsion balance and immediately put in a battery jar filled with water and covered with a ground glass plate to remove all surplus water. The fruit was then taken out and the jar refilled with water, the amount thus required being equal to the volume of the fruit. From the weight of the fruit and volume of water it displaced, the specific gravity was calculated.

APPEARANCE OF FRUIT—The lemons were cut in halves with a sharp knife and the condition of the cell structure noted. Perfect lemons, showing no evidence of having been frosted, are designated as "Sound," those in which about 20 per cent of the cells appeared desiccated, that is, dried and shriveled, due to having been injured by the frost or the resulting thawing of the frozen tissues, "Slightly frozen." The remainder, where the cut surface showed more than 20 per cent of the cells affected, were considered badly frozen and so denoted.

PERCENTAGE OF JUICE—After this examination the half lemons were wrapped in a heavy canvas press cloth, 24 in. square, and squeezed in a hydraulic press with about 1500 lbs. pressure. The juice and pulp were collected and weighed separately and the percentage of each obtained. Owing to the fact that an appreciable amount of juice was absorbed and retained by the press cloth, the more exact figure for the quantity actually present in the fruit was obtained by deducting the weight of the pulp from that of the original lemons. This figure, divided by the weight of fruit pressed, gives the calculated percentage of juice and is the value so tabulated. These figures were used in calculating the percentage of citric acid in the fruit, which probably makes these latter values a little higher than would be obtained had the samples been larger.

SPECIFIC GRAVITY OF JUICE—The specific gravity of the juice was determined at 20° C. by means of a spindle.

ACIDITY OF JUICE—Immediately after taking the specific gravity 10 cc. of the juice were pipetted from the cylinder and titrated against $N/2$ sodium hydroxide solution, phenolphthalein being used as an indicator. From the specific gravity and the acid equivalent thus obtained, the percentage of acid as citric, plus one molecule of water, was calculated.

SOLIDS IN JUICE—Solids were determined in the juice by drying 10 cc. in lead dishes for 8 hrs. in an air bath at about 95 to 100° C. Owing to the difficulty in controlling the oven and the action of the acid on the metal dishes, the solids determinations are probably only approximations.

ANALYTICAL RESULTS

The results are given in the accompanying tables and show the effect of the frost on the stored and unstored fruit. It is true that the sound lemons were in storage two days earlier than the frozen ones, but this would have very little, if any, effect upon the relative condition of the two lots at the time the first analysis was made, 15 days after the freeze. Owing to the small samples used for analysis, peculiarities in individual lemons had an undue influence upon the figures obtained for the entire sample. Too much importance must not be given to the individual determination.

TABLE I—ANALYSES OF UNFROZEN LEMONS, FROZEN LEMONS THAWED SLOWLY AND FROZEN LEMONS ALLOWED TO REMAIN ON THE TREES

FRUIT (a)	Date of Picking	TIME (b)	Sp. Gr. of Lemons	PER CENT OF JUICE Ob-tained	PER CENT OF JUICE Calcu-lated	Sp. Gr. of Juice	PER CENT IN JUICE Citric Acid	PER CENT IN JUICE Solids	Per cent Citric Acid in Fruit
SU	Jan. 4	15 days	0.933	9.0	49.6	1.041	6.5	8.8	3.22
FS	7	Jan. 21	0.914	23.1	42.4	1.041	6.8	9.5	2.92
FT	16		0.837	29.4	41.1	1.037	5.1	8.8	2.10
SU	4	19 days	0.913	27.0	37.4	1.040	7.2	9.5	2.69
FS	7	Jan. 25	0.886	30.0	39.5	1.040	6.6	9.5	2.61
FT	24		0.789	24.9	31.9	1.036	5.3	8.9	1.69
SU	4	28 days	0.920	27.6	42.1	1.038	7.1	9.1	2.99
FS	7	Feb. 3	0.886	22.7	35.9	1.041	7.3	9.8	2.62
FT	Feb. 1		0.779	19.1	26.5	1.038	5.3	9.9	1.40
SU	Jan. 4	32 days	0.940	37.1	44.8	1.036	6.8	9.6	3.05
FS	7	Feb. 7	0.923	31.1	34.3	1.037	6.9	9.0	2.37
FT	Feb. 6		0.710	26.2	28.7	1.032	4.5	8.0	1.29
SU	Jan. 4	38 days	0.952	28.7	41.4	1.040	7.0	9.0	2.90
FS	7	Feb. 13	0.920	27.8	33.9	1.038	6.8	9.4	2.30
FT	Feb. 12		0.729	21.2	25.3	1.032	4.7	8.3	1.19
SU	Jan. 4	40 days	0.951	37.1	46.2	1.041	7.3	9.5	3.37
FS	7	Feb. 15	0.904	21.1	45.5	1.038	7.2	9.3	3.28
FT	Feb. 14		0.701	19.9	29.8	1.032	4.8	7.9	1.43
SU	Jan. 4	50 days	0.944	33.1	42.8	1.040	7.2	9.1	3.08
FS	7	Feb. 25	0.870	....	35.2	1.040	6.6	9.1	2.32
FT	Feb. 20		0.724	24.1	28.4	1.030	4.1	8.4	1.16
SU	Jan. 4	52 days	0.931	30.6	40.1	1.042	7.4	9.6	2.97
FS	7	Feb. 27	0.898	30.3	35.6	1.040	6.8	9.2	2.42
FT	Feb. 26		0.773	28.5	31.6	1.031	4.9	7.6	1.55
SU	Jan. 4	57 days	0.926	....	41.4	1.044	7.3	9.9	3.02
FS	7	Mar. 4	0.882	23.6	36.9	1.045	7.6	9.9	2.80
FT	Mar. 3		0.730	21.6	26.3	1.033	4.8	7.6	1.26
SU	Jan. 4	60 days	0.967	27.6	42.7	1.042	7.3	9.5	3.12
FS	7	Mar. 7	0.894	26.2	32.4	1.044	7.2	9.9	2.33
FT	Mar. 7		0.714	21.1	26.3	1.028	3.7	6.5	0.97
SU	Jan. 4	64 days	0.913	25.4	40.2	1.042	7.4	9.3	2.97
FS	7	Mar. 11	0.870	25.0	36.7	1.045	7.1	9.9	2.61
FT	Mar. 10		0.713	....	33.3	1.032	4.1	7.3	1.36
SU	Jan. 4	67 days	0.949	27.1	40.7	1.042	7.4	8.1	3.01
FS	7	Mar. 14	0.879	23.2	35.3	1.046	7.3	8.4	2.58
FT	Mar. 12		0.682	19.0	30.0	1.030	3.7	6.8	1.11
SU	Jan. 4	93 days	0.954	27.7	39.7	1.046	8.2	9.7	3.26
FS	7	Apr. 9	0.920	33.4	37.3	1.046	7.8	9.6	2.91
FT	Apr. 7		0.713	23.7	26.1	1.032	4.7	6.9	1.23
SU	Jan. 4	100 days	0.934	31.8	44.1	1.050	8.3	10.2	3.66
FS	7	Apr. 16	0.840	30.3	33.9	1.046	7.3	9.4	2.47
FT	Apr. 15		0.753	32.4	34.8	1.031	4.1	6.8	1.43
SU	Jan. 4	109 days	0.968	35.3	48.3	1.048	7.6	10.5	3.67
FS	7	Apr. 25	0.918	37.8	39.4	1.046	7.6	10.2	2.99
FT	Apr. 23		0.766	27.5	35.0	1.026	4.1	6.8	1.43
SU	Jan. 4	116 days	0.991	32.3	33.3	1.046	8.1	9.3	2.70
FS	7	May 2	0.889	31.7	36.5	1.045	7.4	10.0	2.70
FT	May 1		0.722	30.2	31.6	1.030	4.3	7.2	1.37

(a) SU, stored unfrozen fruit; FS, frozen stored fruit; FT, frozen fruit left on tree (picked generally 1 or 2 days before analysis).

(b) Time between freeze and analysis, and date of analysis.

As has already been intimated this work was undertaken without previous preparation, on the spur of the moment, when the material became available. It is perfectly obvious that instead of the small samples of a dozen lemons, at least an entire box should have been used for each analysis, but under the circumstances samples of this size were out of the question.

TABLE II—COMPARISONS OF SPECIFIC GRAVITIES, JUICES AND CITRIC ACID CONTENTS

Date Analysis	SPECIFIC GRAVITIES OF FRUIT SU	FS	FT	JUICE YIELD Per cent SU	FS	FT	PER CENT CITRIC ACID In Juice SU	FS	FT	In Fruit SU	FS	FT
1/21	0.933	0.914	0.837	49.6	42.4	41.1	6.5	6.9	5.1	3.2	2.9	2.1
1/25	0.913	0.886	0.789	37.4	39.5	31.9	7.2	6.6	5.3	2.7	2.6	1.7
2/ 3	0.920	0.886	0.779	42.1	35.9	26.5	7.1	7.3	5.3	3.0	2.6	1.4
2/ 7	0.940	0.923	0.710	44.8	34.3	28.7	6.8	6.9	4.5	3.0	2.4	1.3
2/13	0.952	0.920	0.729	41.4	33.9	25.3	7.0	6.8	4.7	2.9	2.3	1.2
2/15	0.951	0.904	0.701	46.2	45.5	29.8	7.3	7.2	4.8	3.4	3.3	1.4
2/25	0.944	0.870	0.724	42.8	35.2	28.4	7.2	6.6	4.1	3.0	2.3	1.2
2/27	0.931	0.898	0.773	40.1	35.6	31.6	7.4	6.8	4.9	3.0	2.4	1.5
3/ 4	0.926	0.882	0.730	41.4	36.9	26.3	7.3	7.6	4.8	3.0	2.8	1.3
3/ 7	0.967	0.894	0.714	42.7	32.4	26.3	7.3	7.2	3.7	3.1	2.3	1.0
3/11	0.913	0.870	0.713	40.2	36.7	33.3	7.4	7.1	4.1	3.0	2.6	1.4
3/14	0.949	0.879	0.682	40.7	35.3	30.0	7.4	7.3	3.7	3.0	2.6	1.1
4/ 9	0.954	0.920	0.713	39.7	37.3	26.1	8.2	7.8	4.7	3.3	2.9	1.2
4/16	0.934	0.840	0.753	44.1	33.9	34.8	8.3	7.3	4.1	3.7	2.5	1.4
4/25	0.968	0.918	0.766	48.3	39.4	35.0	7.6	7.6	4.1	3.7	3.0	1.4
5/ 2	0.991	0.889	0.722	33.3	36.5	31.6	8.1	7.4	4.3	2.7	2.7	1.4

Disregarding then the great irregularities in the individual figures, it is evident that the frozen fruit stored immediately after freezing is much more like the unfrozen fruit than like the frozen fruit left on the trees. The specific gravity of the fruit and the percentage of acid in the juice are nearly the same for the two lots in storage, while these values for frozen fruit left on the trees are considerably lower. The percentage of juice in the frozen fruit in storage is about a mean between that of the unfrozen fruit in storage and the frozen fruit on the trees.

The figures show that the frozen fruit which remained in the orchard is not nearly so rich in citric acid as the sound fruit or as that frozen but immediately placed in cold storage. This fact is of special importance to those interested in the manufacture of citrus by-products, and is fully confirmed by the work, on a much larger scale, of the By-Products Laboratory in the manufacture of citric acid from the frozen fruit of the 1913 crop. The amount of citric acid in the juice of one ton of frozen lemons, taking the figures from twelve runs of fruit between January 18, 1913, to May 19, 1913, varied from 14.03 lbs. to 30.14 lbs., with an average of 20.16 lbs. Corresponding figures on four runs of sound lemons from April 18, 1914, to June 8, 1914, were 42.75, 49.44, 46.56 lbs. citric acid in juice of one ton of lemons. In this connection, however, it should be mentioned that there is apparently no decrease in the oil content of lemons due to freezing, and that ton for ton the more frozen and consequently lighter the fruit the greater the yield of oil. It has been pointed out that the frozen fruit remaining on the trees decreased in specific gravity and its juice in percentage of solids and acidity. Thus the increasing lightness in the orchard fruit is evidently due both to the decrease in the amount of juice actually present and the percentage of total solids in the juice.

There is but little change in the specific gravity of the fruit held in storage during the first 60 to 70 days, and even up to the end of the experiment the increase is slight and may be accounted for by a normal drying-out or withering of the fruit. But with the fruit that remained on the tree there is at first a very marked decrease in specific gravity and then apparently a gradual increase. It was noticed in cutting this orchard fruit that during the latter half of the observation period the lemons appeared to be filling out a little.

SUMMARY

In so far as a preliminary experiment of this kind can be considered as giving definite results, the following conclusions may be drawn:

I—The lemons that remained on the trees after being frozen retained less juice and considerably less acid than the fruit picked immediately after being frozen and stored at a temperature of 45 to 50° F.

II—The frozen fruit left on the trees decreased rapidly in specific gravity due to the loss of juice and acid and the formation of thick, puffy skins, dried-up cells and hollow centers.

III—Lemons picked immediately after being frozen and stored under ordinary packing house conditions retained somewhat less juice than the unfrozen fruit, but the composition of the juice was nearly the same, and in weight and appearance the slowly thawed lemons compared well with normal fruit.

We wish to acknowledge our indebtedness to Mr. G. W. Hosford of the San Dimas Lemon Association for his valuable suggestions and hearty coöperation, and to the association for so generously supplying us with the fruit used in this investigation.

Bureau of Chemistry, Washington

AN IMPROVED METHOD FOR THE DETECTION OF ARACHIDIC ACID

By Robert H. Kerr

Received May 16, 1916

The method described below for the detection of arachidic acid in peanut oil and mixtures of oils containing peanut oil has been found to offer certain advantages over the Renard method adopted by the Association of Official Agricultural Chemists. These advantages consist in greater convenience, lessening of the number of operations, reducing the amount of attention required, and avoidance of the use of ether.

REAGENTS

Potassium Hydroxide Solution—Dissolve 100 g. of stick potassium hydroxide in 100 cc. of water.

Magnesium Acetate Solution—Dissolve 10 g. of magnesium acetate in a mixture of 100 cc. distilled water and 100 cc. of 95 per cent alcohol.

Acetic Acid Solution—Mix 50 cc. glacial acetic acid with 150 cc. of 95 per cent ethyl alcohol.

Sulfuric Acid Solution—Mix 50 cc. concentrated sulfuric acid with 150 cc. of distilled water.

90 per cent Ethyl Alcohol (by volume).

METHOD

Weigh out 20 g. of the oil to be tested in a 300 cc. Erlenmeyer flask, pour in 200 cc. of 95 per cent ethyl alcohol, and heat to boiling on the steam bath. When the alcohol is boiling add 10 cc. of the potassium hydroxide solution. Saponification begins immediately and is soon complete. After the saponification has been completed add a few drops of phenolphthalein and neutralize the excess alkali with the alcoholic solution of acetic acid. Next add 50 cc. of the 5 per cent magnesium acetate solution and heat the whole mixture to boiling. Allow to cool to room temperature with occasional shaking and then place in a refrigerator at a temperature of 10 to 15° C. and leave until next day. Filter off the solution, wash the precipitate twice with 50 per cent alcohol and three times with distilled water, and return to the flask in which precipitation took place. Pour 100 cc. of hot distilled water into the flask and add sufficient dilute sulfuric acid to decompose the magnesium salts. Heat until the separated acids form a clear layer. Cool the flask, pour off the acid solution, add 100 cc. of hot water. When the fatty acids have melted and solidified, pour off water as before. Free the cake of acids of water as far as possible by draining; dissolve in 100 cc. of 90 per cent alcohol and separate the arachidic acid by crystallization, according to the present provisional method of the Association of Official Agricultural Chemists as given in *Bulletin* **107**, Revised, Bureau of Chemistry, p. 146.

The method as outlined above has been used on a number of samples of peanut oil and mixtures of peanut and other vegetable oils. The results obtained are qualitative only, no attempt having been made to apply the method for quantitative purposes. It has been found to be capable of detecting 5 per cent of peanut oil in olive oil, cottonseed oil, soy bean oil and corn oil. These results are quite as good as the best which have ever been obtained with Renard's method.

Bureau of Animal Industry, Washington

THE HYDROLYSIS OF ETHYL-SULFURIC ACID AND THE ASSAY OF AROMATIC SULFURIC ACID, U. S. P.

By W. B. D. Penniman, W. W. Randall, C. O. Miller and L. H. Enslow

Received September 1, 1916

Aromatic sulfuric acid is a mixture of sulfuric acid, ethyl-sulfuric acid, certain aromatics and alcohol. It is prepared by bringing together, according to the U. S. Pharmacopoeia, 111 cc. of concentrated sulfuric acid and 700 cc. alcohol, and, after the mixture has cooled, adding 50 cc. of tincture of ginger, 1 cc. of oil of cinnamon, and sufficient alcohol to bring the total volume up to one liter. The proportion of ethyl-sulfuric acid present depends upon the strength of the sulfuric acid and alcohol used and upon the length of time the mixture remains hot, and probably increases the longer the liquid stands, even when cold.

The Pharmacopoeia (Eighth Revision) is not concerned with the ethyl-sulfuric acid: its only demand is that the mixture shall contain not less than 20 per cent, by weight, of sulfuric acid, H_2SO_4, after the ethyl-sulfuric acid has been completely hydrolyzed by the action of water.

The method of assay made standard by the Pharmacopoeia has varied in some of its details with each of the recent editions. In the Eighth Revision (September, 1905) the analyst was directed to mix 10 g. of aromatic sulfuric acid with 30 cc. of water and to boil this mixture "for several minutes," after which the total acid present (assumed now to be sulfuric) was to be determined by means of titration with a standard solution of alkali. In the Supplementary Revision of 1907 the only change made was that the words "for four hours" were substituted for "for several minutes." In the Ninth Revision, about to appear, the requirement will be "free sulfuric acid and ethyl-sulfuric acid together equivalent to not less than 19 per cent nor more than 21 per cent of H_2SO_4 (98.09)." The method of assay is also changed and directs that a known weight (which will be about 9 grams) of aromatic sulfuric acid shall be mixed with six times its volume of water, boiled for six hours in a flask fitted with a reflux condenser, and later titrated with standard solution of alkali.

In an article published four years ago, L. A. Brown[1] called attention to the fact that the methods of assay given in the U. S. Pharmacopoeia (8th Revision, 1905, and Supplementary Revision, 1907) fail to determine all the sulfuric acid present. Accordingly, Brown advocated a method in which all free acid present (sulfuric and ethyl-sulfuric) is first determined by titration; by the action of hydrochloric acid and barium chloride the alkali sulfate and ethyl-sulfate thus formed are converted into barium sulfate and the yield of the latter salt determined by weighing. It is thus possible to determine the total acid present, calculated as sulfuric, and also the proportion of ethyl-sulfuric acid.

In trying out this method, Brown analyzed a "standard sample of aromatic sulfuric acid," but does not inform us what its acid strength actually was. By the U. S. Pharmacopoeia method the percentage found was 18.40 in each of two determinations; by his method the percentages found were 20.18, 19.73, and 19.80, respectively. Again, he records the results obtained on analyzing by both methods a series of commercial samples, but as we have no means of knowing the actual strength of any of these, the only safe conclusion we can draw is that the U. S. Pharmacopoeia method is faulty and that Brown's method is more nearly accurate; we are not in a position to say that a satisfactory method has been found. Only where a series of assays upon a sample of known strength yield closely agreeing results are we to claim that the goal has been attained.

Brown concludes from his work that diethyl sulfate is one of the constituents of aromatic sulfuric acid, at any rate after long standing. If, as seems to the present writers, this conclusion has for its basis the fact that his analytic method failed to show the presence of all the sulfuric acid originally used, it rests upon a doubtful foundation. The work of Claesson[1] and that of Villiers[2] seem to prove that, in order that diethyl sulfate shall be formed, absolute alcohol and very concentrated sulfuric acid must be employed, and that diethyl sulfate decomposes comparatively readily when heated with either water or alcohol. The fact that it yields alcohol and ethyl-sulfuric acid when heated in the presence of water, would appear to disprove Brown's assumption that such part of the sulfuric acid as could not be recovered as such, was locked up in the form of diethyl sulfate at the end of the boiling process.

It fell to the chemists of this bureau this summer to determine the strengths of a large number of samples of aromatic sulfuric acid purchased from retail druggists. Making use of the U. S. Pharmacopoeia (1907 Revision) method, it was soon found that few of the samples would show results which could be considered as satisfying the demands of the Pharmacopoeia. Table I gives the percentage figures for a series of samples of various strengths as found by this method and, below them, the figures obtained by the method soon to be described.

TABLE I—PERCENTAGES OF TOTAL ACID ASSUMED TO BE SULFURIC, BY TWO METHODS

Sample	11297	11300	11388	11391	11393	11394	11395	11396	11397	11398
U. S. P. (1907)	23.68	17.13	16.77	11.86	15.92	14.30	15.00	15.76	12.96	17.34
Maryland	25.58	19.08	19.76	14.24	21.74	17.76	18.09	19.91	16.79	20.29
Diff.	1.90	1.95	2.99	2.38	5.82	3.46	3.09	4.15	3.83	2.95

It will be seen that, if judged by the U. S. Pharmacopoeia method, only one out of the ten samples is satisfactory, and that the other nine give figures from 2.66 to 8.14 per cent too low. On the other hand, judged by the improved method, three samples are satisfactory, two approximate 20 per cent, and the worst is 5.76 per cent short of the required amount.

Our attention having been called to the revised method to become standard with the publication of the Ninth Revision of the Pharmacopoeia, a series of assays upon samples of unknown strength was carried out, the amount of added water being increased to 6 volumes and the time of boiling with reflux condenser lengthened to 6 hrs. Under "Ninth Revision Method" in Table II are given the results of duplicate assays and the differences between them, while another column contains the figures found by our revised method:

TABLE II—PERCENTAGE OF TOTAL ACID, ASSUMED TO BE SULFURIC

Lab. No.	NINTH REVISION U. S. P. METHOD A	B	Diff.	MARYLAND METHOD
11051	10.39	11.49	1.10	12.47
11092	15.89	20.70	4.81	23.22
11101	16.48	18.45	1.97	20.41
11108	15.82	17.65	1.83	18.56
11112	22.72	23.00	0.18	23.97
11122	13.66	14.50	0.84	15.24
11125	17.90	18.75	0.85	20.59
11128	26.19	26.90	0.71	27.57
11139	17.60	18.40	0.80	19.84
11148	24.52	24.30	0.22	25.53
11151	30.92	31.80	0.88	32.72
11166	14.24	14.60	0.36	17.01
11175	16.74	17.25	0.51	19.40
11184	11.85	14.75	2.90	16.16
11190	22.90	23.00	0.10	25.26
11195	27.02	27.80	0.78	28.52

It will be noted that parallel determinations by the new U. S. Pharmacopoeia method rarely showed

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[1] THIS JOURNAL, **4** (1912), 512.

[1] *J. prakt. Chem.*, [2] **19**, 257; *Ber.*, **13**, 1699.

[2] *Bull. soc. chim.*, **34**, 26.

satisfactory agreement, and that, judged by our method, all these results are too low.

For a thorough study of the two standard (U. S. P.) methods of assay, there was prepared a standard aromatic sulfuric acid, in accordance with the Pharmacopoeia. A careful specific gravity determination was made in the case of the acid, of the alcohol and of the final product; and a weighed amount of the sulfuric acid used was titrated against standard alkali solution. From these data the percentage of total acid, assumed to be sulfuric, in the product was calculated to be *20.14*. With this standard material the three series of experiments indicated in Table III were conducted.

TABLE III—EFFECT OF VARIOUS TREATMENTS

Results in Percentages Total Acid, Assumed to be Sulfuric

(1) BOILED UNDER REFLUX CONDENSER				(2) SLOW EVAPORATION IN THE COLD			(3) BOILED UNDER REFLUX CONDENSER		
		Water Added						Cc. Water	
No.	Hrs.	3 Vols.	6 Vols.	No.	Hrs.	Results	No.	Added	Results
1	1/2	17.23	17.23	1	24	17.23	1	10	19.05
2	1	17.56	17.67	2	48	17.23	2	20	19.33
3	2	17.67	17.83	3	72	17.23	3	25	18.85
4	4	18.32	18.27	4	144	19.64	4	30	19.36
5	6	18.81	18.70				5	40	18.93
6	12	19.41	19.63				6	50	18.96
7	18	19.63	19.85				7	60	19.53
8	24	19.79	19.90				8	70	19.41

It will be seen that in Series 1 all the sulfuric acid was not recovered even after 24 hours' boiling. While, on the whole, better results were obtained when a larger proportion of water was added to decompose the ethyl-sulfuric acid, this outcome may be chargeable to some other cause.

In Series 2, weighed amounts of the standard aromatic sulfuric acid (to each of which 6 volumes of water had been added) were placed, cold, in a vacuum desiccator over sulfuric acid and left for different periods of time before titration. The results seem to show that the decomposition of the ethyl-sulfuric acid begins only after a certain concentration has been reached, and then proceeds slowly towards completion. This will be referred to again.

Series 3 had to do with the effect of varying proportions of water to acid, time of heating remaining constant. In each case 5 g. of aromatic sulfuric acid were boiled for 6 hrs. in a flask under a reflux condenser, after the addition of the quantities of water indicated. The results fail to show that any appreciable advantage is to be secured by the addition of 6 volumes of water in place of 3.

Finally, two 5-gram quantities of the standard aromatic sulfuric acid were each mixed with 15 cc. of water: one was titrated at once, the other after standing in the cold for 48 hrs. In each case the percentage of total acid, assumed to be sulfuric, was 16.96.

As a result of these various experiments, the following conclusions appear to be justified:

1—The ethyl-sulfuric acid in aromatic sulfuric acid is not appreciably hydrolyzed on standing mixed with cold water.

2—This ethyl-sulfuric acid is slowly hydrolyzed, after dilution with water, as a result of prolonged boiling under a reflux condenser, the decomposition never, however, becoming complete, no matter how much water may have been added. Hence the Pharmacopoeia method will always give low results, the actual figure obtained being apparently dependent largely upon the rate of boiling and the *efficiency of the condenser.*

These same conclusions might be drawn as the result of the following considerations: The reaction between sulfuric acid and alcohol is expressed by the equation

$$H_2SO_4 + C_2H_5.OH = C_2H_5.HSO_4 + H_2O \qquad (a)$$

The acid must be at least fairly strong and the alcohol must not contain much water. Again, ethyl-sulfuric acid is decomposed, to some extent perhaps in the cold, to a large extent when heated, in contact with water, with the formation of sulfuric acid and alcohol,

$$C_2H_5.HSO_4 + H_2O = C_2H_5.OH + H_2SO_4 \qquad (b)$$

The reaction is *reversible*, and should be expressed as follows:

$$C_2H_5.OH + H_2SO_4 \rightleftarrows C_2H_5.HSO_4 + H_2O \qquad (c)$$

Reaction (*a*) begins upon mixing the acid with alcohol, and continues. The accumulation of water, however, soon starts reaction (*b*), which develops until, in a given period of time, as much ethyl-sulfuric acid is being decomposed as is being formed. After this point has been reached, the composition of the mixture remains constant and equilibrium is established among the four reacting substances. The relative amounts of sulfuric and ethyl-sulfuric acid in the resulting mixture will therefore depend, physical conditions being the same, upon the amount of water originally present in the sulfuric acid and in the alcohol. It is a well-known fact that fuming sulfuric acid and absolute alcohol yield a high proportion of ethyl-sulfuric acid and that dilute sulfuric acid has little or no effect upon alcohol.[1] Could we remove the water as fast as it is formed in accordance with reaction (*a*), we should be able to secure a 100 per cent yield of ethyl-sulfuric acid. Similarly, were we able to remove the alcohol formed in reaction (*b*) as fast as it is produced, we should secure a complete decomposition of the ethyl-sulfuric acid present. Now this is just the problem before us. The U. S. Pharmacopoeia assay method is not successful, because it fails to bring about the removal of the alcohol already present as such in the aromatic sulfuric acid, or that is being formed through hydrolysis of ethyl-sulfuric acid. The reflux condenser, in so far as it is efficient, prevents the escape of the very reagent whose presence renders impossible the completion of the reaction.

Even the best of our water-jacketed condensers probably allows the escape of slight quantities of alcohol-vapor, and hence in process of time the hydrolysis may be complete. The experiments reported in Table IV were undertaken to see if evidence of a state of equilibrium among the four reacting substances could be secured. Five-gram quantities of aromatic

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[1] Thus in one of our experiments dilute sulfuric acid (1 of acid to 36 of water, by volume) was boiled continuously for 6 1/2 hrs. with a mixture of alcohol and extract of ginger; samples were removed from time to time and titrated. Not the slightest change in the strength of the acid could be detected.

sulfuric acid were heated with 3 volumes of water in sealed glass tubes, in a bath of boiling water, for different periods of time, after which the tubes were cooled and opened and their contents titrated. (The percentage of acid in this preparation, after complete hydrolysis, was 24.94.)

TABLE IV—TIME REQUIRED FOR EQUILIBRIUM

	1	2	3	4	5	6	7	8
Hrs. heated	0	4	6	8	10	12	14	16
% Acid found	18.57	21.66	21.77	22.60	24.08	24.10	24.08	24.10
% of Total Acid recoverable	74.46	86.85	87.29	90.61	96.55	96.63	96.55	96.63

Apparently equilibrium in the system—sulfuric acid, ethyl-sulfuric acid, alcohol, water—for the concentrations peculiar to these experiments and at the temperature of boiling water, was attained after ten hours' heating. From this time on about 3.4 per cent of the sulfuric acid present remained in the form of ethyl-sulfuric acid, in spite of the presence of a relatively very large volume of water.

The problem is, therefore, after all very simple. We have only to heat a weighed quantity of aromatic sulfuric acid, after dilution with water, in such fashion that the alcohol vapors may escape, and for such a time that all ethyl-sulfuric acid shall have been decomposed.

In Table V are given the results of a series of experiments in which some of the ideas expressed above were tested. In each case 5 g. of the standard aromatic sulfuric acid (20.14 per cent) were heated with 30 cc. of water, the period of heating ranging from 2 to 8 hrs.

TABLE V—COMPARISON OF RESULTS USING REFLUX CONDENSERS OR WATCH GLASS COVERS ON FLASKS, AND HEATING BY FREE FLAME OR ON WATER BATH

Heated Hrs.	REFLUX CONDENSERS Free Flame		REFLUX CONDENSERS Water Bath		WATCH GLASS COVERS Water Bath	
2......	18.74	18.73	17.53	17.58	18.76	18.79
4......	18.97	19.18	17.88	17.86	20.14	19.25
6......	19.46	19.34	17.86	18.01	20.16	20.13
8......	19.61	19.44	18.50	19.14	20.05	19.77

It is clear that much better results are obtained by the watch glass method, than where a condenser is used; also that continuous heating for more than two hours was necessary, in this method, to bring about the hydrolysis of all the ethyl-sulfuric acid.

A weighed amount of the standard aromatic sulfuric acid was mixed with 3 volumes of water and slowly boiled for 3 hrs. in a flask fitted with a Hempel tube and condenser. The alcohol was thus slowly distilled off and the water vapor, condensed in the Hempel tube, returned to the flask. Titration of the residual liquid gave for the total acid percentage, calculated as sulfuric, 19.94, instead of 20.14, actually present.

Two flasks, each fitted with a wide tube about 15 in. long, which served as a condenser, and each containing a weighed amount of the standard aromatic sulfuric acid diluted with 6 volumes of water, were each heated over a small flame in a Kjeldahl rack. The alcohol vapors slowly distilled off, while the water vapor was for the most part condensed in the glass tubes and ran back. On titrating, the liquid whose volume had been reduced to about 15 cc. gave 20.06 per cent; the other, reduced to about 25 cc., gave 19.88 per cent, acid calculated as sulfuric. Repeating the experiment in such fashion that the liquid volume was reduced in each flask to not more than about 10 cc., the figures obtained were 20.12 per cent in each case. These, as well as many other results obtained later, show, as was found by Kastle and Fraser[1] and by Brown,[1] that the hydrolysis of ethyl-sulfuric acid proceeds more rapidly when the solution is concentrated than when it is dilute.

These experiments indicated that satisfactory results might be looked for if the heating were so conducted that all free alcohol present might quickly evaporate and the aqueous solution of ethyl-sulfuric acid left be kept concentrated and hot, until hydrolysis is complete. A large excess of water serves no useful purpose, as the following experiments (Table VI) suggest: Three portions of an aromatic sulfuric acid, which contained 24.95 per cent of total acid calculated as sulfuric, were diluted with large quantities of water and distilled rapidly. This process removed the free alcohol, of course, but failed to break down the ethyl-sulfuric acid satisfactorily.

TABLE VI

No.	Aromatic sulfuric acid Grams	Water added Cc.	Time Min.	Distillate Cc.	Acid and Water Residue Cc.	Ratio acid Vol. to Water in Residue	Total acid Found Calc. as H_2SO_4
1	10	160	30	100	70	1:6	19.43
2	10	115	25	100	25	1:1.5	19.71
3	5	160	45	150	15	1:2	20.31

The least satisfactory result was obtained where the largest proportion of water remained at the end of the experiment. Although the concentration was ultimately greater in (2) than in (3), yet the last result was the best, probably because much more time had been given for hydrolysis to take place.

METHOD ADOPTED

Eight 5-gram portions of our standard aromatic sulfuric acid (20.14 per cent) were diluted each with 6 volumes of water and heated in open beakers upon a strongly heated water bath for different periods of time. The results appear in Table VII. Evidently, as soon as the proper *concentration* of acids and water is secured, the hydrolysis of the ethyl-sulfuric acid is fairly rapid and soon becomes complete, provided the water in the bath is kept vigorously boiling. If the beakers are covered with watch glasses, naturally more time will be required for completing the reaction than if the escape of vapor is unimpeded.

TABLE VII

No.	1	2	3	4	5	6	7	8
Time, hrs.	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4
Total acid Calc. as H_2SO_4	17.23	17.23	17.23	17.45	20.14	20.14	20.14	20.14

It may as well be pointed out here that, although ethyl-sulfuric acid may be quantitatively converted, in the presence of water, into sulfuric acid and alcohol, a similar statement may not be made with respect to its alkali salts. Aqueous solutions of the latter are but slightly, if at all, affected by boiling. Even when heated in the presence of sulfuric acid and water, the decomposition of alkali ethyl-sulfates into sulfuric acid, sulfate and alcohol, is very slow. Ostwald pointed out many years ago[2] that ethyl-sulfuric is a far stronger acid than sulfuric; and our work, in so far as it may be

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[1] THIS JOURNAL, **4** (1912), 512.

[2] *J. prakt. Chem.*, [2] **28**, 449; **29**, 385.

said to furnish evidence on this point, bears out this statement. One of the methods of assay which we attempted to employ was this: A known weight of aromatic sulfuric acid, diluted with water, was titrated while cold; an amount of sulfuric acid exactly equivalent to the alkali used in the titration was then added, and the liquid heated in an open beaker on the water bath. A second titration, it was hoped, would now show the total acid present to be sulfuric, and a comparison of the two titrations would tell us what amount of ethyl-sulfuric acid was originally in the mixture. But in this we were disappointed. The original diluted aromatic sulfuric acid contained 5.12 per cent total acid calculated as free sulfuric. The first titration showed 4.37 per cent; after heating 2$^1/_2$ hrs., the second titration showed 4.50 per cent; after 3$^1/_2$ hrs., 4.94 per cent; and after 4$^1/_2$ hrs., 4.94 per cent. The presence of alkali ethyl-sulfate thus greatly retarded, if it did not altogether prevent, the conversion of all the acid present into sulfuric.

It is difficult to say how long a given sample of aromatic sulfuric acid must be heated in the presence of added water in order that the hydrolysis of the ethyl-sulfuric acid may be assumed to be complete. In addition to the physical conditions of the experiment, we must naturally take into account the proportion of ethyl-sulfuric acid present in the mixture. Certainly in most cases four hours' heating in an open beaker on a water bath, in which the boiling is vigorous, will be found ample. In Table VIII are some results obtained with samples of unknown strength, where the periods of heating were not the same. The figures represent the percentage of total acid, assumed to be sulfuric, as found by titration.

TABLE VIII

Lab. No.	U. S. P. (1916) Method		Flask with Air Condenser over Free Flame		Open Beaker on Water Bath	
	Time	Results	Time	Results	Time	Results
11038	6 hrs.	22.20	1$^3/_4$ hrs.	24.54	4 hrs.	24.83
11047		22.16	1$^3/_4$	24.57	4	24.63
11051		10.39	3$^1/_2$	11.83	3$^1/_2$	12.47
11085		20.90	1$^3/_4$	22.25	4	21.96
11092		20.70	1$^3/_4$	22.22	4	23.22
11190		23.00	1$^3/_4$	24.95	4	25.26
11195		27.80	1$^3/_4$	28.37	4	28.52
11261		28.58	4$^1/_2$	32.49	4$^1/_2$	32.53
11563		35.28	4	35.81	4	35.77

It will be noted that, speaking generally, 1$^3/_4$ hours' boiling in a flask was not sufficient. In the case of No. 11051, the boiling was longer continued but was so slow that the volume at the end of 3$^1/_2$ hours' heating was only slightly reduced and, hence, the reaction was incomplete. The U. S. P. method gave low figures in every case.

It seemed to us desirable to study the hydrolysis of ethyl-sulfuric acid in the case of samples of aromatic sulfuric acid which had not been recently prepared. Accordingly a series of samples, put at our disposal by an important drug manufacturing house, were assayed, with the results given in Table IX.

Apparently the age of the sample affects very slightly, if at all, the hydrolysis of the ethyl-sulfuric acid present. It would also appear that, in order to meet the U. S. P. assay requirement, more sulfuric acid had been used in the manufacture of these preparations than corresponds to 20 per cent by weight.

TABLE IX—ANALYSES OF A SERIES OF MANUFACTURERS' SAMPLES

A—Percentages obtained by the chemists of the manufacturing firm at the time of the preparation of the samples in question, the U. S. P. method having presumably been used. B—Figures obtained by us by the use of the same method.

C and D—Results obtained with open beakers on the water bath, according, respectively, as 3 or 6 volumes of water were added for hydrolysis.

E—Results of direct titrations, made after dilution with water but without previous heating.

F—Percentages of the total sulfuric acid which have been converted into ethyl-sulfuric acid in the respective samples.

No.	Age	A	B	C	D	E	F
1	41$^1/_2$ mos.	19.90	25.40	27.56	27.56	19.11	15.3
2	37$^1/_2$	19.00	25.85	27.49	27.43	19.93	13.7
3	35	19.60	27.30	28.38	28.65	21.34	12.6
4	33$^1/_2$	19.70	26.51	27.69	27.69	20.05	13.8
5	27	20.10	23.89	26.02	25.95	18.67	14.0
6	25	20.40	27.25	28.49	28.65	20.85	13.5
7	22	21.00	27.41	28.86	28.86	20.95	13.7
8	16	19.80	26.32	27.86	27.90	20.00	14.1
9	13	19.50	26.24	27.07	26.95	19.53	13.8
10	8	21.00	25.67	26.71	26.65	19.41	13.6
11	1$^1/_2$	20.00	23.78	25.05	25.00	18.21	13.6

In conclusion, we have thought it well to put on record the results of a progressive distillation of aromatic sulfuric acid which had been diluted with over three times its volume of water. Our object was to show that hydrolysis hardly begins until after the removal of the alcohol present as such in the mixture, and that thereafter the increase in the proportion of free sulfuric acid keeps pace with the removal of alcohol by distillation.

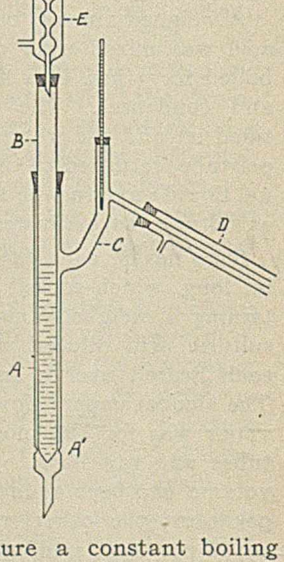
As the apparatus used possibly exhibits some points of novelty, a short description of it may not be out of place. The boiling liquid was contained in a round-bottomed flask through the stopper of which were fitted:

(1)—A thermometer whose bulb was in the boiling liquid.

(2)—A tube through which an aliquot of the liquid could be withdrawn by means of a pipette, and

(3)—The distilling tube shown in the figure.

The inner tube *B* (about 27 × 2 cm.), closed at the bottom and provided with a reflux condenser, *E*, at the top, has an outside diameter about 4–5 mm. less than the bore of the outer tube *A;* the latter is provided at *A′* with three "dimples" which hold *B* in place, and a side-tube, *C*, which contains a thermometer and connects with a condenser, *D*. The tube *B* is partly filled with the same liquid which it is proposed to distil off from the flask—in this case alcohol. The mixed vapors of alcohol and water rise into the annular space between *A* and *B*, where the water is condensed on coming in contact with *B* and flows back; as soon as the alcohol in *B* is heated to boiling the alcohol vapor from the flask passes into *C* and so to the condenser *D*. To secure a constant boiling temperature for the condensing tube *B*, a bundle of



capillary tubes closed at the top and projecting above the liquid surface are placed in *B*.

In order to give an idea of the efficiency of this apparatus, the following may be stated:

Redistilled alcohol was put in *B* and a mixture of 10 cc. alcohol and 240 cc. water was boiled in the flask; when 10 cc. of distillate had been collected, the operation was stopped. The distillate proved to be 95.6 per cent alcohol and there was no alcohol in the residual liquid in the flask.

A mixture of 180 cc. aromatic sulfuric acid and 580 cc. water was placed in the flask and boiled. Ordinary alcohol was placed in *B*. At the end of each half-hour the thermometer readings and the volume of the distillate were noted, after which 5 cc. of the mixture were withdrawn from the flask, cooled, diluted and titrated, while the distillation was resumed. In Table X are given the results. The respective weights of "free H_2SO_4" and "combined H_2SO_4" were obtained in this way: the 5 cc. of liquid withdrawn from the flask were made up to 25 cc. with water; of this dilute solution 10 cc. were titrated at once and 10 cc. were completely hydrolyzed in an open beaker on the water bath and then titrated. From the data thus secured the amount of free sulfuric acid and that of the ethyl-sulfuric acid present in each 2 cc. of the liquid in the flask are calculated.

TABLE X

Time Hrs.	Distillate Cc.	Thermometer in vapor	Reading in boiling liquid	Weights of H_2SO_4 in 2 cc. of Liquid Free	Combined	Ratio of Free to Total H_2SO_4 Per cent
0.0	0.0	78°	89.10°	0.0488	0.0343	79.35
0.5	43.50	78	91.40	0.0532	0.0328	79.51
1.0	80.00	78	93.50	0.0593	0.0314	82.70
1.5	109.20	78	95.90	0.0652	0.0304	84.10
2.0	129.60	78	97.90	0.0721	0.0255	86.93
2.5	141.80	78	99.30	0.0758	0.0231	88.34
3.0	148.70	78	99.80	0.0821	0.0181	91.44
3.5	152.20	78	100.10	0.0870	0.0152	92.56
4.0	154.30	74	100.30	0.0888	0.0147	92.89
4.5	155.80	69	100.50	0.0917	0.0118	94.31
5.0	156.30	60	100.70	0.0939	0.0093	95.49
5.5	156.90	60	100.85	0.0956	0.0088	95.77
6.0	157.20	50	101.00	0.0964	0.0073	96.46
6.5	157.50	48	101.15	0.0991	0.0050	97.64
7.0	157.70	48	101.30	0.1003	0.0034	98.34
7.5	157.80	48	101.45	0.1005	0.0029	98.58
8.0	158.40	48	101.70	0.1010	0.0019	99.05
8.5	158.80	48	101.85	0.1020	0.0015	99.52
9.0	159.00	48	101.90	0.1033	0.0003	99.86
9.5	159.00	48	102.05	0.1040	0.0000	100.00
10.0	159.00	41	102.10	0.1040	0.0000	100.00
10.5	159.00	40	102.10	0.1040	0.0000	100.00

It will be noted that throughout the distillation the temperature of the vapor in the side-tube *C* never rose above 78°; after the bulk of the alcohol had been removed, the reading of this thermometer slowly fell, since the quantity of vapor passing through *C* became less and less and the loss of heat through radiation from the thermometer bulb was not compensated for. At the same time the temperature of the boiling liquid slowly rose as alcohol was distilled off. The sum of the "free" and the "combined" acid also slowly increases, for the percentage of total acid in the boiling liquid rises as the alcohol is removed. Finally, we may note that under the conditions of the experiment over 9 hrs.' boiling was needed for the complete hydrolysis of the ethyl-sulfuric acid present.

LABORATORY OF THE MARYLAND STATE
DEPARTMENT OF HEALTH, BALTIMORE

RENNIN—A NOTE AND A CORRECTION

By HOWARD T. GRABER

Received May 27, 1916

Rennin is not official in the sense that it is recognized by either the United States Pharmacopoeia or the National Formulary, hence there is a wide variation in the article as found upon the market, as well as in the methods used for its standardization. It is universally recognized as a milk coagulant and all methods use milk as a medium for standardization.

In 1911 I published an article[1] entitled "Some Observations upon the Assay of Digestive Ferments." In this article I included the assay used by me in the standardization of rennin. There was an error in this script which has since been corrected. This error to which I want to call especial attention was in the amount of milk specified to be used for the test. It was just twice the volume intended, so that the results by this error were just half what they should be, or in other words the rennin seemed to be just half its real strength. I have tried other methods proposed, but I recommend the method as published by me both for its simplicity of operation and the reliability of the results obtained when one uses a standard of known value as control.

The enzyme rennin, like all other enzymes, is distinctly specific in its reaction and it shows its selective characteristics as to the nature of the proteid, temperature and reaction of the media as well as the presence or absence of organic and inorganic salts, especially those of calcium and the phosphates. Results often vary when samples of milk are used from different cows, as well as different lots from the same cow, and the best results are obtained when using a mixture from the milking of many cows. There also seems to be a *seasonal variation* in the ability of the milk to coagulate.

The following table gives the results of many of the tests:

DATE	ASSAY 1:30,000 in Min.	Sec.	MONTHLY AVERAGE Min.	DATE	ASSAY 1:30,000 in Min.	Sec.	MONTHLY AVERAGE Min.
4/ 1 to			7.5	11/ 5/15	10	30	
4/15/14				12/ 3/15	10	30	
8/ 7/14	10	30		22	11	30	
8	10	30	9	23	8		
10	7	30		24	10		10.5
15	7	30		27	13	30	
9/ 1/14	9		9	28	7	30	
1/24/15	16		13.75	29	11		
21	11	30		30	11		
2/16/15	8	30	9.25	31	11		
22	10			1/ 3/16	10	30	
3/ 8/15	10		11	4	11		
31	11			5	10		10.5
5/ 5/15	8	30		6	11	30	
13	11	10		7	11		
17	11		10.3	8	10		
27	10	45		2/14/16	11		11
29	10	45		3/ 6/16	10		
30	10	10		7	9	45	
6/ 1/15	9	5		8	7	30	
7	11			9	7	30	
12	8	30		10	5	30	
17	10	15	10.6	11	9	30	
22	12			12	9	30	7.5
22	12			14	8		
29	11	30		23	11	15	
7/ 2/15	8	45		24	7		
7	8			28	4		
9	8		9.3	29	6		
10	8	45		30	4		
21	12			31	7		
22	10						

Several years ago I selected a rennin to be used as a standard in the assay of this enzyme, and I have

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[1] THIS JOURNAL, **3** (1911), 919.

followed it quite consistently ever since. In the spring of the year 1914 it was tested for a period of 14 days and was found to assay 1 : 30,000 in 7$^1/_2$ min. and was accepted as such. In every assay made since then it has been run as a check upon the unknown sample.

There are 74 assays here enumerated extending over a period of about 2 years. A series of 14 assays in April, 1914, averaging 7$^1/_2$ min.; a second series of 14 in December, 1915, and January, 1916, averaging 10$^1/_2$ min., and a third series of 14 assays in March, 1916, averaging 7$^1/_2$ min.

This is certainly a very interesting state of affairs and the natural question to be asked is, "What is the cause of this variation?" There are many causes: some are known and some we are still studying.

My experience seems to show that the rennin coagulates more quickly in the fall and spring than in the winter and summer, and this fact seems to prove my contention that there is a seasonable variation in the milk.

There may be several explanations of this phenomenon. The cattle may get more exercise and more organic and inorganic salts in the spring, summer and early fall, than in the winter, hence their milk supply may vary, especially in relation to its coagulability. If this be so, the question rises, why does not the summer supply show this same increment in coagulability? My answer is that it would if we could regulate the supply, but during the hot summer months the milk is so prone to temperature changes that this offsets the other advantages. Then, too, the period of lactation is an important consideration and milk will show great variations in composition during this time.

It is an established fact that the rennet coagulation proceeds in three[1] stages: (1) The calcium casein is changed into the para casein; (2) the rennet enzyme seems to act upon the insoluble calcium salts of the milk, converting them into a form sufficiently soluble to enable them to coagulate the calcium para casein; (3) the true coagulation.

It is the second change or conversion of insoluble calcium salts to soluble salts which seems to retard the progress of coagulation, and I have noticed that in those cases where the time of coagulation was prolonged, the viscosity of the milk gradually changes; it seems to thicken and acts as if it almost wants to coagulate, but something seems to hold it back—either calcium salts are lacking or the insoluble calcium salts are with difficulty made soluble and available. I have also noticed that if a milk, acting in this manner, is divided into two portions, to one of which a soluble calcium salt is added, the coagulation period is much advanced in this portion when compared with the portion to which no soluble calcium salt has been added. Hence my statement that the seasonal variation in milk is an important factor.

There are other factors which, without a doubt, influence this coagulation period. Various samples of milk will show a variation in the fat content and although the large creameries standardize the per cent of fat in their milk, the smaller creameries do not, and the inclusion of a superabundance of fat globules in one sample of milk undoubtedly will have some bearing upon the ease of coagulation.

The effect of bacterial content is an important factor. The milk examined by the Detroit Board of Health ranges in bacterial count from 3,000 to 1,500,000 bacteria per cc., which variation must certainly exert some influence upon rennet action.

The range of reaction of the milk within the perceptible limits of litmus test is an important item for consideration. In some cases I have found that a milk which has started to sour and thus had developed acidity above normal, seems to accelerate the coagulation period of rennin; in other cases it has inhibited it.

The "hydrogen-ion" concentration, a fact overlooked in the past by most of us but receiving more or less consideration at present, may help us clear up some of these peculiarities in enzyme activity. I look forward to the time when we can eventually adopt a standard milk of normal hydrogen-ion concentration and adjust our enzyme solution to a hydrogen-ion concentration found to give its optimum activity, and thus have our method under absolute and scientific control.

Until such time as this arrives, the results here enumerated lead me to say, "Know your standard." Do not adopt it on a single test or even a single series of tests, but follow it through a series of months as I have mine, then assign a strength which seems a fair average.

The method I use for testing follows, with the correction before cited.

(1) Only fresh, whole, unpasteurized milk is to be used, preferably from a herd of many cows.

(2) *Milk*—Heat 2 qts. gradually to 43° C.; mix well and take 1 qt. for the unknown sample and the other for the standard. Do not overheat the milk and if by chance it has been heated high enough to produce a thin skin, discard and use a new lot.

(3) *Rennin Solution*—Dissolve 0.4843 g. rennin in 150 cc. distilled water, mix thoroughly by inversion gently, and take 10 cc. for a test (10 cc. upon 1 qt. of milk gives a proportion of 1 : 30,000). Do not shake the rennin solution violently or the agitation will injure the strength of rennin.

(4) Measure 10 cc. rennin solution into a widemouth precipitating jar of about $^1/_2$ gal. capacity; add 1 qt. of milk at 42° C., mix thoroughly by pouring rennin solution and milk 3 times from one jar to another, taking time with stopwatch after the first pouring. The milk should now be just 40° C. Keep the temperature at this point and test the milk for curd formation at half-minute intervals by tipping the precipitating jar forward gently; note the time required to separate the casein from the liquid whey; report the sample as 1 : 30,000 in this time.

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[1] Allen's "Commercial Organic Analysis," 8, 126.

PEPSIN—A RÉSUMÉ OF TESTS

By Howard T. Graber

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In a previous article[1] entitled "Some Observations upon the Assay of Digestive Ferments," I called attention to the great variation in the apparent strength of a sample of pepsin due to the age of the egg used in the test, and showed that eggs between the ages of 5 to 7 days leave the least residue when used in testing the strength of the pepsin. I therefore recommended, for uniformity in results, that chemists adopt age limits for their eggs when testing pepsin, and it is interesting to note that the Revision Committee of the Pharmacopoeia, having confirmed these findings, have adopted this egg limit in their revised test for pepsin. The revised wording, which I have every reason to believe will appear in the U. S. P. IX test for pepsin, will state: "Immerse a hen's egg, which should not be less than 5 nor more than 12 days old."

After having determined the large factor which the age of the egg bears in the assay of pepsin, it was of interest to me to know how my results would vary when choosing my eggs as to age and when going into the open market and buying "strictly fresh eggs" from a reliable dealer.

I have compiled the results from a series of many tests. Part of these tests were made with eggs of known age (5 to 12 days), and the balance with so-called "strictly fresh eggs." The pepsin used in all these tests was a sample found to leave a residue of about 1 cc. under ideal conditions and was chosen because of the fact that it is easier to note slight differences in strength with a residue of 1 cc. than with a smaller residue.

Table I—Pepsin Tests on Eggs of Known Age

Assay Date 1915	Age of Eggs Days	Residue Cc.	Assay Date 1915	Age of Eggs Days	Residue Cc.	Assay Date 1915	Age of Eggs Days	Residue Cc.
2/13	7	1.25	4/ 3	8	0.75	6/ 2	10	0.6
15	7	0.6	8	9	0.75	7/ 2	10	0.4
19	7	0.9	9	10	0.45	24	12	0.4
20	7	1.25	10	8	1.5	8/ 2	10	1.0
22	7	1.25	12	8	1.0	4	10	0.95
25	10	1.0	13	9	0.6	6	10	1.0
26	5	1.0	14	8	0.5	10	7	0.8
4	10	1.25	15	9	1.5	9/ 3	7	0.75
5	9	1.0	26	7	0.3	6	7	0.8
8	7	0.5	27	8	0.25	9	7	1.0
			29	9	0.4	10	8	1.0
10	9	1.0	5	9	0.35	14	9	0.8
12	6	1.0	7	10	0.5	16	8	0.8
17	9	1.0	8	8	1.25	17	7	0.9
20	8	1.0	14	11	1.25	18	7	1.0
26	6	1.5	21	11	0.65	20	8	0.65
31	7	0.55	22	7	0.55			
			26	10	0.25			

Table I includes a series of 50 assays from eggs of known age, and of this series we find:

28 assays (56 per cent) below 1 cc.
40 assays (80 per cent) not more than 1 cc.
10 assays (20 per cent) above 1 cc. Of the latter 10, just 2 are 1 1/2 cc.

Table II—Pepsin Tests on Eggs of Unknown Age but Guaranteed "Strictly Fresh"

Assay Date 1915	Residue Cc.	Assay Date 1915	Residue Cc.	Assay Date 1915	Residue Cc.	Assay Date 1916	Residue Cc.	Assay Date 1916	Residue Cc.
9/23	1.0	10/25	0.7	12/ 2	0.85	1/10	1.0	2/10	1.0
28	1.0	29	0.6	3	0.4	13	0.6	11	1.0
10/ 4	0.9	11/15	0.5	8	0.4	14	0.9	14	1.75
5	2.25	9	0.5	9	0.9	17	1.25	15	2
7	2.25	11	0.5	10	0.3	19	0.3	18	1
8	2.5	16	0.7	17	0.5	28	0.65	21	1.75
13	2.25	17	2.0	20	0.7	2/ 5	2.5	23	1
14	1.25	22	0.45	23	0.8	7	3	25	2.25
17	1.75	26	0.3	28	2.0	4	2	28	0.9
20(a)	0.75	29	0.2	29	1.25	6	1.0		
				31	0.3				

(a) Source of supply changed.

Table II includes a second series of 50 assays from eggs supposedly fresh, but of unknown age. Here we find:

25 assays (50 per cent) below 1 cc.
32 assays (64 per cent) not more than 1 cc.
18 assays (36 per cent) above 1 cc.

Of these last 18 assays with a residue more than 1 cc., the largest residue recorded was 3 cc. Whether the eggs used in this test were too fresh, or, on the other hand, older than the age limit previously described, I did not determine.

The two tables show well the advantage accruing in choosing eggs of known age, and in the testing of pepsin as well as with rennin, I repeat my caution—"Know your standard." Always use a standard pepsin as control, whose strength you have tested under different conditions as to age of eggs, etc., and draw your conclusions as to the strength of the unknown samples from the deportment of said control.

In concluding, I wish to state that in the above assays the conditions such as temperature, agitation, reaction, etc., were under absolute control, and the error due to the personal equation has been eliminated as far as possible.

Another fact brought out in this connection which I have not heard discussed is this: If we can determine the strength of pepsin by the age of the egg, the contrary is also true. We can approximately determine the age of a number of eggs by testing against a pepsin of known strength. If the residue is much more than experience has shown the control to run with eggs 5 to 12 days old, it is natural to assume that it is due to one of two causes: Either the eggs are absolutely fresh, or they are more than 12 days old. If they are too fresh and one has supply enough, they can be kept for 5 or 6 days and another assay made. If with this second assay a marked decrease in the amount of residue is shown, the eggs can be considered as strictly fresh. If the residue continues to increase, they were more than the age limit to start with and hence not strictly fresh.

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[1] This Journal, 3 (1911), 919.

LABORATORY AND PLANT

ARTIFICIAL GAS-FIRED FURNACE INSTALLATION

By Charles E. Richardson

Received August 14, 1916

One of the largest, if not the largest artificial gas-fired furnace installation in this country has been made in the plant of the Eddystone Ammunition Corporation, Eddystone, Pa., for the purpose of hardening and tempering (or drawing) 3-in. shells. The installation consists of three hardening furnaces and three tempering furnaces. One hardening and one tempering furnace are at present under construction and two each at present in operation. The furnaces are arranged in units—one hardening and one tem-

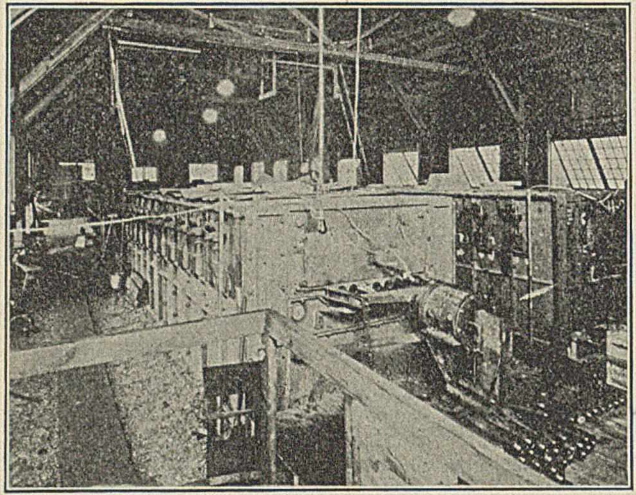

FIG. I—VIEW TAKEN FROM CONTROL PULPIT
Showing front (or charging end) of Hardening Furnaces, with pushes in place. Tempering furnaces can be seen in center on left behind Hardening Furnaces with oil-quenching tanks between. Note red flash lights in front of furnaces, covered conduits for piping and pyrometer locations.

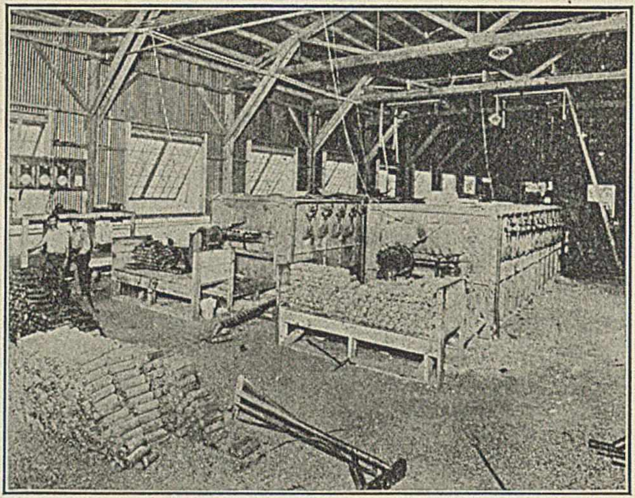

FIG. III
Same view as Fig. I, but taken from opposite side, showing on left (inside of railing) the control pulpit. Note indicating and recording pyrometers, valves and flashers.

pering furnace comprising a unit. Each unit is designed to turn out 5,000 shells in a 20-hr. day. The full capacity of the installation (3 units) would be 15,000 shells per 20-hr. day.

The furnaces are operating at the high average efficiency of 32 per cent—furnace efficiency meaning the percentage of available heat units in the fuel consumed which are actually absorbed by the work being done, in this case heating steel.

The furnaces, designed and installed by the Surface Combustion Company of New York City, are fired by the surface combustion high-pressure system—a process whereby gas under pressure is made, by means of a special governor, to inspirate all the air necessary for complete and perfect combustion, maintaining, automatically, constant mixture proportions and eliminating all motors, blowers and air piping (Fig. II).

Gas under a pressure, ranging from 10 to 25 lbs. per sq. in. passes cock, A, continues through strainer, B, and enters nozzle, C. A portion of the pressure energy of the gas in passing from nozzle, C, into throat, D, is transformed into velocity energy. The pressure head on air opening, E, is thereby reduced, causing air to flow first into air-chamber, F, and from thence into throat, D, where it joins with the gas. The high velocity at the throat, D, mixes the air and gas thoroughly and the velocity head of the mixture is transformed back into pressure head by the pressure tube, G. The mixture then continues to the burner.

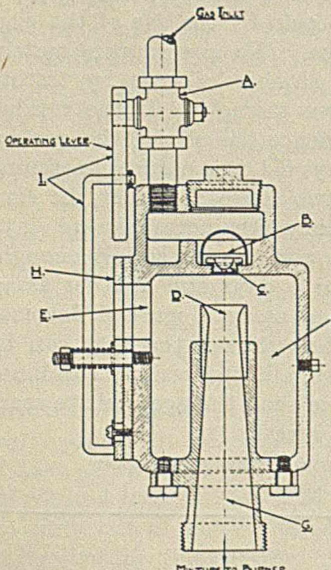

FIG. II

The burners are inserted at the sides of the furnaces and incline downward. The homogeneous mixture of air and gas from the inspirator is forced through the burners at a velocity greater than the rate of flame propagation and each flame strikes a baffle consisting of carborundum or other refractory material resting on the bottom of the furnace. This material attains an intense heat which is radiated very evenly upon the shells, from off the arched top of the furnace.

Each furnace is approximately 22 ft. long, 8 ft. wide and 7 ft. high (outside dimensions) and is set on a slight slope. The furnaces are encased in cast iron casings held together by heavy tie rods and are mounted on concrete foundations. The heavy fire brick linings are backed up by Sil-O-Cel, giving plenty of insulation. This cuts down the radiation losses and protects the operators from the heat. The furnaces are as air-tight as possible. To prevent leakage in of cold air, which would produce an oxidizing effect and, by its cooling action, lower the furnace efficiency, a slight furnace back-pressure is maintained. As in all surface combustion work the furnaces are so designed as to develop and utilize the maximum possible amount of radiant heat. The flues are arranged so as to distribute the hot gases uniformly and to release them at the lowest possible temperature. The hardening furnaces are equipped with 22 high-pressure burners, and the tempering furnaces with 18. All piping is laid in conduits having removable covers, thereby eliminating all overhead work. To give an idea of the simplicity of the system the largest pipe used is a 2 in. Each burner is fed by a 1/2-in. pipe from a 1-in. manifold.

The fuel is a 580 B. t. u. gas (a mixture of water and coal gas), supplied by the Philadelphia Suburban Gas and Electric Company, Chester, Pa. The gas is delivered and metered under a pressure of 25 lbs. It is metered by a Rotary pressure meter and a Bailey flow meter. Each unit consumes an average of 3,300 cu. ft. of gas per hr., turning out 240 shells per hr., or 8

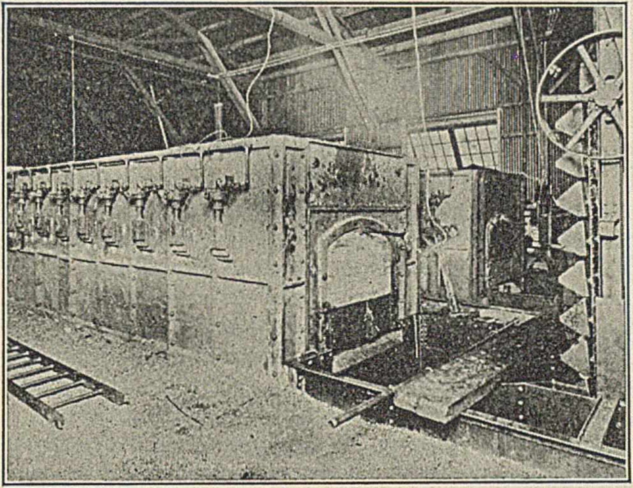

FIG. IV
Rear (or discharge end) of Hardening Furnace. Hot shells pop out of opening, covered by iron flap on hinge, into oil-quenching tank. They are removed from tank by elevator conveyor to drain tables, and are then fed into Tempering (or drawing) Furnace.

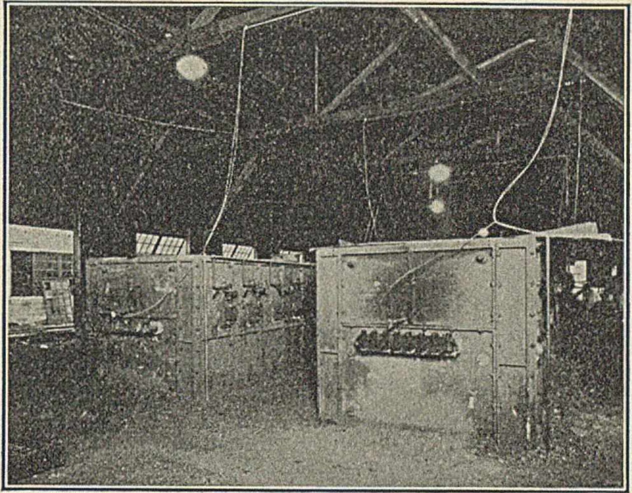

FIG. V
Rear (or discharge end) of Tempering (or drawing) Furnaces. Shells pop out of tubes with flap covers to keep out air.

shells every 2 minutes. Therefore, when all these units are running at capacity, 9,900 cu. ft. of gas per hr. would be consumed, and for a day of 24 hrs., 237,000 cu. ft. of gas, and for 300 such days approximately 70,000,000 cu. ft. of gas. (While shells are turned out during only 20 hrs., the furnaces are kept hot the entire 24 hrs.) The cost of gas in this case is based on a sliding scale rate. The approximate average rate for this work is 43 c. per M. cu. ft.

METHOD OF OPERATION

The shells made are 3 in. in diameter and approximately 8$^1/_2$ in. long. They vary in weight from 8 to 11 lbs. The hardening is done at an average temperature of 1500° F., and the tempering (or drawing) at an average of 1100° F. Each shell is in each furnace for a period of approximately one hour.

Running through each furnace are 8 steel angles which act as troughs to carry the shells. An air cylinder with an arm attached to the piston rod acts as a pusher. A man stands in front of each furnace and feeds shells into the angle troughs. Every 2 minutes the pusher pushes the shells ahead the length of a shell. This causes 8 shells to discharge into the oil-quenching bath located at the discharge end of the hardening furnaces, from which they are taken when sufficiently cool and fed into the tempering furnaces in exactly the same manner.

Frequent flue gas analyses have shown oxygen = 0.0, carbon monoxide = 0.0, and an average of 15.2 carbon dioxide. This shows that the heat is generated with 100 per cent efficiency having no excess air or unburned gases. For the purpose of minimizing the scaling of the shells and to lengthen the life of the angle troughs the furnace is operated with a slightly reducing atmosphere-carbon monoxide reading between 0.3 and 0.5 per cent. This is done to be on the safe side, as an oxidizing atmosphere would be very injurious in this operation.

CONTROL

All of the furnaces are controlled from a central control pulpit. Each furnace is controlled by a single valve which regulates the pressure supplied. The maximum pressure is 25 lbs. and the minimum 5 lbs. The average operating pressure is 15 lbs. All pyrometers, both indicating and recording, are also located in this pulpit. This allows one man to operate easily all of the furnaces. This feature has resulted in considerable saving of labor, since frequently as many as 8 men have been necessary to care for burners and the control of temperatures on a similar number of furnaces of the same size, fired by oil. This feature also allows much more accurate and careful control as evidenced by the practically straight line pyrometer charts which are secured daily. There is also located in this pulpit the electric flasher, which times the charging operation. This machine flashes a red light in front of each furnace every 2 minutes, which flash is the signal for the men to operate the pushers. The furnace operator in the control pulpit, each shift, receives his temperature and time instructions and is able to follow these instructions with the greatest accuracy without moving a step. This pulpit is the brains and heart of the heat-treating building, clock, bells, etc., all being located there.

COMPARISON WITH FUEL OIL

These furnaces are installed in the face of the competition of fuel oil costing 0.045 per gal. Several oil-fired furnaces of practically the same size and doing the same work were in operation prior to the installation of these furnaces. One of these oil-fired furnaces was carefully tested, over a period of several days, the oil being measured in a calibrated tank. Subsequent tests of the gas-fired furnaces have proven conclusively (as was believed in the beginning) that the operating cost of the gas-fired layout is very considerably lower than that of the oil. While it is not argued that all furnace operations can be done more economically with this sytem of gas-firing, still it has been proven beyond doubt that quite a percentage of large furnace work can be done considerably more economically than with oil. Generally speaking, 600 B. t. u. gas at 50 c. per M. compares very favorably with

0.04 per gal. oil in a good many cases, using the surface combustion, high-pressure system in properly engineered and designed furnaces.

For a plant putting in new furnaces where all the necessary equipment must be purchased, the initial cost of installation of this system of gas-firing will be found fully 30 per cent less than the cost of the necessary equipment, including furnaces, for an oil-fired installation. This system of gas-firing, eliminating, as it does, all air or steam supply and the consequent equipment for such, can be compared very favorably with even considerably higher priced fuels, as air and steam and the handling of them cost money, which is just as valuable as the money paid out for the actual fuel. The above figures, however, do not include any of these considerations but are based on straight fuel against fuel costs.

Long Island City
New York

SOME FEATURES OF SWIMMING POOL CONTROL[1]

By W. Lee Lewis[2]

Received June 19, 1916

The responsibility for careful sanitary supervision on the part of those in charge of indoor swimming pools is increasing with the rapid increase in the number and patronage of these pools. Twenty years ago there were few indoor tanks. To-day, every up-to-date gymnasium gives a large place to this splendid feature of physical training. Almost every men's club, many large hotels and some of the larger passenger steamers, maintain swimming pools. Moreover, there is a growing tendency among educational institutions to require swimming as a part of the curriculum. This is true among the secondary schools of New York State and practically so at Northwestern University. The University of Illinois requires of its men students the ability to swim fifty yards. Princeton and Wisconsin require one hundred yards, and the navy a quarter of a mile. Obviously, enforced usage means definite legal responsibility for accidental infection traceable to faulty sanitary control.

Likewise, it must be noted that, through health departments, school instruction, government publications, the press, etc., the general public is gaining a new knowledge of sanitary matters, and sanitary standards in all things are rising rapidly.

The possibilities of an indoor swimming tank becoming unhygienic are apparent when one considers the intensive usage of a relatively small body of water and the absence of sunlight, fresh air, sedimentation and the various forces operative in the self-purification of outdoor waters. Furthermore, the coughing and spitting of the average swimmer is most favorable to contamination of the water with those disease germs typical of the respiratory tract, as those of tonsilitis, pneumonia, common colds and sore throat.

Possible swimming pool infections might be grouped under three heads: gastro-intestinal, respiratory and venereal.[1] To the second group should be added eye infections and possible infections of the skin and outer ear. Organisms causing such trouble would include *staphylococcus*, *streptococcus*, *pneumococcus*, *B. coli*, *B. typhosus*, *gonococcus*, etc.

In respect to intestinal infections, it has been repeatedly established that these may follow bathing in contaminated water.[2] An excellent review of the literature bearing upon this point may be found in a recent article by Mannheimer.[3] In view of the demonstration of *B. coli* in swimming pool waters by practically every worker in the field, the possibility of transmission of gastro-intestinal diseases is apparent. One point, in this connection, is the increasing recognition of typhoid carriers. Since the discovery of the famous "Typhoid Mary,"[4] who infected 26 persons, some fatally, studies have been made showing the prevalence of such types.

Rosenau[5] states that "4 per cent of all typhoid fever patients continue to discharge typhoid bacilli in the urine and feces during and after convalescence." Albert states that 1 person in every 1000 of population is a carrier. Studies by Lumsden and Anderson,[6] on the Washington population during which the feces of 1000 healthy persons were examined, led them to conclude that 0.3 per cent of the general population discharge typhoid bacilli.

The American literature records no cases that have come to the author's notice of actual diseases of this group proved to have originated in swimming pools.[7] Klein and Schütz,[8] however, reported cases of typhoid fever in 6 soldiers who had bathed in water close to the mouth of a city drainage canal; 34 cases of enteric fever were reported among soldiers who had bathed in a swimming pool which derived its water from a polluted source.[9] About 10 per cent of the men using the pool became infected, while only 1 case developed among those who did not use the pool. Baginsky[10] demonstrated 6 cases of typhoid infection as coming from a swimming tank.

The epidemiology of swimming pools offers more direct evidence of infection from diseases in the second group. Baginsky[11] reported several cases of rhinitis from a swimming tank. Fehr[12] reported a number of cases of conjunctivitis among users of a public bath in Berlin. Burrage[13] notes mild epidemics of

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[1] Presented at the 52nd Meeting of the American Chemical Society, Urbana-Champaign, April 18 to 21, 1916.

[2] Assistant Professor of Chemistry, Northwestern University, and City Chemist, Evanston, Ill.

[1] Atkins, *Proc. Ill. Water Supply Assn.*, **1911**.

[2] Jager, *Z. Hyg.*, **12** (1892), 525; Pfuhl, *Deutsche, Militärärztl. Wochenschr.*, **17** (1888), Heft 9; Schäfer, *Ibid.*, **17** (1888), Heft 5; Lenhartz, *Münch. Med. Wochschr.*, **21** (1892), 898; Klein and Schütz, *Wiener med. Wochschr.*, **6** (1898), 238; Drescher, *Sanitätsberichte über die Kgl. Preuss. Armee*, **1898/99**, I Teil, C. I. Gruppe 10 Unterabt.

[3] Mannheimer, *J. Infect. Dis.*, July, **1914**.

[4] Parks, "Pathologic Bacteria and Protozoa."

[5] Rosenau, "Preventive Medicine and Hygiene," p. 83.

[6] Lumsden and Anderson, *Bull. Hyg. Lab.*, U. S. P. H. S., **78** (1911).

[7] Cf. Rettger and Markley, *Eng. News*, **66**, 636; Whipple and Bunker, *Munic. J.*, **31**, 526.

[8] Klein and Schütz, *Weiner med. Wochschr.*, **6** (1898), 238.

[9] Mair, *Proc. Roy. Soc. Med.*, **2** (1908–9), Pt. 2, 227.

[10] Baginsky, *Hyg. Rundschau*, **6** (1896), 597.

[11] *Loc. cit.*

[12] Fehr, *Berlin klin. Wochschr.*, **37** (1900), No. 1.

[13] Burrage, *Proc. Ind. Acad. of Science*, **1909**; cf. *Eng. News*, **63** [25], 740.

sore throats and colds at the Purdue gymnasium pool. The author[1] "noted a prevalence of colds, sore throats and some cases of la grippe and pneumonia, rather strikingly restricted to the users of the swimming tank in Northwestern gymnasium." That was, however, before chemical sterilization was introduced and it is only fair to state that since that time, during which period the water has been carefully watched and treated with hypochlorite, no infection of any kind has been traceable to the pool.

Bunker[2] states that at Brown University no epidemics of any sort could be directly attributed to the pool, but affections of the nose and ear were occasionally found among members of the swimming team. Whipple[3] notes the occurrence of similar mild infections from the Brooklyn Polytechnic swimming pool. Tully[4] concludes that the "Wisconsin University pools are kept in excellent sanitary condition and there is little danger of disease transmission." Levine[5] states that: "During the two years' service of the tank at the Iowa State College, there has been no epidemic of any kind traceable to the pool, but there have been sporadic complaints of colds and sore throats. The danger of infection in pools has probably been overemphasized."

Dr. Cobb[6] says he has had occasion to treat "quite a number of cases of ethmoiditis and acute otitis media which apparently were caused by diving in a swimming tank." He states that a swimming tank can not be kept sterile. "Even if we succeeded in sterilizing it, the first person who entered would contaminate the water anew." Dr. Cobb objects to diving especially and states that people do this "because they are deceived by the ostentatious methods which are employed and believe the water is clean." One of his cases, H. J., 17 years old, made five visits to a swimming tank and returned with acute ethmoiditis. The disease disappeared when the patient refrained from diving. Two other cases, one sub-acute otitis media, the other otitis media, arose from a lake boy's camp. J. S., aged 14, had double ethmoiditis. The author concludes: "These cases are selected out of a large number of similar cases of infection acquired in this way. The danger is a very real one and it would seem that the sooner those who patronize these swimming tanks realize the danger of it, the better it would be for the health of their upper respiratory tract."

In the absence of statements as to the hygienic precautions taken at these particular tanks, charged with having produced ear and nose infections, it would not seem warrantable to assume that they were typical and that, therefore, these are results to be expected from any swimming tank. Definite proof as to the origin of the infection, as well as the meagerness of the data, would not warrant any sweeping generalizations such as that with which the author concludes. Moreover, it is hardly fair to accuse those in charge of swimming tanks with having invited a false sense of security through "ostentatious methods" of keeping the water clean. Finally, the article was written in 1908 and cannot consider the great progress made in swimming tank hygiene during the past eight years. The article was quoted as one of a few going directly on record in the matter of swimming pool epidemiology.

Danger from gonorrheal infection through swimming pools seems least probable as the specific organism is very short-lived in water. No cases of such infection are on record although the possibilities under careless tank control are evidenced in the articles of Hertzka,[1] Steiker,[2] Skutsch,[3] and Bending.[4]

Turning now to the means of safeguarding the swimming pool, the following items are in point: (1) construction and equipment, (2) disinfection, (3) suits, (4) the preliminary shower, (5) inspection and exclusion, (6) sanitary education of pool users, (7) bacteriological control.

POOL CONSTRUCTION is now fairly well standardized. All pools should have smooth walls and bottoms and be free from all obstructions. The maximum of air, light and ventilation should be provided. It is unfortunate that custom and plumbing exigencies have too often relegated the swimming pool to the basement. There should be a raised, broad flat ledge about the pool to protect it from floor drainage. There should also be a combined life rail and overflow gutter, sometimes called a scum gutter. Among other things, such a device protects the wall from discoloration by lapping water. Vacuum cleaning should be provided for the removal of the mixture of hair, lint, rust and coagulum that accumulates in every tank. While not a menace to the health of the swimmers, this material should be removed for aesthetic reasons at least.

Under the heading of construction and equipment comes the question of intermittent cleansing and filling *vs.* continuous re-filtration with complete cleansing and refilling only at wide intervals.

At first thought, a tank cleansed and re-filled weekly or bi-weekly would seem to offer a safer water than that in which the same water has been rotated several weeks. As will be shown later, however, there is no direct relation between the number of pool fillings per week and the sanitary condition of the water.[5] A pool is contaminated very quickly and normally; the contamination, as indexed in the bacterial count, increases until the third day when it falls somewhat.[5] On the other hand, if the pool water is being filtered continuously while being used and a certain amount of fresh water added every day, other things being equal, it will not reach the same degree of pollution as in the intermittent system. The latter system also saves heat and water and maintains the pool at a more uniform temperature. As a matter of fact, neither system is adequate without daily sterilization.

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[1] Lewis, *Eng. News*, June 8, **65** (1911) [23], 689.

[2] Bunker, *Am. J. Pub. Hyg.*, N. S., **6** (1910), 810.

[3] Whipple, *Munic. J. Engr.*, **30** (1911), 577.

[4] Tully, *Am. J. Pub. Health*, March, **1912.**

[5] Levine, *J. Infect. Dis.*, **18** (1916), 3, 293.

[6] Cobb, *Boston Med. and Surg. J.*, **159** (1908), 9.

[1] Hertzka, *Monatsschr. f. Geburt u. Gynäkologie*, **16** (1902), 3.

[2] Stieker, *Z. Geb. u. Gyn.*, **45** (1901), 510.

[3] Skutsch, *Cent. f. Bact.*, **12** (1892), 309.

[4] Bending, *Münch. Med. Wochschr.*, **56** (1909), 1864.

[5] Hesse, *Z. Hyg.*, **25** (1897), 482; Selter, *Hyg. Rundschau*, **18** (1908), 1381; Hilsun, *Cent. Bakt.*, 1 Abt., **27** (1900), 661; Lewis, *Eng. News*, **65** (1911), 689.

Most continuous filters are faulty in not providing a device for the addition of the alum quantitatively or under exactly controlled conditions.

There should also be provided as an adjunct to the filter, a sedimentation or coagulation basin of such size in relation to the filter capacity as to permit the storage of the water at least a half hour after the addition of the alum. This permits complete reaction and coagulation of the alum and saves the filter. As much as 80 per cent purification may take place in such a preliminary basin through settling. Any other arrangements may result in carrying some alum into the tank, especially during periods of rapid filtration or after the water has been refiltered for some time and its natural alkalinity much reduced by repeated treatment with alum. This alum may later react in the pool, making the water irritating and murky.

DISINFECTION is not a substitute for refiltration or intermittent filling, but a daily necessity under either system. Commercial hypochlorite of lime seems to have won its place as an agent, though liquid chlorine is used successfully and eventually ultra-violet light, now being used in a few instances, may supplant chemicals for this purpose.

The amount and method of adding hypochlorite must vary with the nature of the water and with the usage. As a rough criterion, a tank of 60,000 to 70,000 gal. capacity needs 1 lb. per day. The chemical should be supplied in pound cans only, as it rapidly deteriorates. The system of adding in solution by means of a synchronous pump working with the circulative pump in the continuous filtration system, has the advantage of mechanical control and uniformity of feed. I am yet to be convinced, however, of its advantage over the simple expedient of adding the chemical by hand at the end of the day's usage. When added gradually during refiltration, the concentration is never so high as when the whole amount is put in at once. The germicidal action is, therefore, not so great. Moreover, when added continuously, the swimmers are in contact with the fresh solution and may complain of odor and tastes. If added at night it has fully reacted and by morning is fully dissipated leaving a sterile, wholesome water with which to start the day. An effective and simple method of adding hypochlorite is to transfer the chemical to a thoroughly perforated can and drag it by means of a wire and a pole over the surface of the pool until it has gone into solution. Clark and Gage[1] in tests upon the Andover pool obtained more satisfactory results by the periodic application of bleach directly to the tank. The continuous addition of 0.3 part per 1,000,000 available chlorine to the water passing through the filters, resulted in a purification of only 68 per cent. Tests made by the author upon the water of the pool at the New Trier high school, which is equipped with a continuous filter and synchronous pump for adding hypochlorite of lime, showed the water to run high in bacteria with 7 to 8 tubes fermenting out of 10 when inoculated with 1 cc. quantities of water. A change to the system of adding the chemical in 1-lb. quantities at night, conditions otherwise remaining the same, showed marked and immediate improvement.

The preliminary shower with soap should be rigidly enforced. It must be remembered that most of the contamination comes from the buttocks and perineum. As a matter of fact a sitz bath with a perforated ring device, working automatically while the bather sits on it, would be desirable. The average individual gives the matter little thought and few really understand the purpose of the preliminary shower. Women are the worst offenders, neglecting the requirements through indifference or false modesty. Checking up the conditions at Northwestern, we found the women were mostly taking the shower with their suits on. The swimming instructor should educate such persons to the idea that a swimming pool is not a place for cleansing the person, but a kind of gymnasium for a special sort of exercise shared by many as a means of recreation and instruction in life-saving.

SUITS are, of course, no problem with men, but it is a very serious problem where women share the pool, on account of contamination and discoloration of the water through fading. In general, fast black cotton or wool suits which have been previously soaked in salt solution give the best results. It would be desirable to sterilize these in some manner each time after use.

After these preliminary precautions have been taken, a rigid inspection of those using the pool should be exercised, and all those excluded showing signs of infection. This should apply not only to the grosser skin and venereal diseases, but to coughs, colds, sore throats, running noses, etc. The principle of inspection and exclusion is being applied to schools as a supplement to all other hygienic precautions. In the more progressive schools for young children, especially, not only symptoms of the recognized diseases such as scarlet fever, mumps, whooping cough, etc., are grounds for exclusion, but simple colds as well. A running nose is one of the earliest symptoms of a large number of contagions.

Much can be accomplished in pool management by educational efforts designed to create a knowledge of proper sanitary conduct, and a sense of responsibility for the wholesomeness of the pool. Floor talks or instruction sheets and placards should be employed showing the reasons for the requirements, the danger from expectorating in the pool, the need of the thorough soap shower, the desirability of emptying the bladder before entering the pool, etc.

Finally, every director of a swimming pool should, as one of his personal rights, insist on the aid of bacteriological tests in determining the efficiency of his methods. The appearance of a pool is not in the slightest sense any criterion as to its safety. Bacteriological tests alone can tell this. Chemical tests are of little value as the contamination with organic matter from bathers makes interpretation difficult. Even the bacteriologist has difficulty as the subject is new and there is an absence of standards. The

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[1] Clark and Gage, *Ann. Rep. Mass. State Bd. of Health*, **1912**, p. 347.

author's opinion is that a swimming pool can, and should be, maintained up to the standards of a drinking water. Certainly it should be kept free at all times from colon bacilli.

ALKALINITY IN THE ROTATING SYSTEM—As is well known, the reaction of alum when added to water for purposes of producing a "floc," depends upon alkaline salts in the water. Practically all natural waters contain alkaline salts as carbonates and bicarbonates of the alkaline earths, less frequently of the alkali metals. The amount of such alkalinity, however, varies, from which it is apparent that the amount of alum that various waters may convert into "floc," as well as the speed of the reaction, will also vary.

The reaction of alum with the native salts in a water results in the conversion of alkaline calcium carbonate into its equivalent of neutral calcium sulfate as shown by the following equation:

$$2KAl(SO_4)_2.12H_2O + 3CaCO_3 \longrightarrow Al_2(CO_3)_3 + 3CaSO_4 + K_2SO_4 + 12H_2O$$

The aluminum sulfate immediately undergoes hydrolysis. Therefore, when a water has reacted with alum, its alkalinity is reduced to a corresponding extent, while its hardness remains unchanged. It is plain, therefore, that if the water in a swimming pool were rotated through a filter, and treated with alum each time without adding fresh water or alkaline chemicals, there would come a time when a "floc" would form so slowly that the reaction might not take place between the alum chamber and the filter bed. Eventually, with complete exhaustion of the native alkalinity, no reaction whatever would occur. The matter of the speed of the reaction is of special importance in swimming pool filtration as the type of filter used does not permit a fore-period for "floc" formation such as the coagulating and settling basins supply in large filtration plants. Moreover, the turbidity of the refiltered water in a swimming pool is never high, and turbidity aids flocculation.

Applying these considerations to Lake Michigan water and the Evanston Y. M. C. A. pool, the water showed a methyl orange alkalinity of 118.3 parts per 1,000,000 as it entered the system after having been filtered at the city filtration plant. Normal carbonate alkalinity was absent.

The above equation shows that 948 parts of potassium alum (the kind in use at the time these observations were made) will require 300 parts of calcium carbonate for complete reaction. In order to determine how many rotations of the water in the pool this alkalinity would permit, it was necessary to know how much alum was added per gallon to the water being filtered. Since the filter used supplied the alum from an alum chamber attached to the filter inlet pipe and the amount is regulated by the operator according to the appearance of the water, there was no direct method of determining the amount of alum being used. Observations over several weeks showed that the filter was run on an average of 11 hours per day at a capacity of 5000 gal. per hour. By weighing the alum placed in the chamber during the same period it was found to average 5 lbs. per day, or 0.64 grain per gal. As the capacity of the tank is 65,000 gal., the equivalent in volume of the pool's capacity would be refiltered every 13 hrs. Each refiltration would require 0.2025 grain per gal. of alkalinity expressed as $CaCO_3$, this being the equivalent of 0.64 grain of potassium alum. Since the water contains originally 6.902 grains of alkalinity per gal. expressed as $CaCO_3$ it is apparent that theoretically 34.0 complete rotations would be possible, or in other words the same water could be used under the rotating system 6.7 weeks.

In practice, however, the conditions vary from the above in the following respects. Twice a week the sediment in the bottom of the tank is removed by a suction hose attached to a special return pipe of the pump. This necessarily removes considerable water. Furthermore, there is loss from sloppage and evaporation. Fresh water is added twice a week to restore the level in the pool. Careful observations over a period of time established that the amount of fresh water added to supply this loss from these various sources averaged 7,220 gal. per week. In other words, a volume of fresh water equivalent to the capacity of the pool was added every nine weeks. The extent to which this addition of fresh water would increase the number of possible rotations through displacing water of lowered alkalinity by an equal volume of fresh water of original alkalinity may be figured as follows: There would be added each $3^1/_2$-day period 3,610 gal. of fresh water of an alkalinity of 6.902 grains per gal.: $3^1/_2$ days would represent 38.5 hrs. of refiltration and since the 65,000 gal. of water in the tank are rotated every 13 hrs. this would correspond to 2.9 complete rotations. The alkalinity would be reduced by 0.5872 grain per gal. for each such period.

Furthermore, there was added to this pool each night, Sunday excepted, 1 lb. of hypochlorite of lime. Lunge gives the following typical analysis (percentages) of commercial chloride of lime:

Available chlorine	37.00	38.30
Chlorine as chlorides	0.35	0.59
Chlorine as chlorates	0.25	0.08
Lime	44.49	43.34
Iron oxide	0.05	0.04
Magnesia	0.40	0.31
Alumina	0.43	0.41
Carbon dioxide	0.18	0.31
Silica, etc.	0.40	0.30
Water and loss (by difference)	16.45	16.33

Hooker in his "Chloride of Lime in Sanitation" states that from these analyses the following approximate formula may be assumed:

$4CaOCl_2.2Ca(OH)_2.15H_2O$, analyzing

45.1%	CaO		68.00%	$CaOCl_2$
16.85	H_2O		20.00	$Ca(OH)_2$
38.05	Cl	or	12.00	H_2O
100.00			100.00	

The $CaOCl_2$ functions through interaction with the free carbonic acid and probably bicarbonates as follows:

$$2CaOCl_2 + H_2CO_3 \longrightarrow 2CaCO_3 + 2HCl + 2HOCl$$

$$2HOCl \longrightarrow 2HCl + O$$

$$4HCl + 2CaCO_3 \longrightarrow 2CaCl_2 + 2H_2CO_3$$

from which it is apparent that the alkalinity of the water is neither increased nor decreased by this component of the "bleach."

While hypochlorite is soluble in about twenty times its weight of water, leaving a small residue, mostly $Ca(OH)_2$, it would be completely soluble under the conditions. Thus the alkalinity of 65,000 gal. of water gains daily by the addition of 0.2 lb. of calcium hydroxide, corresponding to 0.0290 grain per gal. expressed as calcium carbonate. The alkalinity per gallon at the end of the first half week would then be determined as follows:

$$\frac{(61{,}390 \times 6.3157) + (3{,}610 \times 6.9029) + (65{,}000 \times 0.0870)}{65{,}000} = 6.4353.$$

The alkalinity at the end of the second half-week period would be calculated in the same manner save that the residual 61,390 gal. would have an alkalinity of 6.4353 — 0.5872 grains per gal. This method leads to the following series of values for the alkalinity per gallon at the end of successive periods.

(1) 6.4353
(2) 5.9936
(3) 5.5765
(4) 5.1825
(5) 4.8104
(6) 4.4590
(7) 4.1271
(8) 3.8136
(9) 3.6175
(10) 3.2375
(11) 2.9734
(12) 2.7240
(13) 2.4885
(14) 2.2660
(15) 2.0559
(16) 1.8575
(17) 1.6701
(18) 1.4931
(19) 1.3259
(20) 1.1680
(21) 1.0189
(22) 0.8781
(23) 0.7451
(24) 0.6194
(25) 0.5007

Summarizing, it appears that a pool of the capacity of 65,000 gal. filled with water of an original alkalinity of 6.902 grains per gal. and treated with 0.64 grain of alum, if filtered at such a rate as would permit a complete rotation of the water every 1.2 days, could be rotated 6.7 weeks so far as its ability to react with alum is concerned. If fresh water is added twice a week in amounts sufficient to displace the original 65,000 gal. in 9 weeks, and "bleach" added in 1-lb. quantities 6 days a week, the alkaline life of the pool would be extended to 12$^1/_2$ weeks. These conclusions do not take into consideration the obvious fact that before the alkalinity became zero the reduced concentration would so lessen the speed of "floc" formation as to shorten the above periods in actual practice.

In these calculations a perfect mixing of the water is assumed and the effect of water lost by evaporation is not distinguished from that of water lost by sloppage or in cleaning the pool by the suction method. The first assumption is probably not far from the fact as the swimmers and the refiltration keep the pool water rather thoroughly mixed. Water lost by evaporation would not cause a loss of alkalinity but would concentrate the salts. It would, however, be an involved problem to disentangle this factor, and the error in disregarding it is probably well within the limit of error of the methods employed in the entire calculations. As a matter of fact, the water lost by vacuum cleaning was observed to be the principal source of loss. In a pool provided with a side wall gutter near the surface, the sloppage loss would be greater than in the case studied.

A series of six weekly alkalinity determinations on the pool water gave the following results: 5.8649, 5.5507, 5.3280, 5.0517, 4.5066, 4.2996 gr. per gal. as $CaCO_3$. In another series of daily determinations the following results were obtained: 5.538, 5.352, 5.124, 4.985, 4.950, 4.732, 4.623, 4.490, 4.445, 4.525, 4.249, 4.734. These results show the fall in alkalinity according to the theory. The departure from the theory in the rate of decrease results from the fact that the amount of alum added and the amount of water displaced in cleaning has varied from the quantities used in the calculations.

After swimming meets, when the water was unusually turbid and the sediment greater, the amount of alum, fresh water, and the period of filtration have been increased.

If free chlorine were used as a sterilizing agent, it is obvious that instead of contributing to the alkaline life of the pool this would shorten it by converting an equivalent of alkalinity into neutral chloride.

Sterilization by the electrolysis of sodium chloride would present certain advantages of economy and would supply a needed source of alkalinity as a by-product. A method of saving alum and conserving the alkaline life of the pool has been practised in some cases by feeding alum rather freely for an hour at the beginning of the filtration, then shutting it off during the remainder of the filtration.

HARDNESS IN THE ROTATING SYSTEM

From the fact that the addition of alum to a water does not affect its hardness since calcium is merely changed from a carbonate to a sulfate, it follows that under the rotating system the hardness of the pool water would increase by the amount of calcium in the added chemical. Expressed in terms of $CaCO_3$ this is equivalent to about 80.5 per cent of the total weight of hypochlorite. Added daily at the rate of 1 lb. to 65,000 gal., this would amount to increasing the hardness by 0.0863 grain per gal. With an original hardness of 6.2964 grains per gal. expressed as $CaCO_3$, and with three additions of 1 lb. of hypochlorite the hardness of the pool water in grains per gal. at the end of the first half-week would be calculated as follows:

$$\frac{(61{,}390 \times 6.555) + (3{,}610 \times 6.2964)}{65{,}000} = 6.540$$

The hardness at the end of the second half-week would be calculated in the same manner save that the hardness of the residual water would be (6.540 + 0.2589). The values for successive half-week periods are:

6.296
6.540
6.770
6.988
7.174
7.388
7.571
7.744
7.908
8.063
8.209
8.347
8.477
8.600
8.716

The rotation of Lake Michigan water, under the above conditions, would in three months produce an appreciably hard water through the cumulative effect of the added "bleach."

In a series of hardness determinations commencing the sixth week, the following results were obtained: 8.745, 9.390, 10.332, 10.000, 10.062, 10.228, 10.359, 10.768, 11.188 grains per gallon.

THE SANITARY CHEMICAL ANALYSIS IN SWIMMING POOL CONTROL

It is apparent from the principles of interpreting a sanitary-chemical water analysis that this method has little or no place in studying the sanitary condition of swimming pool water.[1] The small amounts of organic matter, ammonia, chlorides, etc., determined in such an analysis are harmless in themselves, but are taken as an index to the bacterial process by which nitrogenous organic matter is oxidized ultimately to nitrates. In a swimming pool, these same substances may come in various forms from the bodies of the swimmers and so would not correctly index the bacterial process occurring. By the same principle, the author has noted heavy indol tests on swimming tank water unrelated to changing bacterial counts.

A series of 6 daily analyses of the tank water at the Northwestern pool gave the following results, expressed in parts per million:

	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Total solids	134.8	152.4	176.0	133.2	132.0	179.2
Volatile matter	13.6	18.0	24.0	20.0	28.4	15.6
Chlorine	9.809	9.809	8.583	9.809	11.079	12.262
Nitrites	None	Trace	Trace	Trace	Trace	Trace
Nitrates	0.116	...	...	0.120	0.112	0.116
Free NH_3	0.030	0.019	0.052	0.075	0.098	0.091
Albuminoid NH_3	0.042	0.060	0.071	0.074	0.087	1.228

The pool, at the time of these analyses, was emptied, cleaned and refilled each Saturday. It was being used each week by an average of about 500 persons, one-fifth of whom were women.

A fairly consistent rise in chlorides, volatile solids, "free" and "albuminoid" ammonia is noticeable.

The following table gives an analysis of the Evanston Y. M. C. A. tank-water after six weeks of rotation, together with a typical analysis of Evanston city water for comparison. The latter is filtered at the municipal plant and is very pure at all times.

	Tank Water	City Water
Albuminoid ammonia	0.087	0.047
Free ammonia	0.011	0.015
Nitrites	0.026	0.000
Nitrates	1.64	0.08
Chlorides	12.5	5.00
Alkalinity	82.0	118.0
Hardness	149.0	108.0
Total solids	206.0	147.0

The decrease in alkalinity, increase in hardness, chlorides, total solids and nitrogen forms is such as one would expect, but affords no information as to the sanitary state of the pool at the time, since most of these variations from the original water, with which the pool was filled, have a purely chemical origin.

A COMPARISON OF THE EFFICIENCY OF THE ROTATING AND THE INTERMITTENT SYSTEMS[2]

The two Evanston pools offered opportunity for a comparative study of the bacterial efficiency of the two prevailing systems used in swimming tanks, the rotating or continuous filtration and the intermittent. The Northwestern pool is emptied, cleaned and refilled once a week during the winter and twice a week during the more intensive summer use. The Y. M. C. A. pool is used the year round by a larger number of persons, but the Northwestern pool is also used by women, who are harder on a pool than men. On the other hand, more young boys patronize the Y. M. C. A. pool, and these are not so controllable in the matter of precautionary measures as older persons. The factor of patronage, therefore, in the two cases, might be considered balanced. Both pools are of modern construction, have the same capacity, the water is maintained at the same temperature, and each receives 1 lb. of hypochlorite at night. Each pool is in charge of a competent swimming instructor. Preliminary soap showers are enforced in both cases and exclusion in the case of persons obviously affected with coughs or colds. It is believed, therefore, that differences in the bacterial condition of the water may fairly be attributed to differences in the two systems employed, the rotating and the intermittent. Over 200 analyses have been made on each pool and the rotating system has consistently shown a better condition of the water. Below are summarized the results of 22 analyses made upon each pool during the summer of 1915, each pair of samples being taken upon the same day. The samples were taken from the spring board in each case, and about 6 in. under the surface. This uniform method of sampling was adopted after failure through repeated tests to detect any consistent variation in bacterial content at different points in the same pool. Atkins[1] remarks this same lack in data collected by him on the Chicago pool. Levine[2] states that samples taken from different parts of the tank showed some differences in bacterial content, but these variations were not of sufficient magnitude to be of any sanitary significance. He remarks that in the Iowa pool, stratification of the water might result with the cooler and purer filtered water at the bottom of the pool. However, this pool was idle 20–22 hrs. each day.

The samples taken were, in all respects, handled in the same manner. Various dilutions were made and the samples plated upon plain agar with 4 days' incubation at 20° C., and litmus lactose agar with 2 days' incubation at 37.5° C. For the gas production test 1 cc. of the undiluted sample was placed in each of 10 fermentation tubes of lactose broth and incubated 2 days at 37.5° C. Transfers from tubes showing over 20 per cent gas produced gas in lactose bile in over 90 per cent of the cases.

TABLE I—RESULTS OBTAINED IN 22 ANALYSES EACH UPON NORTHWESTERN GYMNASIUM POOL WATER (INTERMITTENT FILLING) AND EVANSTON Y. M. C. A. POOL WATER (CONTINUOUS FILTRATION)

No. of Tests and Per cent of Tests Falling within Limits Indicated

Bacteria per Cc.	4 days P. A. at 20° C.				2 days L. L. A. at 37.5° C.			
	Y. M. C. A.		N'western		Y. M. C. A.		N'w.	
	No.	%	No.	%	No.	%	No.	%
0–100	10	45	..	..	19	86	2	9
101–500	3	14	1	5	1	5	2	9
501–1000	3	14	..	..	..	..	2	9
1,001–5000	3	14	2	9	1	5	4	18
5,001–10,000	..	..	3	14	..	..	6	27
10,001–100,000	..	..	7	32	..	..	5	23
100,001–500,000	1	5	5	23	1	..	1	..
500,001–over	..	..	1	5	..	..	..	..
Lost	2		3	..	..	..	..	..

Red Colonies 2 days L. L. A. at 37.5° C.	Y. M. C. A.		N'w.		Gas Producers in 10 cc.	Y. M. C. A.		N'w.	
	No.	%	No.	%		No.	%	No.	%
0	22	100	10	45	0	17	77	11	50
0–50	..	..	6	27	0 to 2	..	..	2	9
51–100	..	..	..	..	2 to 4	1	5	1	5
101–1000	..	..	2	9	4 to 6	1	5	1	5
Lost	..	..	..	..	6 to 8	..	..	1	5
					8 to 10	3	14	6	27

In respect to the relative cost of rotating the water for a period of 3 months and the intermittent system, filling the pool afresh each week, the saving under the former system was found to be 51.7 per cent at the

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[1] Atkin, *Proc. Ill. Water Supply Assoc.*, **1911**, 3, 73; Mannheimer, *Am. Phys. Ed. Rev.*, **17** (1912), 669.

[2] Angel, *Proc. Incorp. Assn. Munic. & Co. Engin.*, **34** (1908); Bunker, *Am. J. Pub. Hyg.*, **20** (1910), No. 4.

[1] Atkins, *Proc. Ill. Water Supply Assn.*, **1911**.

[2] Levine, *J. Infec. Dis.*, **18** (1916).

Evanston Y. M. C. A. There is a saving in the cost of water and of heating, which is reduced somewhat by the extra cost for alum and power.

HYPOCHLORITE VS. COPPER SULFATE AS A STERILIZING AGENT IN SWIMMING POOLS

Copper sulfate has recently been recommended, and in a number of instances adopted, as a substitute for "bleach" in swimming tank sterilization. It has the advantage of economy and ease of addition. Copper sulfate has long held a place in drinking water purification as an agaecide, but its bactericidal powers in safe amounts have never been urged. Stokes[1] obtained satisfactory results in swimming tank disinfection with copper sulfate in a dilution of 1 in 100,000. Mannheimer[2] notes its use in three New York pools studied by him. Rettger[3] abandoned sulfate of copper because of the hardness of the resulting water. Thomas[4] found 0.4 part per million of copper sulfate more efficient than 2.5 parts per million hypochlorite. Levine[5] obtained very satisfactory results with copper sulfate in amounts of 1.5 to 3 parts per million added intermittently. He considers it preferable to "bleach," to which he attributes an irritating effect upon the eyes and possible harmful influence on the teeth. The last objection seems to the author rather strained.

In Table II appears the result of analyses made upon the water of the Evanston Y. M. C. A. pool for a typical one-week period followed by a 15-day copper sulfate treatment. One pound of hypochlorite was added each night in the usual manner, while the copper sulfate was used in the proportion of 0.4 part per million. During the hypochlorite régime there was an average of 106 persons using the tank per day, while during the copper sulfate treatment the average was 125. There was some complaint during the latter period of the irritating effect of the water upon the eyes. This latter was noted also in a series of experiments upon the Northwestern pool water where 0.5 to 0.6 part per million of copper sulfate was used. If copper sulfate in these quantities is irritating, it is obvious that its use in the rotating system is questionable, owing to the cumulative effect.

TABLE II—RESULTS OBTAINED UPON EVANSTON Y. M. C. A. POOL WATER DURING A HYPOCHLORITE TREATMENT FOLLOWED BY COPPER SULFATE TREATMENT

Per cent of Tests Falling within the Limits Indicated

Bacteria per Cc.	4 day P. A. at 20° C.		2 day L. L. A. at 37.5° C.	
	$CuSO_4$ 0.4 pt.	Hypo. 1.9 pts.	$CuSO_4$ 0.4 pt.	Hypo. 1.9 pts.
0–100	6	....	66.6	83.3
101–500	6.6	....	6.6	16.6
501–1000	....	....	6.6	....
1,001–5,000	....	50	6.6	....
5,001–10,000	....	16.6	13.3	....
10,001–100,000	53.3	33.3	....	....
100,001–500,000	26.6	....	....	....
500,001–over	6.6	....	....	....

Red Colonies 2-day L. L. A. at 37.5° C.	$CuSO_4$ 0.4 P. p. m.	Hypo. 1.9 P. p. m.	Gas Producers in 10 cc.	$CuSO_4$ 0.4 P. p. m.	Hypo. 1.9 P. p. m.
0	100	66.6	0	73.3	83.3
0–50	...	33.3	0 to 2	26.6	16.6

In both series of experiments with copper sulfate its effectiveness in removing gas producers and red colonies was noticeable. During a period of 22 days at the Northwestern pool gas producers were noted only on 6 days, which in this respect is a better showing than under the hypochlorite administration.

In a series of bottle experiments upon pool water using copper sulfate in a dilution of 0.5 part per million and 33 per cent hypochlorite in a dilution of 1.9 parts per million, the author's results were conflicting. In the main the "bleach" gave better count. A typical result in this series is given in Table III. Some 8 liters of pool water were taken in the evening just before the addition of "bleach." Control tests were run at once upon the untreated water from which two 4-liter portions were then taken, treated respectively with the agents in the above amounts, well shaken and allowed to stand over night.

TABLE III—RESULTS OF BOTTLE EXPERIMENTS UPON A SAMPLE OF NORTHWESTERN POOL WATER

	Control	"Bleach" 1.9 per million	Copper Sulfate 0.04 P. p. m.
BACTERIA PER CC.;			
Plain agar, 4 days, 20° C.	27,750	900	26,250
L. L. agar, 2 days, 37.5° C.	35.0	11	20
RED COLONIES, L. L. agar	0.0	0	0
GAS PRODUCERS:			
1 cc. each of 10 tubes (no. fermenting)	6	0	7

Five cc. of sample in a fermenting tube showed 40 per cent of gas in the control and copper sulfate-treated sample and none in the sample receiving "bleach."

Transfers from the fermented tubes fermented lactose bile vigorously.

The author's confidence in the advisability of applying conclusions deduced from bottle experiments on water sterilization to large scale conditions, has, however, been somewhat shaken by similar attempts in connection with city filtration plant control.[1] It is obvious, from the conflicting opinions on this point of the relative value of copper sulfate and hypochlorite in swimming tank sterilization, that more experimental results by different workers are greatly needed. No doubt the varying alkalinity of pool water would be a modifying factor in copper sulfate efficiency.

As pointed out by Levine[2] standard methods of pool analyses looking toward proper bacterial standards are greatly needed in the whole field of swimming pool sanitation.

SAFETY OF SWIMMING POOLS

The question is often asked, "Is a certain pool *absolutely* safe?" There is but one answer: "No, nor can it be made absolutely safe." There is no practical environment wherein an individual is "absolutely safe." In recognition of this, a certain firm recently devised a necktie attachment which automatically sprayed formaldehyde in front of the wearer's visage, truly a "*reductio ad absurdum*" of germaphobia.

It is probably not desirable that an individual should live in an absolutely aseptic or antiseptic environment. It is very reasonable to suppose that the personal equipment which we call individual resistance to disease is acquired in part through repeated exposure to different mild contagions resulting in slow body immunization.

This possibility of infection is always greater in crowds and greater in winter when the population

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[1] Stokes, *Am. Med.*, **10** (1905), 1075.

[2] Mannheimer, *J. Infect. Dis.*, **15** (1914), 159.

[3] Rettger, *Eng. News*, **66** (1911), 636.

[4] Thomas, THIS JOURNAL, **7** (1915), 496; *Jour. A. M. A.*, **65**, 1104.

[5] Levine *J. Infect. Dis.*, **18** (1916), 3, 293.

[1] Lewis, *Proc. Ill. Water Supply Assn.*, **1912**.

[2] Levine, *J. Infect. Dis.*, **18** (1916), 3, 293.

congregates in schools, theatres and assemblies of various kinds. The statistics of every health department bear this out. The crowd-contagion danger is undoubtedly greater in a swimming pool than under ordinary conditions for two reasons: *first*, water is a better transfer medium for bacteria and infectious material than air; *second*, in swimming pools there is coughing, clearing of nostrils, sometimes spitting, together with the probability that some one will snuff the water or even swallow it. There is no system of filtration or sterilization yet known that will absolutely safeguard this contingency. Infectious matter from the mouth or nostrils might be passed between adjacent swimmers even if the water were a dilute solution of disinfectant.

Is this a serious indictment against the swimming pool? I believe not, for the reason that sick people do not visit swimming pools as often as they might mingle in crowds, for example. Furthermore, those using swimming pools are usually athletically inclined and not easily susceptible to infection. No doubt the exhilaration, quickened circulation, etc., incident to such exercise makes for special resistance at the time. The possibility of "disease carriers" innocently mingling with those using such pools must be conceded. Certainly it is the duty of those having charge of indoor swimming pools to take every precaution to protect their patrons. Refiltration and sterilization, together with the strict enforcement of the preliminary shower with soap, are the accepted primary measures. In addition, the tank room should be kept scrupulously clean and well ventilated. There should be sufficient equipment for expectoration, and floor talks should be frequently given, explaining the necessity of coöperating in keeping the pool clean and wholesome. The dangers of carelessness should be pointed out and a group consciousness on the matter of thorough preliminary showers and the proper use of cuspidors should be created. When all this has been done, there should be established a strict inspection and exclusion régime. Every cough or skin infection should be forbidden entry to the tank.

With these precautions, conscientiously enforced, the swimming pool is certainly as safe as any other feature of gymnastic or athletic activity. If the records prove anything, indoor swimming compares most favorably in the matter of injury and mortality statistics with such accepted sports as football, hunting, boating, etc.

Acknowledgment is herewith made to Mr. A. F. Whipple, former graduate student at Northwestern University, for part of the analytical data used in this paper.

EVANSTON, ILLINOIS

EXTENDING THE USEFULNESS OF A SHAKING MACHINE[1]

By ROBERT M. CHAPIN AND JACOB M. SCHAFFER

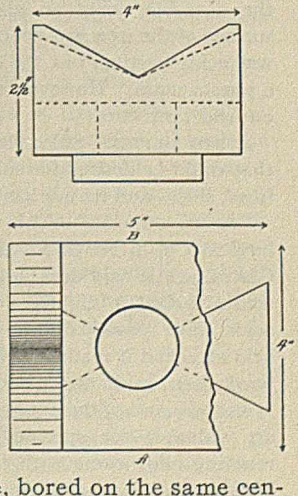
Received May 27, 1916

A shaking machine, if not a necessity, is at times a great convenience in any laboratory. But the purchaseable types of machines are in general each adapted to only a single kind of work, so that a complete equipment demands two or more different machines, which may easily deter one from the purchase of any. The purpose of this paper is to describe simple attachments whereby one machine may have its usefulness at least doubled.

The machine referred to is of a well-known type,[1] in which an oscillating platform is driven by a vertical bent axle, the platform being prevented from rotating by cogs in its sleeve meshing with cogs fixed to the frame. The platform is constructed to carry 6 flasks, the necks of which are held in 6 spring clamps radiating from a central collar about the sleeve.

The first discovered extension in the possibilities of this machine was its use as a sieve shaker. The collar holding the spring clamps is raised and fastened so that the plane of the radiating limbs of the clamps is slightly above the end of the sleeve. Upon the center of this skeleton platform is placed the charged sieve or sieves, with cover and receiver. In the sieve itself must be placed a couple of pebbles or balls of flint, iron or porcelain, the motion of which will prevent clogging. But slight ingenuity is then needed to lash the whole down with cord, or with what is much better, a length of $^1/_4$ in. rawhide belt-lacing.

From satisfactory results as a sieve shaker, the use of the machine as a shaker for liquids naturally developed. A cradle must be constructed of appropriate form for the work in view. The one illustrated in the figure, made of hard wood and faced with leather, will carry separatory funnels or bottles up to 2 liters capacity. When the cradle is set on the radiating clamps, the collar carrying the latter being fastened in its lowest possible position, the projecting end of the sleeve enters the hole in the center of the base of the cradle, while the two trapezia beneath the base fit between adjacent clamps. Then pass a bight at the middle of a length of rawhide belt-lacing under the clamp projecting at either A or B, carry the doubled lacing over the base of the cradle, once or twice around the opposite clamp, pass between the spring leaves of the clamp, and draw tight. Now place in position the bottle or separatory funnel, and pass the lacing back and forth over it and around the two clamps, finally securing the ends as before. If the container is a globular separatory funnel the lacing is best passed over the neck and the throat just above the stop-cock.



The idea is the important thing here presented, and hence the simplest possible type of fittings has been described. One may elaborate on the idea as much as circumstances warrant. In this laboratory the cradle now in use has the large hole in the base bored only about half way through from the bottom, where it is met by a $^1/_4$ in.-hole, bored on the same cen-

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[1] Published by permission of the Secretary of Agriculture.

[1] It is contrary to the policy of the Department of Agriculture under such circumstances to refer to a proprietary article by name.

ter. Through the latter hole passes a wing-headed screw bolt which enters a female screw threaded into the oil hole found at the upper end of the sleeve. The head of the bolt plays on a countersunk iron washer. The container to be shaken is secured in place by a leather band and clamp permanently attached to the cradle.

With proper speed adjustment the shaking is thoroughly effective, while either form of cradle is quickly demountable if the machine is wanted for its originally intended use as a flask-shaker.

A minor drawback to this type of machine is a tendency to pound sometimes under an imperfectly balanced heavy load. It would seem that this might be overcome by better designing of the cogs. Meanwhile the pounding may be considerably lessened if a cup made from a pipe cap is fitted around the lower cogs, and filled with grease mixed with sawdust or granulated cork. In extreme cases a clamp or other weight may be fastened to the light side of the platform.

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ADDRESSES

ACID-RESISTING ALLOYS[1]

By W. C. Carnell

Received June 19, 1916

The development and progress of the Chemical Industry is vitally dependent on the development of materials out of which the plant equipment may be constructed. A process that is a success in the laboratory will be a success in the factory, if conditions are duplicated. Platinum and glass are available in the laboratory, but may be prohibitive in the factory. Platinum at $30.00 per Troy oz. was used for the manufacture of concentrating stills for sulfuric acid; platinum at $95.00 per oz. cannot be considered. Glass has its place, but at best is unsafe for extensive processes.

The branch of the chemical industry that suffered most for materials out of which to construct apparatus was the mineral acids division.

For many years various metals and alloys were offered for which more or less acid-resisting properties were claimed. They had their uses but as complete acid-resisting materials they were not successful. With the advent of fused silica a decided advance was made, and it successfully replaced platinum in a number of processes.

In 1911 a basin of fused silica was tried out at the factory with which the writer was connected; so successful were the results that a 10-ton cascade concentrating plant for sulfuric acid was erected to replace a platinum outfit. The results were all that could be desired. The acid made was even better than that made in platinum. Fused silica is brittle and costly and must be handled with as much care as glass.

In 1913 a material under the trade name of "Feralun" was tried out. This was a mixture of cast iron and an abrasive, the abrasive being an alloy of aluminum and silicon. The surface of the iron was covered with the abrasive. The abrasive was acid-resisting, but the acid soon destroyed the iron, leaving a porous mass. However, we found "Feralun" useful for nipples on acid tank cars.

FUSED SILICON—Silicon has acid-resisting properties that are all that could be desired for sulfuric acid, but it is more brittle than fused silica, and its use has not been very extensive.

"FERRO CHROME"—This alloy is made by the Electro Metallurgical Co. of Niagara Falls, and is a very promising product. Glacial acetic acid does not attack it; 56 and 28 per cent acetic acid attacked it slightly. Strong and weak nitric and sulfuric acids have practically no effect on the alloy. Hydrochloric acid attacked it readily. The experiments were carried out in a bowl 18 in. in diameter and 6 in. deep.

SILICON AND IRON ALLOY—The materials thus far mentioned are valuable for specific purposes. The real dawn of acid-resisting alloy came with the use of "silicon iron" alloy. The beginning of the use of this alloy was about 6 yrs. ago. The first advertisement the writer observed of this alloy was in the *Journal of the Society of Chemical Industry*, January 15, 1912. This was of a silicon iron alloy, "tantiron," put out by the Lennox Foundry Co., Ltd., of London, England.

In May, 1912, after a year of experimenting, the first silicon iron alloy in the United States was put on the market under the name of "Duriron," by the Duriron Castings Co. of Dayton, Ohio. In 1913 the American rights for "Tantiron" were taken over by the Bethlehem Foundry and Machine Co., of South Bethlehem, Pa.

"Ironac" is another trade name for a silicon iron alloy made by the Houghton Co., Ltd., of London, England. While these are all alloys of iron and silicon, their composition is not the same.

Silicon iron alloy as put out under the above names is very resistant to all strengths of sulfuric acid, and apparatus made of this alloy is used in all forms of concentrating vessels and cooling devices for the concentration of sulfuric acid. By the use of the so-called "cascade basins" set in a proper furnace, full strength oil of vitriol is made from 50° Bé. acid. If all the fittings and coolers are made from this alloy the resulting oil of vitriol is practically free of iron after the plant has been in operation a few weeks. Where brimstone acid is used the resulting oil of vitriol should not contain over 0.0002 per cent iron. For sulfuric acid concentration, the alloy is durable and the breakage is very small. A plant properly handled will run for months without a shut-down. The success of the modern tower system for concentrating sulfuric acid has been due largely to the use of pipes and fittings made of this alloy.

Silicon iron alloy castings have extensively replaced stoneware parts for the manufacture of nitric acid. Early in 1916 the demand for nitric acid increased to enormous proportions; extensions to old nitric acid plants and the erections of new and larger plants was immediately demanded. The capacities of the stoneware factories of the country were soon taxed to their limit. Deliveries could not be made under 6 months, if at all. Had the production of nitric acid been dependent upon stoneware as it was a few years previous, the production of nitric acid would have been greatly curtailed and the story of the World's War would probably be different.

The silicon iron alloy is resistant to nitric acid of various strengths. It can be cast into all the various forms required for nitric acid apparatus. Castings can be made as readily and as quickly as can those made of cast iron. Here was the ideal substitute for stoneware. Necessity compelled its use and to-day it has largely superseded stoneware for nitric acid production.

A large nitric acid plant equipped entirely with this alloy in the form of "Duriron" was in service for 8 mo. and the alloy showed no indications of corrosion or deterioration. There was practically no breakage. Fire destroyed the building housing the plant and most of the supports for the apparatus. The fire did not harm the castings, though they were exposed to intense

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[1] Read before the Eighth Semi-Annual Meeting, American Institute of Chemical Engineers, Cleveland, June 16, 1916.

heat. Eighty per cent of the castings were recovered and put into service and are in use at the present time. Ninety per cent nitric acid made in a plant equipped with "Duriron" castings showed an average iron content of 0.0014 per cent iron while 36 Bé. nitric acid (52.30 per cent) showed 0.0042 per cent iron.

The silicon iron alloy was developed to resist acid. It not only resists acid, but it is resistant to erosion and to rust. Ground surfaces, representing the true alloy, are practically immune from rust. The rough casting may show some rust on exposure, but this is due to impurities in the surface caused by contact of the alloy with the molding sand; this is a surface rust only and will not penetrate. The alloy is also heat-resisting, when made of suitable design. For very high temperatures, the walls must not be too thick. Castings do not distort on heating but hold their form up to the melting point.

The following data are given for "Duriron":

TABLE I—ANALYSIS (APPROXIMATE) OF DURIRON

	Per cent		
Silicon	14.00 to 14.50	Melting point	2500° to 2550° F.
Manganese	0.25 to 0.35	Specific gravity	7.00
Total carbon	0.20 to 0.60	Compression strength	70,000 lbs. per sq. in.
Phosphorus	0.16 to 0.20	Tensile strength	25 per cent less than cast iron
Sulfur	Under 0.05		

A bar of "Duriron" was compared with a bar of equal size of the best grade of chemical pottery, under equal conditions; the earthenware test bar broke so quickly that the testing machine gauge did not record any pressure. The "Duriron" bar broke under a load of 1000 lbs. By using a suspended vessel on an earthenware bar and gradually loading it with small pieces of metal and sand, a breaking test of 100 lbs. was obtained for the earthenware bar.

TANTIRON—Tantiron was first produced by Mr. Robert W. Lennox of the Lennox Foundry Co., of London, England, about 1908. In 1913 the rights for the use of this alloy in the United States, Canada and Mexico were acquired by the Bethlehem Foundry and Machine Co. of South Bethlehem, Pa.

TABLE II—ANALYSIS (APPROXIMATE) OF TANTIRON

	Per cent		
Silicon	14.00 to 15.00	Melting point about	2550° F.
Sulfur	0.05 to 0.15	Specific gravity	6.8
Phosphorus	0.05 to 0.10	Tensile strength	6 to 7 tons per sq. in.
Manganese	2.00 to 2.50		
Carbon (graphite)	0.75 to 1.25		

The alloy is not suitable for apparatus in which high internal pressures are to be used, unless it is strengthened by a protecting jacket. Forty to fifty lbs. is given as the maximum working pressure for an autoclave made of Tantiron.

In general, silicon iron alloy cannot be cast in rectangular shapes or flat surfaces. The chemical engineer should collaborate with the foundryman in order to design shapes which can be produced in the foundry, and still serve the purpose of the operating conditions required.

CONCLUSION

While there is still opportunity for improvement and while there is much more to be desired in an acid-resisting material out of which to construct apparatus for the acid industry, yet, the silicon iron alloy or silicide of iron, as it has been called, has proven a boon to the acid industry; without it many things could not have been accomplished. It is more efficient than stoneware. At best, chemical stoneware if made properly should take 10 to 12 weeks for its production. Castings of this alloy can be made and delivered in the same time it takes to make castings out of cast iron. The limitation to castings made of this alloy are those of shop and foundry alone. One company has a foundry with a furnace capacity of 72 tons per day. To-day thousands of tons of castings made of this alloy are in use. It is finding its way in all branches of chemical industry. Since its introduction new chemical processes have been started which were impossible before, because of lack of suitable apparatus. Silicon iron alloy is being improved upon rapidly and the time does not seem far distant when all sorts of vessels will be made of this or a similar alloy that will give to the chemical industry the ideal non-corrosive material that may be fabricated into all the shapes peculiar to the needs of the industry.

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PHILADELPHIA

COKE-OVEN AMMONIA FOR MUNITIONS

By J. W. TURRENTINE

It is a very healthful reconnaissance that the nation is now making of its resources and industries in relation to national preparedness for defense. For the first time it has become recognized in this country that successful wars are to be fought as much with mine, factory and skilled labor as with gun, battleship and armies. The nation finds itself peculiarly independent of foreign sources of materials essential to a state of preparedness: of food materials, the metals, fuels, fabrics and—we hope to show—explosives.

Since for the manufacture of the various explosives for munitions purposes we have been using nitric acid obtained exclusively from sodium nitrate imported from Chile, the impression has come to prevail that we have no domestic source of nitric acid, and, therefore, that in case of war with a nation of sufficient maritime strength to enforce a blockade, we would be seriously embarrassed.

Upon investigation it develops that we have a domestic source of raw materials from which nitric acid may be prepared; that this source is now large and rapidly growing, and that it is susceptible of a practically unlimited development should necessity or public exigency demand. The source meant is the ammonia recovered as a by-product in the distillation of coal for the production of coke and gas. That it has not become more generally recognized as a source of nitric acid is because it has found a ready market in that other great industry dependent on cheap nitrogen compounds, the fertilizer industry, to which it contributes about 40 per cent of the nitrogen now consumed therein, and because commercial methods of converting ammonia into nitric acid are new and imperfectly understood. The explosives industry has been content with its abundant and convenient supply of raw materials obtainable from Chile and, therefore, has not demanded the development of an additional supply. The question has never before arisen in a popular way; hence, the popular misconception.

In time of blockade, with Chilean nitrate no longer available, ammonium sulfate would be the main nitrogenous compound available in this country for munitions and fertilizer purposes. To what extent would this be adequate to meet the demands of the country in such an emergency?

PRESENT DOMESTIC PRODUCTION OF AMMONIA

The present production of ammonia in this country is from two main sources: (1) By-product coke ovens, and (2) coal-gas and bone carbonizing works. The production of by-product ammonia has developed from an output of 13,800 tons in 1900 to 153,000 tons in 1913. The details of the record are set forth in Table I; likewise are presented, figures showing the production of ammonia from coal-gas and bone-carbonizing works. From these figures it is evident that the by-product oven is not only the chief source of domestic ammonia, but that it is rapidly overshadowing the other two sources.

Bituminous coal contains 1.2 to 1.34 per cent combined nitrogen. By ordinary methods of coking and from the average coal, a yield of 20 lbs. ammonium sulfate is expected per ton of coal. This is realized when the coking is done in the so-called by-products oven, that type of oven which makes possible the recovery and utilization of the surplus gas (*i. e.*, the gas not needed in the process itself to produce the heat for the coking).

TABLE I—UNITED STATES AMMONIA PRODUCTION, EXPRESSED IN SULFATE EQUIVALENT (TONS OF 2000 LBS.)

Year	By-product Coke Ovens	Coal-Gas & Bone Carbonizing Works	Total Production	Per cent from Coke Ovens
1900	13,800	13,800(*a*)	27,600	50
1901	15,279	14,000(*a*)	29,279	52
1902	18,483	17,641(*a*)	36,124	51
1903	24,098	17,775(*a*)	41,873	57
1904	32,653	22,011(*a*)	54,664	60
1905	41,864	23,432	65,296	64
1906	.....	..	75,000(*a*)	..
1907	62,700	36,609	99,309	62
1908	50,073	33,327	83,400	60
1909	75,000	31,500(*a*)	106,500	70
1910	86,000	30,000(*a*)	116,500	74
1911	95,000	32,000(*a*)	127,000	75
1912	130,000	35,000	165,000	79
1913	153,000	42,000(*a*)	195,000	78.5
1914	183,000	..	...	..
1915	220,000	..	...	..
1916	234,000	..	...	..
1917	376,000	..	...	..

(*a*) Estimates.

The surplus gas amounts to from 4,000 to 6,000 cu. ft. per ton of coal. Most of the coal coked, however, is coked in the so-called beehive ovens, a type of oven which makes no provision for the recovery of the surplus gas or other by-products. The ammonia produced in the process, in amounts per ton of coal potentially as great as in the by-product recovery process, is evolved with the surplus gas and with that is destroyed. Likewise, other by-products, such as *coal tar*, the source of various substances essential to the modern dye industry, *toluol*, of importance in the explosives industry, and *benzol*, of great value as a substitute for gasoline as a motor fuel and in other ways, are lost. These have a total value of $1.50 a ton of coal coked. The coke is the only product realized from the coking in beehive ovens. For every ton of coal so coked, then, we may compute the loss as $1.50.

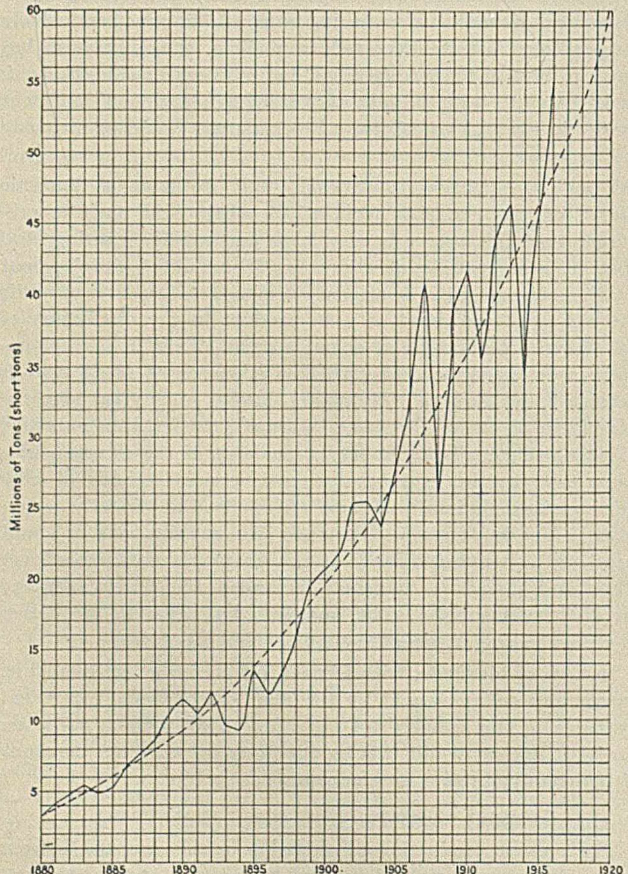

FIG. I—PRODUCTION OF COKE IN THE UNITED STATES

In the year 1914, approximately 52,000,000 tons of coal were coked in the United States, yielding 35,000,000 tons of coke. Of this coal, 35,000,000 tons, or 68 per cent, were coked in beehive ovens, while only 17,000,000 tons, or 32 per cent, were coked in by-product ovens. From the latter were obtained as by-products approximately 61,000,000,000 cu. ft. of surplus gas, valued at $6,000,000; 110,000,000 gal. of tar, valued at $3,000,000; ammonia in various forms of a total value of $7,700,000; and other by-products, principally benzol, valued at $1,000,000; a total value of $18,000,000, in amount only 32 per cent of those recoverable from the total coal coked.

These figures show that the by-products recovered in 1914 have a value of $1.13 per ton of coal. Recent developments in the industry and market have advanced this value to $1.50 per ton of coal. On the basis of the latter figure, the by-products producible, but lost, from the coal coked in beehive ovens in 1916 will be approximately $55,000,000. The ratio of value of coke to that of by-products is $2.37 (the value in 1914 of the coke produced from a ton of coal) to $1.50 (the value of by-products).

The increase in the amount of coal coked in the by-product ovens is due to two causes: (1) the increase in the total amount of coal coked, and (2) the substitution of the by-products oven for the beehive. The former increase is slower than the latter. It also fluctuates, due to the varying prosperity of the steel and other industries using coke. Its increase, of course, is due to the growth of these, and to the introduction of the use of coke into other industries. In this connection Fig. I shows the rate of increase in production of coke. The estimate for 1916, 55,000,000 tons, indicates that during this year approximately 80,000,000 tons coal will have been coked. The trend of the increase, fluctuations being averaged, is shown by the dotted line. This indicates that by 1920, the production will be 60,000,000 tons of coke, requiring the coking of approximately 90,000,000 tons of coal.

The substitution of the one form for the other is undoubtedly induced by the greater profits to be realized from coking in the by-products oven. Not only is a higher yield of coke realized, but, as has been shown, the by-products represent increased revenue. This transition probably has been gauged to keep pace with the demand for the by-products. Ammonium sulfate, for example, while being produced in increasingly great quantities, has not suffered any marked decrease in price. Coal tar is finding increasingly wide application in road building. The reported development of the American dye industry, if existent, will undoubtedly increase the revenue realized from the sale of coal tar, the source of most of the dyes. The sudden demand for toluol for use in the explosives industry has drawn attention to that valuable product. The high price of gasoline has given impetus to the production of benzol, a product now only partially developed, which can be produced cheaply and which constitutes an ideal motor fuel. From the by-product ovens now in operation 54,000,000 gal. of this commodity could be produced.

The rate of substitution of the by-product for the beehive oven is illustrated by Fig. II. The dotted portion of the line is an extrapolation to show when this substitution will approximate 100 per cent. The present rate of increase indicates that this approximation will be realized in about 5 yrs.

In Table II are set forth figures showing roughly the general development of the coking industry and the output of by-product ammonia in the United States.

TABLE II—DEVELOPMENT OF THE COKING INDUSTRY AND BY-PRODUCT AMMONIA PRODUCTION (SHORT TONS) IN THE UNITED STATES

Year	Total Coal Coked	Total Coke Produced	Beehive Coke	By-products Tons	By-products Coke Per cent	Ammonium Sulfate
1901	33,000,000	21,795,883	20,615,983	1,179,900	5.41	...
1911	53,278,248	35,551,489	27,703,644	7,847,845	22.07	95,000
1913	69,239,190	46,299,530	33,584,830	12,714,700	27.46	153,000
1916	80,000,000	55,000,000	37,000,000	18,000,000	32.7	234,000
1917	......	......	......	33,000,000	...	376,000

Especially notable is the fact that the production capacity of the by-product plants completed and operating on April 1, 1916 is 18,000,000 tons of coke, and those now built, under construction and determined upon, by the close of the year 1917 will produce 33,000,000 tons of coke; correspondingly, the ammonia, reckoned as ammonium sulfate, produced during 1915 was 220,000 short tons;[1] that which can be produced by the by-product ovens completed and operating on April 1, 1916, was 234,000 short tons; and finally, that to be expected by the end of 1917, is 376,000 short tons.

THE OUTPUT FOR THE IMMEDIATE FUTURE

The present rapid increase in the rate of transition from the beehive to the by-product coke oven permits no other conclusion than that shortly the transition will have been realized. We can predict, then, with confidence, the amount of combined nitrogen which the immediate future will make available for domestic arts and industries. Already the market exists for the coke, the main product, and undoubtedly the demand for it will continue. If the demand for coke does not increase, we can still confidently expect the recovery of the bulk of the ammonia now liberated in the coking industry. On the basis of figures obtaining in 1914, that would bring the total production of by-product ammonia to 520,000 tons ammonium sulfate; and on the basis of the estimate for 1916 (80,000,000 tons of coal), the total would be 800,000 tons ammonium sulfate. This will be realizable by the by-product oven alone. In addition there will be a further amount of ammonia from coal-gas and bone-carbonizing works, certainly an increased amount over present production.

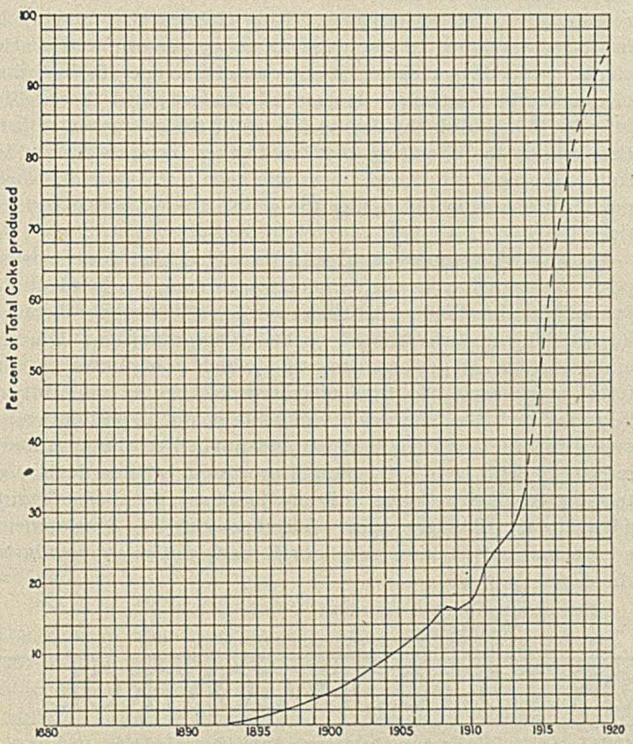

FIG. II—SUBSTITUTION OF BY-PRODUCT COKE IN THE UNITED STATES

This, then, is the production of ammonia which we may look forward to with confidence. This is the development which is taking place normally, in response to ordinary economic and business laws, without apparent stimulation or artificiality. This is what we have available for normal conditions. This is supplemented, it must be remembered, by Chilean nitrate. The supply appears entirely adequate for any development now contemplated. It is probable that Chilean nitrate will continue to supply the munitions industry, and ammonium sulfate the fertilizer industry. The conversion of ammonia into nitric acid for application to the explosives industry, however, is a distinct possibility of the future, which may result in a keener competition between the two commodities and a reduction in their price to the consumer.

OUTPUT POSSIBLE UNDER EMERGENCY CONDITIONS

In time of emergency the bulk of the ammonia produced would be immediately available for conversion into nitric acid for munitions purposes. All of that normally entering the fertilizer trade could be so applied, since, be it remembered, the staple food and forage crops on which a nation depends in times of emergency are produced in this country without the aid of fertilizers. Agricultural production would even be restricted in case of blockade, since we normally produce a great deal more than we consume. Not more than 7 per cent of the ammonia produced now enters the refrigeration industry; this could not be withdrawn entirely without inconvenience, though it could be reduced. To this sum could be added that obtained from the other sources, coal-gas and bone-carbonizing works.

In contrast with the foregoing is the situation in Germany where the normal production of by-product ammonia is 550,000 tons ammonium sulfate (1913). This was applied to agriculture. Conditions made necessary a stimulated agricultural production instead of a restricted one, so that it was not possible to withdraw the ammonia from agriculture for munitions purposes without impairing an already inadequate food supply. Therefore, extreme measures had to be adopted to increase the supply of ammonia.

By methods to be described later, whereby ammonia is converted into nitric acid, one part ammonium sulfate would produce nitric acid equivalent to 1.16 parts of sodium nitrate, from which it follows that the ammonium sulfate produced at the normal rate of output obtaining on April 1, 1916 (234,000 tons) would yield nitric acid equivalent to 271,000 tons sodium nitrate; that estimated for 1917 (376,000 tons ammonium sulfate), 436,000 tons sodium nitrate.

The importations of sodium nitrate during the year 1911 were 547,000 tons, and during 1915 were 577,000 tons. Normally, it is estimated that 40 per cent of the amount imported enters the explosives industry of the country; that would be about 220,000 tons sodium nitrate, an amount decidedly less than that which could be produced from our present output of by-product ammonia.

If the above quantities of ammonia were not adequate, the first step would be to replace all beehive ovens with the by-product form, whereby the ammonia now lost from these would be saved. This would be effecting at once (by the Government) that which is now being accomplished more slowly by the industry itself. Since the ammonia so produced could be regarded as a by-product, its cost would be negligible, the sale of the other products being at such a price as to cover all costs of operation. The size of the investment required, then, would have no significance, since ample interest could be assured.

To erect by-product ovens requires not more than $1,500 per daily ton coal capacity. Operating 360 days per year, the yearly capacity would be 360 tons coal. The proceeds from the sale of the products would be $540 for the by-products and $850 for the coke, from which must be deducted, of course, the cost of the coal, operating expenses and overhead charges.

One of the by-products obtained from the proposed by-product ovens would be combustible gas, about 5,000 cu. ft. per ton of coal coked. If so desired, and if additional ammonia were required, this gas could be used with gas engines to generate electrical energy for the electrical fixation of atmospheric nitrogen by any approved method. The surplus gas from a ton of coal, when so used, generates electrical energy equivalent to

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[1] This represents approximately 85 per cent of the total production of ammonium sulfate of the country, the remaining 15 per cent, or 40,000 tons, coming from coal-gas and bone-carbonizing works.

160 kilowatt hours; the gas produced from coking 35,000,000 tons coal (1914) would yield over 800,000 continuous horse power, which would be sufficient for the fixation of an amount of nitrogen equivalent to an additional 1,400,000 tons ammonium sulfate. The gas, being a by-product, is produced at slight cost and the installation for the development of the power is limited to comparatively inexpensive gas engines.

As a concrete proposition, in case the normal production of by-product ammonia was not sufficient for the emergency at hand, it would be possible for the Government to install by-product ovens and use the gas for the generation of electrical energy for the fixation of nitrogen. This could be put into operation quickly and at a comparatively small cost. Ammonia would be produced as a by-product at the same time, and use could be made of the coke and other products.

Were the emergency postponed to a time when all the coke was produced in by-product ovens and a market had been found for the gas, use could be made of the enormous quantities of waste and low-grade coals, the lignites and even the peats available, all of which on distillation yield ammonia and combustible gas suitable for use in gas engines. Or should it be desired to effect a permanent and large production of ammonium sulfate, the use of coke could be encouraged by restricting the use of bituminous coal where coke can be used as advantageously. The Government itself could produce coke and sell it at the same price as coal, reserving to itself the ammonia and other by-products. Not only would by-products worth $1.50 per ton of coal be conserved, but an increase of about 20 per cent in the efficiency of the coal as a producer of power would be effected. Likewise, the smoke nuisance would be abated. It is reported that such a restriction has been in effect in Germany since 1914. This is a measure which would have to be inaugurated by the people, for the producer of coal is interested in the use of more coal, not in its more economical use; and the producer of coke is more interested in the maintenance of good prices for by-products than a larger production. It is a suggestion which is deserving of very careful consideration, for, with the coal now wastefully used, is lost enormous quantities of ammonia and benzol (and power). This rigid conservation would afford agriculture the best of fertilizers and the public as a whole an excellent motor fuel, at a fraction of their present cost.

The basis of practically all explosives is nitric acid. This, usually, is prepared from sodium nitrate. It may be prepared also from ammonia. When ammonia gas and air, mixed in the proper proportions, are allowed to flow through platinum gauze or other suitable materials, known as catalytic agents, heated to the proper temperature, the ammonia is converted into nitric acid. While the chemical reaction involved has long been understood, its recent modifications and commercial application have come to be known as the Ostwald process for manufacturing nitric acid.

It is reported that this process is in successful operation both in England and Germany; that in the latter country all the nitric acid being produced is obtained by means of it. If, in our country, it could be developed to a degree of efficiency where nitric acid obtained by means of it from by-product ammonia could be made to compete so successfully with Chilean nitrate as to exclude it from American industries, the large sum now annually expended for that commodity in a foreign market could be retained for the domestic market.

Obviously the Ostwald process is of prime importance. Steps should be taken at once to determine all the conditions surrounding its best performance. It is claimed that already it has been developed to the stage where 53 per cent nitric acid can be produced by means of it at a cost of $0.03 per lb., inclusive of cost of the ammonia. It should be investigated thoroughly in order to establish the best technique of the operation, to further reduce the operating cost, to further increase the yields, to develop new and cheaper catalytic agents and to make such modifications as would render the people free of patent restrictions.

By way of summary it should be added that for times of peace America has a supply of nitrogen compounds adequate for both fertilizer and munitions purposes. This supply includes imported nitrate which is adequate for the munitions indutry, and domestic by-product ammonia which contributes to the fertilizer industry. In time of emergency, should importation be prohibited, the by-product ammonia could be withdrawn at once from the fertilizer industry and applied to the munitions industry. This source, by normal processes, is being developed to a degree where no longer will any doubt remain as to its entire adequacy for all emergencies. Accompanying this development a conservation is taking place worth many millions annually to the American people.

Department of Agriculture
Washington

THE CHEMIST IN RELATION TO FOOD CONTROL

Papers presented at the 52nd Meeting of the AMERICAN CHEMICAL SOCIETY, Urbana-Champaign, April 18 to 21, 1916

THE CHEMIST IN FOOD CONTROL AS RELATING TO THE ENFORCEMENT OF LAW

By L. M. Tolman
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The work of the chemist in food control, in so far as it relates to the enforcement of regulatory laws, is largely the obtaining of scientific evidence which may be of value in detecting the adulteration or misbranding of food products. He must not, however, be limited to the use of chemistry in obtaining this evidence, but will find that chemistry is only one of the many tools that he must use and his effectiveness and the value of his evidence will be very much restricted unless he brings to bear upon the question the assistance of bacteriology, botany, physics, and other of the sciences and arts.

The adulteration of food products, in a general way, consists in the debasing or imitation of recognized food products, and the Food and Drugs Act defines these various forms of adulteration as follows:

"The mixing of any substance, which reduces or injuriously affects the quality or strength of the article; such as the addition of water in milk.

"The substitution of foreign material, in whole or in part; such as the mixing of distilled vinegar with cider vinegar.

"The removal of any valuable constituent of the article, in whole or in part; such as extracting the essential flavoring oil from cloves.

"The coloring of an article, so as to conceal its inferiority; such as coloring noodles yellow so as to imitate the color of eggs and conceal the fact that there is a lack of this material.

"The addition of a deleterious or poisonous substance; such as the addition of salicylic acid to preserves in such quantities as might render the article injurious to health.

"The using of spoiled or decomposed products; such as moldy tomatoes in catsup."

All of these forms of adulteration above enumerated assume the existence of an unadulterated or genuine product, and the basis of most of the work in the obtaining of evidence of such adulteration depends largely on comparison of the genuine with the adulterated article. The greatest difficulty in the work is to get an accurate standard with which we can compare or measure the article under examination. It is comparatively easy to detect and measure adulteration if we have the article before it is adulterated to compare exactly with the article after it has been adulterated. For instance, if we have a pure cider vinegar, before its mixing with distilled vinegar, to compare with the mixture, we can tell with accuracy and measure almost exactly the amount and kind of the adulteration.

If we have a sample of the cloves before the extraction has been made, to compare with the extracted product, we can measure accurately the amount of oil that has been removed. If we have a sample of the milk before it is watered, to compare with the watered sample, the detection of the adulteration is simple and conclusive; and so on through the various forms of adulteration.

The best and most accurate standard or measuring rod is the product itself before it has been adulterated. Such standards, however, are not always, or often, available for the food chemist. In fact, his chief work might be said to be to obtain the best possible standard to use as a measuring rod, and he should bear in mind that the farther he departs from the thing itself the more subject to criticism becomes his evidence.

In general, there are several kinds of standards or measuring rods which are employed, and I am giving them in the order of their value as it seems to me:

(1) The product itself, before adulteration.

(2) Records of analyses of similar products, as nearly as possible representative of the thing itself.

(3) The general literature on the class of products and compilations of data.

The chemist finds, when he starts to use any of the other standards than the product itself, that there is such a natural variation in products that his standard of comparison must become either a maximum, minimum, or average, so that, while he may be able to prove that the product is adulterated, the accuracy of his estimation of the amount of the adulteration is very much diminished. If he is compelled to use only the data published in the books and literature as to the composition of the product under consideration, he will find that there is probably such a wide variation as to the composition of the product that his accuracy of measurement is very slight. He also finds this condition to exist—that records have been made of many samples regarding which there must be doubt as to their genuineness and of which there is little information as to their exact kind.

STEPS IN ANALYSIS OF A FOOD

The skill of the food chemist, therefore, depends largely on his ability to classify the article under examination, and then to obtain a proper standard of comparison, and, finally, to make an accurate comparison. Assume, for instance, that the problem presented to the chemist is a sample of ground black pepper which the inspector has collected and which, for reasons he has obtained from the trade and from a general knowledge of the situation, he believes has been mixed with some material whereby its price has been reduced. The chemist takes the sample and examines it for clues, and his first work should be to classify the article as closely as possible. In order to do this, he must first know who is the manufacturer, where the product is produced, and, if possible, from what it was produced. At least these should be the lines of thought toward which he should direct his attention. Then he should consider the product itself, as to its color and appearance in comparison with samples of known origin and of the various kinds, since this color or appearance may be sufficiently decisive to give an indication as to the variety of pepper used in its manufacture or as to the presence of probable adulterants. After he has very carefully considered the article itself from the standpoint of appearance, taste, smell, and character, he should then make his analysis, and, after this has been completed, we may be able to say that the product has the appearance of a black pepper, that the microscope does not show any foreign material, that the product has an abnormally high ash and crude fiber, and is somewhat peculiar in color and appearance; but we must still further classify the product we are working with before we can obtain a proper measuring rod with which to compare.

We know that there are on the market at the present time at least four kinds of black pepper used commercially, and this product may be made from any one or from a mixture. If by any means we can show that it is made from one special variety, we have classified the product to a very considerable extent, so that we can eliminate from comparison the data, analyses and information regarding the other three varieties. For, if we go to the published results of analyses, we find that there is a wide variation in the compositions of these four varieties of pepper commercially on the market. We also find that, unless by some means we can exclude from consideration at least one of these varieties, we will not be able to show that the product is adulterated, for we find that the data on Acheen peppers show an especially high crude fiber and ash, and, in all probability, we will find analyses of supposedly genuine products which will have a higher ash and higher crude fiber than the sample under consideration. On the other hand, if we can exclude this grade of pepper from consideration by some means, we find that the other peppers vary only within rather narrow limits, and we will have a fairly satisfactory standard or measuring rod with which to compare our sample under consideration, and from which comparison we will probably be able to prove the adulteration. If we now compare our analysis with the data on Singapore, Alleppey and Tellecherry peppers, we find the crude fiber and ash in our sample are excessive, probably due to the admixture of pepper shells on account of the fact that no foreign ingredients were found. In order, however, to further limit our standard, and in order to be able to estimate approximately the amount of adulteration, which is a very desirable thing to do, we must develop if possible a still more accurate standard of comparison. This we may be able to do if we can limit our standard to a single variety. In order, however, to get such a standard, it is necessary for us now to go back to a consideration of the manufacturer, what we know of him or of the raw materials he is using, what peppers he has on hand, and whether or not he has purchased or has in his possession pepper shells.

In order to get such information, we have to depend on other methods than pure chemistry, and work with the inspectors, without whom our work would be exceedingly difficult. If then we can find that a certain grade or kind of pepper is exclusively used and that this manufacturer has purchased pepper shells from time to time and samples of these can be obtained, we have a possibility of preparing a standard for measuring our product which will give us a very much greater accuracy, especially in a quantitative idea. If we had been compelled to depend upon the literature as a standard, or upon our knowledge of the composition of various kinds of peppers, or practical standards adopted by regulation or law, we would have been very much in the dark in regard to what our results meant, but, by classifying our product and eliminating from our standard everything except what is truly comparable, we are able not only to show that adulteration has taken place but approximately the quantity.

After we have reached our conclusion and go back over the evidence, we find that we have used the eye, the taste, the microscope, knowledge of trade conditions, and study of factory methods combined together with a little chemistry.

ADVANTAGES OF INDIVIDUAL STANDARDS

The chemist in reality might be considered as a scientific detective who must follow every clue until he makes out his case and obtains a true and correct standard with which he can compare the unknown. The possibilities of this method of making an individual standard for each case are much greater, I think, than most food chemists have realized or have used. Take, for instance, the question of watering and skimming of milk. If our analytical data indicates the possibility of the addition of water and we turn to the literature for information, we find a most confusing condition. Thousands and thousands of analyses of milk, widely varying, have been published, and it is doubtful if any of the mixing would be detected if these records were permitted to be used as a standard, but it is recognized that different breeds of cows give milk of entirely different composition, so that the first thing that should occur to us is to determine from what breed of cattle the milk which we have analyzed comes. Then it is possible for us to eliminate from our comparison all of the data which has been published or recorded on cows of other breeds, but it is almost always a practicable and feasible proposition to get a sample of the milk under consideration before it has been adulterated. By going out to the farm, we can find out the kind of cattle which are being milked, we can stay there during the milking periods and obtain samples of the milk under our personal supervision in such a way that water could not be added. When we have obtained an average sample of the milk of the night and morning and have obtained the analysis, we then have an accurate standard with which to compare the product under consideration. If it is not possible to get such a sample, we can at least narrow our standard down to determining the breed of cattle. If it is necessary for the chemist to take a sample of milk and analyze it without any information as to its source and he is unable to obtain any information as to its source, we have a very unsatisfactory and inaccurate standard or method of proving adulteration. We must then take into consideration the wide variations recorded in the literature, and our final conclusion must be a more or less accurate guess.

It would be possible to go on and outline a number of other cases where it is possible and feasible practically to obtain the product itself before adulteration as a standard for comparison, but I think these two illustrate a general principle toward which the intelligent and thoughtful man must work in every case. We know from our experience that the composition of natural products varies from time to time, from season to season, and from location to location. The article now on the market may not have existed a year or ten years ago.

Take, for instance, the grapes of a certain section, which are peculiar in that they have certain qualities, and a grape juice made from them has certain peculiar characteristics as to acid, sugar, and color. The grape juice made from the same variety of grapes, grown in another section, might be materially different, so that, in our classification and comparison of grape juices, we must try to eliminate from consideration grape juices which were not made under the same conditions and in the same location.

The first thing the analyst should do in examining grape juice is to determine, by taste and appearance if possible, the kind of grapes from which manufactured, and, if possible, the place of production. Then he is in a fairly good position to eliminate from consideration the analyses and data which have been published on other varieties.

It has seemed to me, during the consideration of this paper, that some results published in the past have been of comparative little value, because exact detailed descriptions of the samples are not given. It seems to me that data, in order to have the greatest value as a standard for comparison, must describe exactly in minutest detail the kind, place of production, and every other factor which would have an effect upon the composition of the product.

The idea was spread abroad some years ago that it was impossible to determine by an analysis whether American beers were made from malt or malt substitutes, because the recorded analyses of foreign beers made from a certain kind of malt were similar in analyses to American beers made from malt and malt substitutes. Of course it was impossible to determine, by analyses of American beers and comparing them with data on German beers, that there was any substitution for malt, but why should we do so unscientific and inaccurate a thing as to permit ourselves to use for a standard for comparison a product which is not a true standard? The proper standard for comparison of American beers would be American beers produced from the malt used in this country and under the conditions prevailing in this country. The point that I wish to make, and to reiterate, is that it is not scientific or proper to use, as a basis of comparison, data or records or analyses of products which are not the same as the product with which we desire to make the comparison.

We have in our literature many, many analyses of maple sugars and maple products, and we find that maple products coming from certain sections are quite different in composition from those produced in other parts of the country. It is impossible, in some cases, to reach any conclusion as to whether or not a maple product is adulterated if we must consider in our comparison the wide range of variations which have been found in these products made all over the country, but, if we can limit ourselves to maple products made in Ohio, or maple products made in Vermont, or maple products made in Canada, for the basis of our comparison, if we can classify our unknown sufficiently to eliminate certain kinds of products, we may be able to get a fairly accurate standard or measure. In other words, the first thing to do with an unknown is to classify the product by smell, taste, appearance, analysis, method of manufacture, and knowledge of varieties on the market. Then, when we have classified our product as far as possible, we must limit our standards so that we do not include in them anything but the products properly comparable, and, finally, we must make our comparison as accurately as possible.

It is perfectly obvious, it seems to me, that our measuring rods or standards of comparison must be really measuring rods, and we must not deceive ourselves into thinking that they are real when as a matter of fact they are not.

I recently read an article in which the man's success had depended upon his being able to see things as they were, and to do the obvious thing, but to do the obvious thing requires two things—knowledge of the situation and thought regarding it, and it seems to me that these are the two things which every food chemist should apply to the question of a proper standard of comparison.

CHICAGO

FOOD CONTROL FROM A STATE VIEWPOINT

By David Klein
Chemist, Illinois State Laboratory

The chemical aspect of state food control work is so intimately connected with the inspection and field investigation phases of the problem that it is not possible to limit the province of the chemist and to confine the discussion within such bounds. To be sure, the chemist is supposed to analyze the samples sent in by the inspectors, and to render an opinion upon their compliance with the provisions of the law. But the chemist's greater contribution to food control lies in a field not circumscribed by the walls of a laboratory: his sphere of activity should be co-extensive with the boundaries of the state. I refer to the application of scientific principles in the regulation of food industries, for the method employed in investigating and controlling an industry should differ in no essential from the course pursued in carrying out an investigation of some highly theoretical subject in the university. Just as every research problem has its characteristics to which the general principles of scientific procedure must be adapted, so has each state its characteristics which must be taken into consideration. Among these may be mentioned geographical features (size, climate, location, topography), population and food productivity (kinds and amount), and transportation facilities.

The distribution of population is an important item. The problems of controlling the food supply increase in more than a direct ratio to the population gathered into cities. The larger the city, the greater the need for vigorous supervision. It may be argued that the control of city food supplies should be performed by municipal officers. Theoretically, this condition may be the most desirable. Practically, the plan has not been generally successful. The larger cities are bending their efforts towards controlling milk and a few other foods. The smaller communities as a class have not been sufficiently impressed with the need for local food control. Lack of funds, inefficient health departments, indifferent public opinion and local politics are the common causes for failure to supervise the food supply of the municipality. Under such conditions, the state food commissions have a splendid opportunity for municipal surveys, having for their object the educating of the community in matters pertaining to the food supply.

Work of this character was attempted last year by the Illinois Food Department, upon the question of small municipality milk supplies. In a temporary laboratory established in the town to be surveyed, chemical and bacteriological analyses were made of the milk in various stages of its progress from the cow to the consumer. *First*, the milk was examined as delivered by the dealer to the housewife. Then samples were obtained as served at the restaurants and cafeterias, and as sold by grocers. The condition of the milk as received by the city dairies or as delivered by the railroads was also investigated. Finally, inspections were made of the farms at milking time, where samples of milk from the individual cows were obtained, as well as composite tests. In several instances, the pasteurization process was studied in detail, in order to point out to the owner the causes of the very unsatisfactory product that he was offering under the label "pasteurized milk." Throughout the work, the findings were not based on a single sample; *second*, and often, more samples were obtained upon which to base our conclusions. Thus the survey was a more or less complete picture of the condition of the municipal milk from the time of milking to the consumer.

The purpose of the survey was not solely regulatory: the educational aspect was not neglected. The conditions surrounding the milk production on the farm were carefully noted, especially of the sources that cause the greatest contamination. The essentials of cleanliness and cold were continually impressed upon the farmers, with surprising improvement of the milk—at least as long as the survey lasted. In many instances, where pasteurization was practiced by the dealer, the milk was worse after pasteurization than before. Bacteriological investigation easily detected the cause, with the gratifying result that the milk was properly pasteurized.

Surveys such as outlined above are expensive financially, and extremely arduous to the men doing the field work. The results were commensurate with the efforts expended on the work. Public sentiment is of slow growth, and official reform is often slower. Hence, a single survey could not be expected to be productive of great improvements. This much has been achieved. One city established a well equipped laboratory to continue the work. Another city is agitating a new milk ordinance, of a very comprehensive nature. A third city is conducting a survey of its own. In most cases, much public interest was evinced, which only requires further stimulus to assume tangible form. Requests for similar surveys have been made by other cities.

I have dwelt at some length upon this work because it emphasizes a method of state food control tending towards the permanent improvement of the food supply in the large cities along scientific lines. With the knowledge acquired from the data, it was possible to fix the responsibility of each person who had to do with the milk. Contrast such a plan with one where a few samples of unknown history picked up at random are sent to a laboratory several hundred miles away, for examination. Not only is it difficult to form correct judgments, but the results of such efforts make little impression. The law of mass action is just as applicable in improving food conditions as in making reactions go in the laboratory.

Another example of intensive control may be found in the almost revolutionary changes in the egg industry. A detailed historical development of the situation would be too time-consuming. Beginning with an investigation of the traffic in rotten eggs among unscrupulous bakers in Chicago, the scope of the inquiry inevitably widened to include the entire method of handling eggs, down to the farm house. Then it passed state bounds and became national, so that to-day the permanent improvement of the egg industry is more than a dream of the conservationist. This again is merely a case of finding the cause, for the observed effect; of getting to the real source of the evil and beginning the correcting there.

In the past, much of the efforts of state officials has been devoted to the regulation of the food entering the state from another state or even a foreign country. Where the product is not of local origin, the securing of the necessary evidence, other than analytical information, is very difficult, if not impossible. The attempt of a state official to regulate, at long range, a foodstuff whose production is entirely beyond his jurisdiction, often results in embarrassment to the official and discredit to food control work. More profitable would be the intensive surveys of home industries. There would be the opportunity to study intimately the various steps in the preparation of the product; to detect intentional or accidental adulteration or manipulation; to determine to what extent deviations from analytical standards are inherent in the process; to investigate seasonal variations in natural products. Such a study could easily lead to improved sanitary handling of the food and to utilization of wasted material. Home industry would be fostered and developed, with the result that the products would enter interstate commerce in better condition, with practically no supervision by the officials of the states in which the product is to be sold. It would place the food official in an authoritative position with respect to the foods produced in his state. Control at the source would become a reality.

The place of the chemist in such a scheme would be one of importance. The present very vexing question of the interpretation of analytical results would be answered with much more assurance and accuracy. Factory practice would be combined with laboratory examination. In formulating rules for sanitary equipment and conduct of an industry, there would be a solid basis of fact for each regulation, with a clear distinction between essentials and non-essentials. In every industry there are many who have developed the sales end of the business with practically no regard to the manufacturing side. There are many who have but little knowledge of the nature of the products dealt in, or of the sources of contamination, much less any idea of control. Here is an opportunity for applied science that the state officials have not utilized to the greatest advantage. The educational phase cannot be disassociated from the law enforcement side of food control work. The educational project must always be augmented by the force of the law. Without it, the whole plan will soon become useless, because of the debasing influence of unfair competition. Education and improvement mean nothing to the unscrupulous food manufacturer. But he thoroughly understands that it is up to him to stay in the procession because the law can compel him to remain there, if he shows a disposition to fall out of line.

In this brief outline I have tried to indicate the possibilities of chemistry and the allied sciences in the service of food law enforcement and control. A plea is made for the application of the elementary principles of scientific attack to the large complex problems of food production and distribution. The food control chemist is, or should be, something more than a laboratory analyst. His spheres of labor and of usefulness are co-extensive with the food industries of his state.

CHICAGO

FACTORY CONTROL IN THE MANUFACTURE OF CORN-STARCH AND CORN SYRUP

By A. P. BRYANT
Chemist, Clinton Sugar Refining Company

The number of industries in which a certain amount of chemical control is exercised is constantly increasing, and in those industries which have a more or less elaborate system the nature of this varies with the nature of the manufacturing process and even in the same line there will be considerable variation in its extent and details.

I have been asked to tell you in a few words something about the chemical control in the manufacture of corn-starch and corn syrup, an industry which annually uses over 50,000,000 bushels of shelled corn and produces from it a large variety of products, of which starch and corn syrup are the chief. The object to be obtained in an industry of this sort is the recovery of as much of the starch of the corn as possible and the utilization of the remainder of the grain to the best advantage and with the least possible loss.

The different steps in the process of obtaining the starch separated from the rest of the corn are all mechanical, but the completeness of separation is controlled only by analyses of the materials at different stages, the results of which analyses serve as a guide for factory operations. In fact it may be said that these operations are based almost entirely upon the data furnished by the laboratory. It follows, therefore, that it is necessary to have not only accurate and representative samples, but also quick and accurate methods of analysis.

In different factories the details and extent of control will vary somewhat, but the general character is the same. In what follows I shall attempt to describe very briefly the methods more particularly as practiced in one factory.

The chemical work will naturally fall under four divisions: (1) Examination of supplies and raw products. (2) Control of factory operations. (3) Examination and standardization of finished products. (4) Special and research work.

EXAMINATION OF SUPPLIES AND RAW PRODUCTS

The extent to which supplies are analyzed and their quality or strength thus controlled will depend upon the extent of laboratory equipment and force; the analyses may be more or less complete and will follow to a considerable extent similar control in other industries. There will be analyses of coal, lubricating oils, and general manufacturing supplies, which in this case include sulfur, soda ash, bone-black, muriatic acid, etc.; and finally the examination of the corn, *i. e.*, the raw product. Each car of corn is carefully sampled and the moisture determined. Also, from time to time, complete analyses are made of average samples of corn to determine the amount of protein, oil, starch, water soluble matter, fiber, and ash present. Upon these determinations are based the comparison of the yields actually obtained with what should have been obtained, as well as the variation in treatment which may be required for most satisfactory operation.

CONTROL OF FACTORY OPERATIONS

The manufacture of corn-starch and corn syrup may be divided into three parts: the soaking of the corn; the separation of the different parts of the corn kernel (germ and oil, hull, gluten, and starch) and the manufacture of the finished products from these.

The control in the soaking or steeping process consists in the regulation of the strength of the steep water, *i. e.*, the very weak sulfurous acid obtained by burning sulfur in a draft of air and dissolving the sulfur dioxide in a large quantity of water. The amount of sulfur dioxide is determined at frequent intervals and the relative amount of sulfur burned and water used regulated according to these tests. Later in the process further tests are made to assure the total elimination of the sulfur dioxide in the finished products. This sulfur water is used to keep the corn sweet during the period of between one and two days, while it is soaking in warm water preliminary to the subsequent operations. These involve first the tearing apart of the soft, soaked corn; then the floating of the germ on a mixture of starch and water and its removal from the rest of the corn; next the grinding of the remaining portion of the corn and the separation of the bran or hull from the starch and gluten by means of silk covered shakers or reels; and finally the settling of the starch from the gluten on starch tables.

These successive steps are all in the wet and are governed by the gravity of the mixture of starch, gluten and water, and controlled by frequent observation. The completeness of each separation is determined by the analyses of samples, either taken automatically and continuously or at frequent intervals by a sample carrier.

As an example of the way the laboratory results are used a few illustrations may be given. The completeness of the separation of the germ from the rest of the corn is determined by taking a measured amount of germ-freed corn and adding it to a mixture of salt and water heavy enough to float any germ which might not have been removed in the factory process. The presence of floating germ indicates that the starch and water was not sufficiently heavy in the factory operations and the gravity is then increased. On the other hand the presence of germ which will not float because it is weighted down with starch and hull indicates that the degerminating mills are not working properly and should be attended to.

Again, a sample of the bran from the shakers or reels is tested for its starch content. This indicates the satisfactory or unsatisfactory operation as a whole. A duplicate sample thoroughly washed over silk bolting-cloth and then tested for starch shows whether any improvement that ought to be obtained should be sought for at the mills by closer grinding, or at the shaker and reels by more thorough washing, or both.

The satisfactory separation of the starch and gluten is tested by determining the protein in the starch on the one hand and the starch left in the gluten on the other. Some light immature starch granules will of necessity be carried away in suspension with the gluten, but this must be reduced to the lowest possible amount.

The starch, which is obtained as the final result of the operations already alluded to, is used for the preparation of the various kinds of starch (such as pearl, lump, powdered, laundry, etc.), for roasting to produce dextrin, or is sent to the refinery to be made into corn syrup, or corn sugar. The gluten and bran are united, filter-pressed and made into gluten feed. The germ is sent to the oil house from whence, after due time, it emerges as corn oil and corn oil cake or corn oil cake meal.

The control work thus far outlined has to do simply with the completeness of the mechanical operations involved in the separation of the different component parts of the corn. In the refinery on the other hand a chemical change is involved in the hydrolysis of the starch under pressure and in the presence of a trace of hydrochloric acid. In the manufacture of corn syrup the hydrolysis is carried only to a point where from 40 to 50 per cent of the starch has been actually hydrolyzed, the remainder being split up into dextrins. There are found both dextrose and maltose in the hydrolyzed products, but for control work it is sufficient to determine the reducing value of the product and report this as dextrose.

The acidified starch milk of the desired gravity, usually 22° Bé. for syrup conversions, is run into a converter and cooked with live steam until the color reaction of a test sample drawn from the converter coincides with that of a similar sample tested in the laboratory and found of the desired degree of conversion or dextrose ratio. The operations of the converter are thus controlled directly by the laboratory. The charge, once having been brought to the desired test, is released into a neutralizer where sufficient sodium carbonate is added to neutralize exactly the hydrochloric acid in the syrup. The completeness of the neutralization is determined at frequent intervals, but cannot vary one way or the other more than a trifle for this reason: there still remains in the starch a minute amount of gluten after all the previous treatments and this is kept in solution in the hot slightly acid syrup. Once neutrality has been reached, this trace of gluten, carrying with it a trace of oil and pentosans, separates, causing a "break." At this point the liquid can be filter-pressed and this residue removed, but either a trace of acid or of alkali prevents this; consequently, the neutralization in a way is fool-proof although there is a fine point of exact neutrality that can be determined only by laboratory tests.

In the manufacture of corn sugar, the operations are similar to the above excepting that the action is carried further, until from 85 to 95 per cent of the starch has been hydrolyzed, depending upon the kind of sugar. The neutralization and subsequent purification, however, are practically the same as with corn syrup.

The purification of the syrup is obtained by means of charred bone or bone-black and throughout the process until the refined and concentrated liquors are finished and ready for shipment great care must be taken to see that all conditions are the most favorable; that the gravities of the liquors are kept constant; that no contamination by dirt or entrance of wild yeast is allowed; in short, that all conditions are as ideal as possible. This is brought about by means of laboratory tests on average or special samples taken at all stages of the refining and finishing processes. In this way it is possible to detect and remedy trouble or irregularities, which, if allowed to persist, might affect the color or general appearance or even the quality of the finished product. For example, a leaking valve might allow raw starch to escape from the converter before it had had a chance to be hydrolyzed, but a test with iodine would reveal this. Or the sides of some of the tanks might become infected by wild yeast, but as tests would show this long before any real trouble could be experienced, the source of the irregularity is thus discovered and remedied. Thus by constant watchfulness and frequent tests it is possible to maintain uniformity and satisfactory operations in this most important department, but this eternal vigilance must not let up day or night.

The finished corn syrup is concentrated *in vacuo* to a gravity of 42, 43, 44 or 45° Bé. based on a temperature of 100° F. These gravities are taken at the vacuum pans, but samples taken to the laboratory serve as a check and keep the pan man lined up.

The gluten and the bran separated as already outlined are united, the concentrated soluble matter removed from the corn during the steeping added, and in due time we get corn gluten feed. The chief function of the laboratory in connection with this is to determine the moisture in the finished product, and thus keep the product up to standard in this respect.

The germ of the corn, removed in the first mechanical separation, is sent to the oil house where it is dried, ground, cooked and the oil expressed, the residue forming corn oil cake or corn oil cake meal as the case may be. A determination of the oil left in the cake or meal shows the satisfactory or unsatisfactory operation of the hydraulic presses or oil expellers.

In what has been said, account has been taken only of the material actually in process and recovered. It is necessary, however, to look out for losses. These are sought in the sewers. Inasmuch as the milling process requires a great volume of water, it is necessary to get rid of this at various places. Wherever there is an outlet to the sewer a continuous automatic device is or should be placed and the samples tested for solids in suspension and solution. Solids in suspension are unnecessary loss and require immediate steps to remedy or obviate the condition permitting this. Solids in solution may indicate avoidable loss or a loss too small in amount or too diluted in quantity to recover. In the refinery there is possibility of entrainment during boiling in the vacuum pans and the slight amount of syrup which would be carried over can be detected and roughly estimated colorimetrically, if desired, by use of the alpha naphthol test. Leaks in the steam tubes of the vacuum pans which might permit syrup to leak through when the vacuum is broken can be detected by this same test in samples of the condensed steam from the tubes. Similar tests will show whether the filter presses and the bone-black filters have been sweetened off properly before being washed to the sewer.

By making tests of these waters, day and night, a very accurate control is possible of the conditions in the refinery, and, in fact, in the whole plant, which might lead to avoidable losses.

SPECIAL METHODS AND TESTS

In order properly to guide factory operations it will be seen that the laboratory must make many tests and that the results must be obtained in the shortest time conducive to a satisfactory degree of accuracy. This means that short-cuts and quick methods are required and that these shall give essential agreement with official methods. A few examples will illustrate:

Moisture determinations may be made in a vacuum bath heated by steam jacket at atmospheric pressure in three hours.

In determining oil in various products carbon tetrachloride may be used as an extractive reagent and the total time of extraction reduced to 2$^1/_2$ hours, the results agreeing very closely indeed with official results by ether extraction by the official method. This method has been used by the writer for many years and was described in the *Journal of the American Chemical Society*, **26** (1904), 568. Another advantage of this solvent is its freedom from danger of combustion. Starch may be determined indirectly by malting in the usual manner, filtering on weighed filters and determining the loss of weight after thorough drying. This loss of weight corrected for moisture and water-soluble matter in the original material and for insoluble solids in the malt extract used may be taken as starch and is perhaps as accurate as the official determination of starch by the reducing value of hydrolyzed malted extract, and the time consumed is much less.

Reducing value is determined volumetrically by a Fehling solution standardized by C. P. dextrose so that 25 cc. solution is completely reduced by 12$^1/_2$ cc. of 1 per cent dextrose solution.

Protein is determined by the modified Kjeldahl method using copper sulfate. Where practicable 0.875 g. material is taken and the final titration with $N/10$ alkali gives percentage directly, 1 cc. being equal to 1 per cent protein in the sample.

The above are the more important control tests, but special tests suggest themselves for special cases. Colorimetry plays an important part in comparing colors of starch, syrup, and other materials with standards. In controlling the strength of the weak sulfurous acid used for soaking the corn and testing for its subsequent removal, considerable amounts of iodine solution are required. Owing to the increasingly high cost of iodine and potassium iodide, the writer has been using for routine work a solution of potassium permanganate standardized through sulfur dioxide against iodine solution. This solution works admirably for control work and yields a marked saving in expense.

The results furnished by the laboratory show what is taking place at different steps of the process through the factory. These results, however, must be coördinated and applied in order to make them of value. From the results of the routine tests the foremen in the different departments of the plant can correct their respective operations so as to improve the results. At other times some unusual condition or combination of conditions may bring about unfavorable results, which will require special tests and analyses and perhaps more or less research work in order to avoid them. Once a certain kind of trouble has been experienced it becomes easy to avoid this a second time, but in the manufacture of corn-starch and corn syrup, as of course, in other industries, it is the unexpected that usually happens. Consequently, the one in charge of operations must not only keep in constant touch with the laboratory results, but carry on such additional tests and experiments as seem necessary in order to obtain the information which will permit getting the most satisfactory results from the plant.

EXAMINATION AND STANDARDIZATION OF FINISHED PRODUCTS

A complete analysis of the different finished materials serves as a guide for standardization. For example, the gluten feed and corn oil cake meal must be guaranteed to contain not less than a stated minimum of protein and fat and not more than a stated maximum of fiber. These limits will naturally be put at such values that under the individual factory conditions they can always be attained unless for some very unusual cause. It is the function of the laboratory to prove whether or not these guarantees are met, although for that matter the process control will give a very definite idea as to this. The crude oil is analyzed for its content of free fatty acids: if the oil is refined, a still further control must be exercised, both over process and finished product. The starch is tested for moisture and for impurities, which in this case are the other normal constituents of the corn, *viz.*, protein, oil and fiber, which should be present in the merest trace. Corn syrup will be tested for gravity and perhaps acidity. It is interesting to note that pure corn syrup has a trace of acidity, using phenolphthalein as indicator, due apparently to some slight acidity of the dextrins or other inversion products formed in the hydrolysis of the starch. It also has a trace of alkalinity, using methyl orange as an indicator, due to traces of sodium phosphate present in the ash of the syrup. With rosolic acid as indicator, it is practically neutral. In addition the syrup may be tested for its boiling properties as used with sugar in candy making, and its resistance to discoloration when heated. This latter would be noticeably affected were the refining process insufficient to remove all but the most infinitesimal traces of gluten, etc. In short, it is the duty of the laboratory to devise and execute the most rigid and severe tests in order that the syrup may be brought to the very highest state of purity.

SPECIAL AND RESEARCH WORK

No industry is in a really healthy condition unless it is advancing along the lines of improvement of its products or development of new fields for their use. In the starch and corn syrup industry there is still opportunity for abundant research work and there will be found many new uses for the products already made and many new products discovered which can be manufactured from the constituents of the corn kernel. The number of different products is already large, including pearl and powdered starch, various kinds of lump starches, modified starches, soluble starches, dextrins of various kinds, corn syrup, several preparations of corn sugar, refined oil for table uses, rubber substitute, cattle foods and many other products.

As regards improvements in quality, it may be said that the pure food law, which some ten years ago abolished the bleaching of corn syrup with sulfur dioxide, has been most beneficial as it necessitated improvements in the refining process so as to get a more highly refined product, and to-day corn syrup is whiter even than in the old days of bleaching syrup, and much better. In fact, it is one of the most, if not the most highly purified food product that we have.

In conclusion we may repeat that the manufacture of corn-starch and corn syrup, while almost entirely a mechanical process in its execution, can be guided and controlled intelligently only by the most thorough, rigid and comprehensive system of chemical supervision.

CLINTON, IOWA

THE CHEMICAL CONTROL OF GELATINE MANUFACTURE

By J. R. POWELL

Chemist, Armour Glue Works

Previous to the present decade, chemical control in the gelatine industry was rather limited. The manufacturer bothered himself chiefly about producing a product that would give a sufficiently strong jell, and be brilliant enough in appearance to satisfy a trade which was critical about these points only. With the recent awakening to the possibilities of better manufacture and control of all food products, a more exacting chemical control of gelatine manufacture became a commercial necessity. Once this control was established, it became, and still is proving of real assistance to the manufacturer, in addition to developing a product acceptable to the trade. Improved methods introduced have tended to increase yields, improve what is commercially known as test, and conserve by-products, all of which gives the producer greater returns. As a result, what was once looked upon as a necessary nuisance will soon come to be accepted as a necessary source of help.

However, in outlining the precautions taken in this industry, many things will be mentioned under chemical control, that, while properly so designated, are the outgrowth of long practical experience, and cannot be directly credited to the introduction of chemistry. It is remarkable, however, as others have undoubtedly noticed in other industries, how many processes or tests practical men sometimes use, which, on first inspection, seem to be without rhyme or reason, are found to be based on very sound principles, when given a thorough study.

Control work naturally divides itself into three classes: (1) inspection of raw materials and chemicals, (2) control of the manufacturing process, (3) inspection of the finished product.

RAW MATERIALS AND CHEMICALS

Raw materials for the manufacture of gelatine, being by-products of other industries, have been far from being standardized, and the quality has been extremely variable. When the supply of materials was great, corresponding to the demand, and as a consequence, the price was correspondingly low, this variation did not worry the manufacturer so much. Margins were great enough that some variation in yield could be overlooked. As the demand for this material comes to exceed the supply, and it becomes necessary to buy on a competitive basis, the possible yield from such material becomes a vital point. As a result, inspection of such material for its actual value to the manufacturer is continually becoming more important. If the stock is to be used only for glue manufacture, examination ends at this point, but that used for the manufacture of gelatine should be examined for impurities that would render it unfit for making an edible product. For instance, arsenic and other heavy metals that are not permissible in the finished gelatine may be present in such quantities that the stock cannot be used, so it must be turned to the manufacture of glue or technical gelatine. Other stock may contain only such impurities as can be removed by proper processing, and subsequent treatment must, at least in part, depend upon the results of the examination. Still other stock may be found that shows no impurities and may be processed without any such special provisions being made.

In the examination of chemicals, it is such impurities as just mentioned that require the greater attention, as most of these products have been standardized, and variations in quality are limited. It is easy to conceive how acid used in the process may contain objectionable quantities of the tabooed metals. Water is so common that it is not usually considered a chemical, but in certain manufacturing processes would rightly be considered as such. Although at first thought it seems easy to obtain a water supply that is free from objectionable impurities, it would be interesting to consider the effect the total solids in a water of ordinary purity would have on a finished product, when this water is used for boiling out the gelatine. Gelatine liquor leaves the boiling vats at a concentration of from 2 to 3 per cent. If the water in question contained 15 grains of total solids as mineral matter per gallon, this would add about 1 per cent of an ash in the dry gelatine obtained to that extracted from the stock and coming from the other sources.

MANUFACTURING PROCESSES

The chemical control of the various processes of manufacturing can be made very elaborate. For the sake of economical and convenient operation, however, this control work usually is, as far as possible, worked out to a system of simple tests that can be made by the operators who handle the routine of the manufacture. These operators may not understand the mechanism of the tests, or know what they are really testing for, but are trained to expect certain reactions, and if they do not obtain them, they know all is not well, and the attention of the proper party may be called to the trouble.

This control of the manufacturing process begins with the first treatment of the raw material, which is usually the so-called liming. As this is usually conducted in a saturated solution of lime-water, the strength of the solution requires no control. On the other hand, the stock must be well watched, as over-liming will reduce the yields very materially, while under-liming will likely leave behind certain impurities that should be removed, and, at the same time, require such drastic treatment in boiling that the test will be decidedly injured.

Following the liming comes the washing, wherein the excesses of alkali must be removed to within certain limits, together with other impurities that the lime has dissolved. As it is usually customary to boil slightly acid, this is usually followed by an acid wash, which neutralizes the residual alkali and gives the required acidity. It can be readily seen that, without some control, large amounts of acid may be wasted, unnecessary time and labor consumed in washing, or impurities left behind that should be removed.

The boiling of the stock follows the proper preparation in the wash-mills. The chemical control here is rather limited, the points of interest being chiefly the reaction and the temperatures. High temperature and excessive acidity or alkalinity rapidly hydrolyze gelatine into products of considerably less value.

From this point on through the process, the chemical control diminishes in importance, unless the liquors are to be clarified, or subjected to some other treatment for removal of impurities. However, as the importance of this control decreases, the importance of bacteriological control increases. This is another type of control which will be but mentioned here, that offers a very wide field of application to all points in the manufacture of gelatine, and the possibilities of which we are just beginning to appreciate. But it is especially while gelatine is in these comparatively dilute solutions, and varying in temperature from boiling through an ideal incubating state to the necessary refrigeration required for its congealing, it becomes an ideal breeding place for bacteria. Hence all possible precautions must be taken to prevent infection and get the material past the danger stage as rapidly as possible.

Another item of importance is the air used in the drying of the gelatine. This is especially so where the air must be drawn from the badly polluted atmosphere of our larger cities. Impure air offers three possibilities: *First*, the dirt that may be collected, giving a gelatine that will dissolve with great turbidity; *second*, infections are frequently picked up in the drying alleys, from this dirt, although the product may have entered them practically sterile; *third*, the chemical contamination due to the absorption of chemical fumes in the air.

As has been mentioned, one of the points that must be carefully watched is the reaction of the material throughout the process; and to see how far-reaching the effects of any one factor might be, we will consider this more in detail.

The well-known influence of acidity on the swelling of gelatine and like colloids points to the importance of such control. The points of maximum and minimum swelling of the stock must be definitely related to the extraction of the gelatine and the properties of the resulting product. The fact that salts again modify this action of acidity only adds other complicating factors. The possible detrimental hydrolyzing action of acid or alkali has already been mentioned. Although the process of boiling out of the gelatine is most probably one of hydrolysis, it must be done under such control as will insure the action going only so far, or the product is deteriorated.

Likewise the wonderful probabilities for the formation of undesirable precipitates must be considered. We may have almost any combination of acid, or alkaline albuminates, mucins, and such substances, together with the inorganic compounds, especially the uncertain phosphates. There are conditions where a very slight change in acidity may bring down any one of these, or more likely, a combination of several. Much work has been done on the preparation of colloidal precipitates along other lines, and the operators have gone to great pains and trouble to obtain such precipitates. Here the conditions are somewhat reversed, and great care must be taken to avoid the formation of precipitates in the colloidal state. One of the great factors in this is that gelatine is a protective colloid, and the tendency is for all precipitates to separate in the colloidal form. This is the case even when precipitation is intentionally produced under careful control, for purification or clarification, making it easier, in most cases, to keep impurities out, rather than to attempt to remove them.

Besides the principal product, gelatine, the by-products must also be considered, and given their proper attention. There may be, depending upon the nature of the stock, a recovery of more or less fat, which is to be properly collected and graded. There will be the residual tankage which has its definite value as fertilizer, which valuation must be made on suitable analysis.

THE FINISHED PRODUCT

Any control work done on the finished product simply amounts to such analytical work as is necessary to check up the work previously done during the process of manufacturing. Physical tests such as the rigidity of jell, the viscosity of a solution, together with the appearance of the product gives data upon which the commercial value is fixed. Besides this, of course, the impurities must be checked up to show its suitability for edible purposes. Frequently, other special tests are demanded, depending upon the use to which the gelatine is to be put, but each case of this sort is a law unto itself, these tests being the outgrowth of some special demand made by the consumer.

CHICAGO

FLOUR MILLING PROBLEMS

By Harry Snyder

Chemist, Russell-Miller Milling Company

In responding to the request to present a paper on "Flour Milling Problems," at this meeting of the American Chemical Society, I shall discuss briefly some of the problems with which the flour manufacturer has to deal, what is being done to solve them, the aid Chemistry renders in their solution, and the direction wheat and flour investigations should take in order to be of the most use to all concerned: the producer, the manufacturer and the consumer. By flour I mean the fine bolted product of wheat—as this is what is usually understood by the term when one purchases flour in the market.

The flour milling industry is of large proportions. The U. S. Census numbers the mills by the thousands. Although many of those included are old grist mills, by force of circumstances idle, it is estimated that the total number of flour mills either in active operation or capable of being operated is approximately 7,500, with a total daily capacity of about 1,000,000 barrels. The industry is widely distributed, no one state having over 15 per cent of the total flour-making capacity of the country, and no one manufacturer over 4 per cent.

WHEAT

The United States produces annually from 600,000,000 to 1,000,000,000 bushels of wheat, from 50 to 70 per cent being raised in the winter wheat states, the balance being spring wheat. The wheat yield in the United States fluctuates from 12.3 to 16.6 bu. per acre, the average for the past 17 years being about 14.2 bu. The yield per acre compared by 10-year periods does not appear to be decreasing. There has been a tendency for a decrease in wheat acreage (if we omit the past two years which have stimulated wheat production). The average consumption of wheat in this country is about 5.3 bu. per capita.

The United States is a wheat-exporting country, but how long she will continue to be so no one can accurately predict. While no large areas of virgin land remain to be brought under wheat culture, it is estimated that nearly one-fifth of the land area of this country now classed as "non-tilled agricultural" is suitable for agriculture.

With the application of improved methods of farming the wheat yield could easily be increased 20 per cent or more. Speaking of the agricultural phase of the wheat-supply question as it deeply concerns the miller, I believe we are reaching a point in our agriculture where wheat must be raised as a regular farm crop under good systems of rotation rather than be produced as a virgin soil crop. If the United States is to maintain her prestige for wheat production, it must be through a continuance, or even an improvement, in the production of the best types of wheat for flour and bread-making purposes. The miller occupies an intermediate position between the producer and the consumer. He buys the wheat, makes the flour, sells it to the distributor or consumer and has to shoulder any responsibility as to lack of quality.

There are a number of flour milling problems which are interesting, but of which only brief mention will be made, as variations in the character of wheat from year to year, due to climatic conditions. Some years the miller has to use wheat which contains 14 to 16 per cent of moisture and this results in heavy losses in milling; then again the wheat is dry and more normal conditions prevail. Weeds have become very prevalent, causing much trouble in cleaning the wheat. Smut and fungus diseases, some of which can be largely prevented by proper treatment of the seed wheat, present difficult milling problems. Rust is a factor that some years must be reckoned with. The tendency of wheats at times to become starchy as in yellow berry, the influence of storage upon the quality of the grain and the effect of different methods of storage are other problems with which the miller must be more or less conversant. Many of these problems are worthy of the best attention of our National and State Departments of Agriculture and Experiment Stations.

The miller, as a manufacturer, has entirely different conditions to contend with than the manufacturer where the raw material is absolutely uniform from year to year and where only the process of manufacture needs to be considered in order to make a uniform product. At times, if he secures his raw material at not prohibitive cost, he must obtain it from different states or localities. This he is privileged to do, as is right, provided he maintains his flour qualities and makes no deceptive claims as to the origin of the wheat used. During the past year the very wet harvest time spoiled more or less of the wheat in some of the southwestern states. As a result an appreciable volume of strong wheat has been shipped from the northwest to the southwest, and consequently flour qualities were maintained. In other years, with reverse conditions, the hard southwestern wheats find their way to northwestern points. This is regulated largely by transportation charges and local conditions. Many small mills, too, in the eastern and central states, find it advantageous to use some northwestern and southwestern wheat to blend with their local wheat. In other countries the blending of wheats is more extensively practiced than in the United States, particularly where there is but little home-grown wheat and the country is dependent upon the surplus of other countries.

PROCESS OF MANUFACTURE

Flour milling is distinctly a mechanical industry, the object being to remove from the wheat berry the outer coat or wheat bran and the other offal, and to reduce the wheat to a fine state of division, thereby making a product that is in a better physical condition for bread-making and also in a form that is more completely digested and absorbed by the body.

Since the advent of the bleaching processes, suggestions have been made that flour milling is both a mechanical and a chemical industry, but this is not a correct view, because flour milling is in no way primarily dependent upon bleaching processes no matter what the status of bleaching may prove to be. There are no chemical processes involved in the separation of the bran and the wheat offals and in the reduction of the flour, nor are there chemical reagents of any kind employed; hence the problems which arise are necessarily different from those in a manufacturing plant where chemical reagents are used and where a series of chemical changes occur.

The principal features of the milling process are cleaning the wheat, removing the offal, and then the gradual reduction of the stock into flour. By means of "break rolls" the wheat kernels are partially flattened and crushed, making a mechanical mixture of various sized particles: a little break flour, intermediate particles (called Flour Middlings), and larger sized crushed or flattened portions of wheat kernels. All of these particles are separated by means of sieves of different sizes ranging from fine silk with 15,000 or more meshes per sq. in. to coarse wire cloth. The middlings are conveyed to the middlings purifying machines and the coarser stock to another break roll. The purified middlings are in turn gradually reduced to flour by means of smooth rolls. There is no sharp line of division between the flours obtained at the break and the middlings rolls. Some of the middlings are no more free from fiber and débris particles than the best of the break flours. Much depends upon the system of milling employed and the skill of the miller in making the mechanical separations. The break and reduction rolls and the middlings purifier are among the essential features of the gradual reduction process. If a short break system of milling is employed with a minimum of purification, the flour is not so free from dust, fiber, and débris particles. In general, the cleaner and purer the flour, the better its baking qualities.

APPLICATION OF CHEMICAL TESTS

The task of distinguishing between flours of various degrees of commercial quality is complicated by three sets of factors: (1) Variations in wheat qualities not susceptible to chemical determinations, (2) lack of uniformity as to milling processes, and (3) lack of sufficiently refined methods to distinguish differences in proportion to commercial values.

One of the methods proposed for determining the mechanical grade of a flour is from the ash content. So far as I am aware I was the first to propose this method, about 25 years ago. I, therefore, feel at liberty to discuss the subject fully. As I have published a number of articles relative to the ash content and the grade of a flour, there is but little to add at this time other than to say that my view now is substantially the same as expressed in my writings.[1]

> "Flour made from fully matured wheat has the minimum ash content because high maturity is usually accompanied by low ash. The ash determination, alone, cannot be used to establish the comparative value of two samples of flour containing, respectively, 0.36 and 0.40 per cent ash; the one with the lower per cent ash is not necessarily the better flour. If, however, two samples of flour contain 0.42 and 0.55 per cent ash, respectively, the former is a patent and the latter a straight grade flour. When making comparisons, however, too strict an application of the results is not admissible, particularly when the ash determinations are made in different laboratories and by different analysts, as the results then are not always strictly comparable. When the ash determinations are made under similar conditions the results are of much value in determining the grade of a flour." (Minn. Expt. Sta., *Bull.* 85, p. 192.)

In my published works I have placed the ash content of patents as ranging from 0.35 to 0.48 per cent, straight grade from 0.48 to 0.55 and clears from 0.60 to 1.80 per cent. In my "Human Foods," p. 145, I state:

> "Patent grades of flour rarely contain more than 0.55 per cent ash, the better grades less than 0.5 per cent. The more completely the bran and offals are removed during the process of milling, the lower the per cent of ash. The ash content, however, cannot be taken as an absolute guide in all cases as noticeable variations occur in the amount of mineral matter or ash in different wheats. Starchy wheats that have reached full maturity often contain less than hard wheats grown upon rich soils where the growing season has been short, and from such wheat a soft, straight flour may have as low a per cent of ash as a hard first patent flour. When only straight or standard patent flour is manufactured by a mill, all the flour is included which would otherwise be designated as first and second patents and first clear."

As these quotations are from my published works of years ago, and prior to my becoming a miller, or identified with the milling industry, any similar statements that I may now make concerning the application of ash tests in determining the grade of flours can not be regarded as biased. As previously stated, ash determinations made in different laboratories and by different analysts are not always comparable.

To what extent do variations in the ash content of a flour occur when the same sample is tested in different laboratories and by different analysts? Such a test was made by the Association of Official Agricultural Chemists and is reported in Bureau of Chemistry *Bulletin* 152 (*Proc. 29th Annual Convention, Ass'n of Agr. Chemists*, p. 107). "Sample *A* was a straight flour from Fife wheat." The wheat was stored and milled at "the mill at the North Dakota Agricultural Experiment Station."

PERCENTAGES ASH:	METHOD *A*	METHOD *B*	METHOD *C*
Analysts	Electric Muffle	Muffle Furnace	Addition Calcium Acetate
Leila Dunton, Manhattan, Kans.	....	0.708	0.706
F. M. Thomas, Ag. Col., N. D.....	....	...	0.647
H. L. Wessling, Chicago, Ill.......	0.72	...	...
B. R. Jacobs, Washington, D. C..	0.70	...	0.695
R. B. Beard, Ag. Col., N. D......	....	...	0.695
H. L. White, Ag. Col., N. D......	0.71	...	...
C. K. Glycort, St. Paul, Minn....	0.678	0.673	0.663

In commenting upon the tests, Mr. A. S. Mitchell, then in charge of the St. Paul Laboratory of the U. S. Department of Agriculture, aptly states: "Since *A* and *B* give practically the same results, there seems to be no necessity for distinguishing between a method in which an ordinary muffle is used and one where an electric muffle is used."

As all of these methods are used by chemists it is fair to draw conclusions as to the variations which may occur when a number of chemists test the same sample of flour. The maximum result is 0.72, the minimum 0.663 per cent. Hence it would seem fair to say that in well controlled analytical work variations of 0.05 to 0.06 per cent in the ash content of a flour may occur between the results of different analysts. These extremes were found respectively in the Chicago and St. Paul Laboratories of the U. S. Department of Agriculture. With less experienced analysts the differences undoubtedly would be even greater. Since we must allow at least 0.06 per cent tolerance in an ash test of flour for uncontrollable analytical errors, serious difficulties may arise in the practical application of the results.

Suppose a miller sells to a flour dealer 100,000 bbls. of flour, not an unusual order. It was agreed that the flour should contain a certain percentage of ash. Suppose the flour declined $0.50 or $1.00 per bbl., as has been the case the past year, and the purchaser was facing a loss of $50,000 or $100,000. Now if the flour was received and a sample was tested by another chemist and found to have 0.04 or 0.06 per cent more ash than was agreed, the purchaser could claim that he had received a poorer grade of flour than the contract specified. If there really was an actual difference of 0.05 per cent ash, the flour shipped would be worth from 30 to 40 cents a barrel less than the contract grade. On the basis of a difference of 0.05 per cent ash a claim for $30,000 to $40,000 could be made for damages by the purchaser and there would be an excuse for litigation, when, in fact, there is no basis for any dispute because the 0.05 per cent difference in ash is within the limits of error when flour is tested in separate laboratories by different chemists.

Reverse the conditions—suppose the flour advanced in price. If the miller wished to take advantage of the facts, knowing that two chemists would differ by 0.06 per cent in ash, and knowing that such a factor of tolerance must be allowed, there would be nothing to prevent the order being filled with an inferior flour that would pass the ash test and would not be the quality that the purchaser supposed he was getting.

FLOUR GRADES

The sample tested by the Official Chemists is a straight grade flour milled at the North Dakota Agricultural Experiment Station, and contains 0.66 to 0.72 per cent ash. It is a type of flour made by what might be termed a mill of very limited or of minimum capacity. How would such a sample compare in ash content with a straight flour made by another mill? That would depend upon the character of the wheat used and the nature of the machinery employed. Dr. Ladd, as chairman of the Flour Standards Committee, Department of Agriculture, proposes "straight flour from hard spring wheat 'contains' not more than 0.52 per cent of ash." If such a standard were adopted Dr. Ladd's flour mill, along with a large number of others, would have to stop making flour, as such a mill's product would be illegal, being a straight flour with 0.66 to 0.72 per cent of ash, determined by two separate U. S. Department of Agriculture Laboratories and with 0.14 to 0.20 per cent excess of ash over and above the limit of 0.52 per cent. On such a basis the flour would be adulterated or misbranded, probably the latter.

Various attempts have been made to define flour grades. What is patent flour? Who can tell? As well try to answer the question: "How old is Ann?" In discussing flour topics in a recent hearing before the Ways and Means Committee of the House of Representatives on the proposed Mixed Flour Law and the

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[1] Early reports Minnesota Experiment Station; also *Bull.* 101, O. E. S., U. S. Dept. of Agr.

amendments to the Pure Food Law, Dr. Wiley aptly answered the question from a chemical point of view (page 374, H. R. 9409).

MR. RAINEY: "In what way are the different grades of flour designated?"

DR. WILEY: "I am not a miller and I do not know. I know the common names that are applied."

The difficulty is that mills do not have wheat of uniform character from year to year. The wheats differ widely in different parts of the country, and furthermore the equipment in mills is necessarily so varied, in order to mill the different kinds of wheats, that the products designated as patents, straights, or clears are not admissible to classification on a hard and fast basis of ash content, or on the basis of any other constituent or quality.

If these chemical tests are not as yet sufficiently accurate to determine the grade and quality of a flour, are baking or other tests any more accurate and reliable? This question can best be answered by reference to the Association Report previously quoted. The straight flour testing 0.66 to 0.72 per cent ash, as noted, was subjected to baking tests in different State and Government Laboratories. The results showed a range in volume from 1990 to 2520 cc., a difference of 530 cc. The largest loaf volume was 25 per cent more than the smallest loaf. The color values ranged from 90 to 101. The absorption of water for the 340 g. of flour used in baking ranged from 50.2 to 57.3. It would seem then that allowances of 7 per cent in absorption, 25 per cent in volume and 10 points in color and texture must be allowed for differences in the work of individuals, testing flour by baking tests. As to the comparisons of gluten tests, but few figures are available, but they show a range from 33.7 to 37.57 for moist gluten and 13.1 to 13.82 for dry gluten. The total nitrogen content ranged from 2.34 to 2.505, a difference of 0.165 per cent or about 1.0 of protein. In another report (Aug. 15, 1915, *Journal of the Association of Official Agricultural Chemists*), the dry gluten of two analysts working on the same samples ranged from 10.81 to 14.63 per cent on one sample, to 10.95 and 13.32 per cent on another sample.

In interpreting the comparative results of either chemical or bread-making tests of two persons working on the same sample of flour and with the same methods, but in different laboratories, a range of 10 to 25 per cent must be allowed for uncontrollable errors, depending upon the feature under comparison. These differences between the results of investigators are well established by the work of the Association of Official Agricultural Chemists. It is better for chemists frankly to admit these limits of error than to attempt to condone them.

I do not wish to leave the impression that chemical and baking tests of flour are of but little value. Their greatest value comes when the "personal error" is reduced to the minimum by the skilled flour technologist who is making the same tests day after day in the same way, under absolutely uniform conditions and when his results are compared one with another. When millers and bakers get such widely divergent results on the same sample of flour tested by different chemists in different laboratories, they are confused and there naturally arises more or less a feeling of lack of confidence for the whole system of flour testing. I heard one mill manager express himself thus: "If you have a flour tested, be sure and have it tested by a number of chemists so as to have a variety of results to pick from."

A mill owner, Mr. Krafts, of St. Louis, at the hearing before the Flour Standards Committee last June, said in part (p. 168):

"But I don't remember ever having any flour analyzed. Only once I heard of it. Once my partner said to me that somebody said his 95 per cent flour was better than ours, and that he had this thing and that thing in it. I said, 'Maybe it has: What are those things?' I knew we did not put anything like 'em in ours, that's all I knew, and he said, 'Suppose we get some of our samples analyzed, and see.' I said, 'Go ahead, I don't mind,' and so he sent some to some fellow—somebody told him about—and it came back, and he came in and showed me the returns from the doctor. And he said: 'What's this mean—do you know?' and I said: 'Chris, look at that, will you! Look what you have got in the flour.' I knew we hadn't put anything like that in there and that's all I knew. I said: 'What are all these things anyhow?' They didn't convey to my mind anything at all. I rolled it up and threw it in the waste basket, and that's how I know we had it analyzed once."

Another method occasionally employed by practical millers to determine the value of chemical or baking tests is to send separate portions of the same sample of flour, under different names, to the same laboratory for tests. At the hearing to repeal the Mixed Flour Law such an incident is given by Mr. Shoening, a miller of Illinois:

"Now, no man has more respect for a chemist than I have. I have a chemist in my family now. My son is a graduate of the ——— University. He took a special course in chemistry and has a diploma. When he came back I put him to work. I bought him a pair of overalls and made a practical miller out of him. He wanted to run the mill. This is his hobby. Then he began to analyze the flour as he made it. I knew that the flour was uniform, but he got a different result every time he made an analytical test." Then Mr. Shoening tells how he took a sample of flour, divided it into three parts, sent the samples from different express offices to the same laboratory. "Well, sir, when those reports came back—and I have the documentary evidence now in my desk at Columbia, although I have never said anything about it—they were such that if those laboratory tests would govern the price of flour, I would have to sell the same flour, made out of the same wheat—90 cents a barrel less for one sample than I would have to take for the other."

These quotations are not given with any view of discouraging flour testing by chemical or baking methods, but rather to show how many millers actually regard such tests. The fact is, millers in general do not consider flour-testing, as it is ordinarily practiced, of any great value. I think much of this view is due to the chemist not perfecting his methods of investigation, not thoroughly studying the questions involved and attempting to draw definite conclusions on insufficient data. In the case of the ash test, too much is left to the individual judgment of the chemist as to just how far the refining process should be carried so as to secure an ash of definite characteristics. The old distinction between crude ash and pure ash seems to have been discarded. In discussing the ash content of cereals and flours, the Chemical Division of the U. S. Dept. of Agriculture, years ago,[1] stated some general principles which are particularly applicable to the question. At that time the Official Method was

"The charring of the material at a low temperature, the extraction of the char with hot, distilled water to remove the soluble ash therein and the final combustion of the carbonaceous residue at as low a temperature as possible until an ash fairly free of carbon is secured. While this method can be applied with a fair degree of success to small quantities of cereal flours, and for the purpose of determining simply the percentage of ash therein, the attempt to apply it to considerable quantities for the purpose of securing an amount of ash for the complete analysis is attended with difficulties."

These difficulties are enumerated under four headings, showing whereby excessive temperatures may bring about losses and unbalanced combinations of the ash constituents, and incomplete oxidation on the other hand may leave a considerable amount of carbon. "At best the ashes are of a light gray color and in some cases, owing to the excess of carbon, inclined to be black. The application of sufficiently high temperature to secure complete oxidation produces serious changes in the composition of the ash, rendering complete oxidation difficult."

A crude ash determination cannot be left to the novice. The ash should be granular, and as free from carbon as possible. If fused, a glassy coat of phosphates may be formed causing a dark ash due to occlusion of carbon. Constant weight is not necessarily a criterion of an accurate ash test. Many flour ashes apparently pure are found upon examination with a low-power microscope to contain innumerable unburned carbon

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[1] *Bull.* **13**, Part 9, p. 1210.

particles, appearing like unburned coal in coal ashes. Particularly is the ash rich in carbon if too much flour has been burned, say over 2 g., in a dish that is not sufficiently exposed to the air, and where the ash forms an appreciable layer. The best ash results are obtained by long combustion at a low temperature to insure reasonable oxidation of carbon. Such an ash can at the close of the operation be fused, if desired, without loss of weight, provided the temperature is not raised much above 675° C. An ordinary set of analytical weights of the first class when checked against special standardized weights of the Bureau of Standards may show variations sufficient to cause a difference of nearly 0.02 per cent in an ash test. When we consider all of the possible sources of error in an ash test, it is not surprising that two analysts may show a difference of 0.06 of a per cent when testing the same sample of flour. Errors in drawing samples also occur: these I have discussed in a previous paper and will not consider at this time.[1]

NEW ACIDITY TESTS

In considering acidity, difficulties arise which are very confusing. The per cent of acid obtained from a sample of flour varies directly with the time of extraction and the temperature employed; hence it is essential that these two factors be uniformly maintained to secure concordant results. The acidity is a measure of a number of things—soluble proteins, certain soluble ash constituents and any free lactic and similar acids that may be present. In the Official Tests as previously mentioned, a variation of 0.10 per cent may occur between the results of different investigators working on the same sample (see page 108 for results: 0.29, 0.275, 0.258, 0.198 and 246 per cent acid obtained by different official workers).

Last year or the year previous the Association of Official Agricultural Chemists adopted as a provisional method a temperature of 40° C. and a time limit of one hour(?). This method, until further tests are made, should be considered no more than provisional, as it appears to have been tried by only two coöperating chemists although with quite satisfactory results. This method gives somewhat higher figures than obtained formerly where 17° C. was the temperature employed for extraction. A flour with 0.09 per cent acidity by former tests may show 0.11 per cent or so by the present provisional method with a higher temperature for extraction, and hence this year where millers and bakers have had acidity tests made and higher results reported, some have been unnecessarily alarmed, fearing that the excess of acid indicated unsoundness of the flour, when in fact the higher acidity is not due to unsoundness but to changes in methods of analysis. This is confusing to the layman and difficult to explain to him.

FLOUR BLEACHING

I am not discussing the color of flour, or flour bleaching in this paper, because this matter is still in litigation and its discussion now would be inopportune. There are certain general facts, however, which appear to be established by the U. S. Supreme Court decision in directing a retrial of the case.

> "If it cannot by any possibility, when the facts are reasonably considered, injure the health of any consumer, such flour, though having a small addition of poisonous or deleterious ingredients may not be condemned under the act," and "It is not required that the article of food containing added poisonous or other added deleterious ingredients must affect the public health, and it is not incumbent upon the Government in order to make out a case to establish this fact." * * "the added poisonous or deleterious substance must be such as may render such article injurious to health. If the testimony introduced on the part of the respondent was believed by the jury they must necessarily have found that the added ingredient, nitrites of a poisonous character, did not have the effect to make the consumption of the flour by any possibility injurious to the health of the consumer."[2]

Hence it would appear that the question as to possibility of injury to the health of the consumer by the use of bleached flour has been disposed of by the Supreme Court decision. This would leave, however, other phases of the question unsettled. It would seem then that bleaching of flour is not to be prohibitive on the basis of any possible injury to health, but if anything is to be done it will be of a regulatory nature. In considering flour bleaching, each method of bleaching, nitrogen peroxide, chlorine, etc., should be considered upon its own merits or demerits as the case may be. The full legal status of flour bleaching should be settled for the general good of the flour trace, and a uniform practice be followed in all parts of the United States.

As a rule, flour made by mechanical processes is not subject to adulteration. The Mixed Flour Law passed by Congress in 1898, put a stop by regulatory measures to indiscriminate mixing of corn and wheat flours and introducing into flour corn-starch and other materials, which practice at that time was quite threatening to the flour industry. During the past year it has been proposed to repeal this law and amend the present National Pure Food Law, so as to permit the blending of corn-starch and wheat flour without the present regulatory measures—the mixture to be sold under the name of flour. It is a measure which the flour industry opposes practically as a unit.

Unless the miller makes some misstatement in labeling his packages of flour, he has but little to do with food laws, as the fine bolted material made from wheat is flour and there is no possibility for adulteration to occur. In the case of the feeds and wheat offals, a statement of protein content, crude fat and crude fiber is generally given on the package, also a statement as to any screenings present, as most states have laws calling for this data. Usually the labeling of his feeds gives the miller but little trouble, as he generally aims to make the guarantee low enough to cover ordinary fluctuations. However, errors in sampling and analysis arise and sometimes the same goods made from identical wheat on the same day will be tested and reported on favorably by one state inspection and reproved by another as deficient in some constituents, and the miller is warned. This brings up the question as to how much tolerance should be allowed for uncontrollable errors in analysis of a sample of feed. If, say a dozen or more state chemists were all working upon the same sample, to what extent would their results vary? Such tests have been made by the Association of Official Agricultural Chemists.

An interesting report on coöperative total nitrogen tests upon which protein content is calculated is recorded in *Jour. Assn. Official Agricultural Chemists* (Nov. 15, 1915), p. 380. Sixteen Official Chemists took part in the work, all testing the same sample for total nitrogen. The Associate Referee who conducted this comparative work remarked: "The figures for total nitrogen are, with the exception of one result, quite satisfactory." Omitting this high result the difference between the lowest and highest nitrogen tests (2.46–2.76) is 0.3 per cent nitrogen, which calculated into protein is equivalent to 1.87 per cent. On the basis of the lowest test 15.37 per cent protein was found, and on the highest 17.25 per cent.

Some state chemists frankly admit that at least 1.0 per cent or more can be allowed in a protein test for uncontrollable errors. Other state chemists will not admit any tolerance and stand ready to consider mill feeds below the guarantee if they fall short of 0.50 per cent. There should be a uniform practice followed in all states, and a fair tolerance allowed as chemical analyses of feeds have by no means reached a position where the results of one chemist can be absolutely duplicated by another.

FUNCTION OF THE CHEMIST IN A FLOUR MILL

A small or medium-sized mill cannot afford to employ a chemist regularly. A flour technologist, a person familiar with the manufacture of flour from the mechanical or milling point of

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[1] *8th Intern. Congr. Appl. Chem.*, **18**, p. 323.

[2] U. S. Supreme Court Decision No. 548, October Term, 1913.

view, will be of the most service in such mills. Such a person must have a practical knowledge of bread-making and of the general working qualities of flour. In a large flour mill organization there is a place for the chemist provided he is properly equipped for the position. He must have a fair knowledge of flour milling from the mechanical side, and also a thorough knowledge of technical bread-making, along with his chemical training. The broader his chemical training the better equipped he is for his work. There are many chemical engineering problems in a mill to investigate, as cost of fuel, reduction of boiler scale, lubricants, strength of cloth used for flour containers, etc. If the chemist can help reduce the cost of a barrel of flour even a fraction of a cent, he is assisting materially in the general economy of production.

FLOUR RESEARCH

The main part of the chemist's work should be research. Many of the possible problems are of such a character as to escape entirely the notice of chemists not intimately connected with a flour milling plant. Such a problem is wheat storage in its relation to flour qualities. The wheat kernel undergoes a cycle of interesting changes from the time of harvest until it reaches what might be termed its old age. These are largely cell respiration changes. The activity of the germ and the products which it forms are interesting questions. Our ordinary methods of analyses are not sufficiently refined to investigate many of the problems. Some of the methods employed in measuring changes in physical chemistry are promising. A slight increase in soluble constituents, as changes preceding germination, are reflected in the conductivity. The chemist and flour technologist can closely coöperate in the study of many questions, but the chemist must not get the mistaken idea that his analyses will point the way to the solution of all of a mill's problems. He must coöperate with all departments. If, along with the necessary equipment for his position, he has a fair business knowledge, he may occasionally make suggestions that will be of some value. A little of the time of the chemist will necessarily be given to routine work, but this he can well afford to reduce to the minimum as the flour technologist can generally give more and better information than can the chemist from the chemical analysis alone. A good flour technologist often makes a poor chemist, and a good chemist often proves a poor technologist. Chemical and technical knowledge are sometimes possessed by the same individual to a fair degree.

Many of the problems in connection with wheat and flour are of a biochemical nature. I use this term advisedly as it is becoming such a popular one that there is a tendency to use it indiscriminately, and I fear some of the courses of instruction in biochemistry that have sprung into existence "over night," as it were, will need to be greatly strengthened in order to prove satisfactory.

It is as difficult in wheat and flour work to measure life processes by chemical analysis as it is elsewhere in the animal and vegetable world. Two flours may have practically the same percentage composition in protein, starch, and other constituents and yet have widely different values for bread-making purposes. It is not possible to take a flour of high protein content, dilute it with starch from any cereal so that it will show the same amount of protein or crude gluten as some other flour and have the two alike in their bread-making qualities. There is an individuality to wheats and flours which is not as yet susceptible to exact measurements by chemical methods. It is not only a question of the per cent of constituents in a flour, but also of their interrelationship and the way in which the flour responds in bread-making. Some of the factors which impart quality to flour for bread-making purposes are well known, others are not; some even impart a negative value. It is the sum or total of all of the factors, positive and negative, which must be considered in reaching a conclusion, rather than any one factor.

Since the modern reduction process of flour milling is of such recent development, much of the literature and the traditions of flour making apply to the old mill-stone days when a less refined product was made. There are some who still argue with vehemence that the old grist mill and millstone flour is superior to the modern product. A few facts will, I believe, help to place before you the difference between the two flours so that comparisons can be made. In the old gristmill days little or no attention was paid to the cleaning of the wheat, and in the milling process some of the bran and fiber were reduced with the flour, and the flour middlings were not completely removed from the bran and offal. The flour was dark in color, mainly on account of its dirt content, and if used at once made very good bread, but soon developed a so-called "nutty flavor." The flour had poor keeping qualities because it was poorly milled and was not made from thoroughly cleaned wheat. The nutty flavor was due to the first stages of butyric acid fermentation, the ferments being associated with the dirt and impurities in the flour. Modern, well-milled flour has good keeping qualities; in fact, it gradually improves with moderate age. In modern flour there is a larger percentage of the total wheat kernel present, although somewhat less of the dirt, bran and fiber. This is due to improvements in the milling system. Modern flour is much cleaner and contains less impurities than the old gristmill product and from a sanitary point of view is a better food product.

The flour chemist must be familiar with nutrition investigations as problems relating to the nutritive value of flour are continually arising. The general public is not well informed upon the nutritive value of foods and frequently is imposed upon by the statements of the uninformed or those who wish to be pecuniarily benefited by the promulgation of such ideas as that ordinary white flour and the bread made from it are deficient in nourishment. Graham Lusk[1] briefly notes this lack of knowledge as to the value of foods: "Even among educated persons one may hear the grossest error of judgment regarding the nutritive value of a hen's egg, and few of those who eat in restaurants realize that the greatest quota of nourishment which is brought to them lies not in the specific dish served, but in the bread and butter which ostensibly is presented as a gift."

The miller is sometimes violently censured for removing the bran from his flour. It is said that he robs the flour, takes out the most valuable and nourishing part and sells a depleted article to the public. It would be made to appear that the miller was doing this for his own profit. What are the facts? The bran and wheat offals sell for 1$^1/_4$ to 1$^1/_2$ cents per lb., while his flour sells for 2$^1/_2$–3 cents per lb. It certainly would be financially to the benefit of the miller to sell bran at flour prices. Where, then, is there any gain to the miller for the so-called robbing of the flour of its most nutritious part? The general public do not want and will not buy flour containing bran, and the public cannot be coerced in matters concerning food any more than they can in religion or politics. Then, too, there is sound reason in the public demand for white flour bread in preference to bread with bran. The extensive experiments conducted by the U. S. Department of Agriculture, covering a series of years, have plainly demonstrated that the flours with the larger particles containing the bran are not so completely digested and absorbed by the body as the fine flours containing no bran. The bran lowers the digestibility and the availability of the nutrients in the bread. There are cases where this may be an advantage, but not in the case of normal persons as the average mechanic or laborer. There are also individuals who are benefited by the mechanical action of the bran during digestion, but these cases form no valid basis for reasoning that all persons of normal digestion should eat only bread containing the bran.

England, a short time ago, was violently agitated by the Bread Reform League's advocacy of standard bread, bread made

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[1] "The Fundamental Basis of Nutrition," p. 1.

from standard flour containing bran. A Commission of Parliament finally had to investigate the subject and wisely reported that what was most important was increasing the protein content of wheats and encouraging the use of flours with the maximum of gluten or protein.

Another accusation occasionally made against bread is that it is deficient in phosphates and mineral matter. The chief function of flour is to furnish protein and carbohydrates cheaply and in liberal and well proportioned amounts, but it furnishes also liberal amounts of mineral matter. In a study of the question some years ago, Dr. H. W. Wiley[1] in discussing the mineral matter of flours says: "Enough is left, however, not only to supply the need of the body for mineral constituents, but also for the condimentary purposes mentioned above." Graham Lusk says: "However, those who live on the usual mixed diet rarely suffer salt hunger." The term salt being used in the broad sense to indicate mineral matter. "Salts, therefore, scarcely enter into the food as an economic question." The layman fails to appreciate that phosphates are included in the mineral matter and "salts" along with inorganic or ash constituents as a group.

PROTEINS IN FLOUR

The more recent investigations of the proteins, particularly of their derivative and component parts, show that not all proteins have the same nutritive value. Some contain a larger number of typical substances necessary for growth and muscular construction and others are deficient even in certain derivative products. To call a substance a protein does not necessarily signify its absolute food value. This brings up the question: What of the proteins of flour? Generally speaking, a flour with 12 per cent protein has about 5 per cent each of gliadin and glutenin, and about 2 per cent collectively of a number of other proteins, albumins, globulins and proteoses. The gliadin is the glue-like body particularly characteristic of wheat and which serves as the "binder" of the gluten. The glutenin has all the essential components for purposes of nutrition, and ranks equally with any protein as casein, or meat proteins, or ovalbumin for "all sufficient sources of protein supply."[2] There is present in flour approximately 6 per cent of these proteins of the *A* or highest grade, which is twice as much as is found in milk, and besides these there are 6 per cent more of gliadin and similar proteins to serve for general conservation purposes. The proteins of corn, the zeins, are not the equals of the wheat proteins, as the zeins do not contain in their make-up certain component substances necessary for growth. Recent investigations and the views advanced in regard to the nutritive value of the proteins in no way affect the high position which flour and bread occupy in the dietary, because flour contains so much of the growth promoting proteins combined with the conservation proteins.

There are other substances, such as vitamines, which are receiving deserved attention in the study of foods. These protein derivative substances, the products of cell activities of both plant and animal substances, take a very important part in nutrition since in their absence neurotic conditions arise from malnutrition. The vitamine bodies are particularly lacking in such foods as rice and corn which are deficient in protein. Beriberi and pellagra are diseases caused by the use of large amounts of foods which are deficient in protein and vitamines. Pellagra occurs mainly in those localities of the United States where the average consumption of wheat per capita falls below 4.6 bu., and not in the states consuming the average of 5.3 or more. According to statistics pellagra is practically absent where a liberal diet is used in which bread forms an essential part.

In this connection it is interesting to note that vitamines are produced from the activity of the yeast plant, and hence bread made with yeast contains not only the vitamine of the flour but also that made by the action of the yeast plant during breadmaking. In fact, Funk of the Lister Institute in the study of beriberi and its cure obtained the vitamine principle from yeast. Whether the temperature in baking is sufficient to destroy completely vitamine products has not been demonstrated, but it would appear that it is not, as the interior of the moist loaf in baking does not reach a particularly high temperature. In the case of polished and unpolished rice in the pellagra question, no study appears to have been made of the vitamine products contributed by the wild yeast present on the surface of the rice and a constituent of the rice polish.

VITAMINE CONTENT OF OLD AND MODERN FLOURS

Illogical comparisons are sometimes attempted as to the vitamine content of old millstone and modern flour. It is asserted that the old flour contained the vitamines in abundance while the modern flour contains none. What are the facts? In the absence of exact quantitative methods for determining vitamines, indirect means are employed. It is argued that as more of the bran and fiber are removed from the modern flour it must of necessity contain less vitamines. But here is one fallacy of argument; bolting-cloths and sieves were used in making the old flour long before the advent of modern milling. The difference in bran content between the two is altogether too slight to ascribe special vitamine virtues to the one and not the other. Furthermore, in modern milling the flour layers supposedly richest in vitamines are now more completely recovered than in the old gristmill product when much of these flours went with the feeds. Now in the end the two flours, old and new, stand on the same basis as to vitamine content.

Bread enters into the dietary to a greater extent than would appear from a superficial view of the subject and is justly designated "the staff of life." The Eastern, Northern, Central and Western States all consume more flour than the Southern States. The U. S. Department of Agriculture estimates the consumption of wheat per capita as ranging from 4 to $4^1/_2$ bu. in Georgia, Florida, North and South Carolina, Alabama, Mississippi, Kentucky and Tennessee, and from 6 to 7.2 bu. per capita in all of the states west of the Rockies except California, also in Minnesota, the Dakotas, Colorado, Wyoming and Oklahoma. The remaining states consume from $4^1/_2$ to 6 bu. per capita, the general average being 5.3. Assuming the wheat to weigh 60 lbs. per bu. and to yield 72 per cent of flour, it would be equivalent to 240 lbs. of flour consumed per capita in the United States.

It is interesting to look at the economic aspect of the question. A family of five persons, two adults and three others, either children or elderly persons, consuming respectively 0.27, 0.24, 0.19, 0.12, 0.10 lb. of protein per day in accord with our dietary standards, would require a total of 0.92 lb. of protein. This family of five consuming the average of 240 lbs. per capita of flour would use 1200 lbs. of flour per year. Assuming this average flour (the total flour from the wheat) to contain 11.50 per cent protein, the 1200 lbs. of flour would, therefore, contain about 138 lbs. of protein. The average dietary of the family called for 0.92 lb. of protein per day, or 336 lbs. per year; that is to say, over 40 per cent of the most expensive and most important nutrient in the daily dietary of the average individual of the United States is supplied in the flour. In the states consuming 6 bu. and more per capita of wheat, 45 per cent or more is thus supplied. Calculations made by the writer a few years ago and based upon the amounts of foodstuffs consumed by the average family, according to statistics of the U. S. Bureau of Labor, show that flour costs about one-tenth as much as all other foods combined, although it furnishes over 40 per cent of the total protein and over 50 per cent of the energy of the daily ration.

The per capita consumption of flour in the United States is not as large as in some countries where cheap foods are neces-

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[1] "Food and Food Adulterants," *Bull.* **13**, Part 9, p. 1217.

[2] G. Lusk, p. 22.

sary. A barrel of the best flour rarely retails for upwards of $8.50. During the past twenty years it has been much below this figure. Even if flour should be sold at retail in small lots at 5 cents per pound it would still be the cheapest and best food to form the basis of a dietary.

There are other economic phases of the flour question that deserve brief mention. There are upwards of 66,000 persons engaged in various ways in the milling industry, over 40,000 as daily wage earners, 11,000 clerks and salaried officers and about 15,000 proprietors and firm members. The total pay-roll is over $35,000,000 annually. The flour mills represent a capital investment of over $400,000,000, pay over $2,000,000 in taxes, and manufacture nearly a billion dollars' worth of products in a year, and over 95 per cent of this sum is paid out for raw material and cost of manufacture and sales. This and similar data previously given are taken from U. S. Census Reports, abstracted and compiled in the Millers' Almanac, 1916, published by the Northwestern Miller, Minneapolis, Minn.

It is very essential that the export flour market be kept open, otherwise many flour mills will be idle. If all the flour mills of the country were operated to full capacity for a little over three months (100 days), they would make enough flour for home consumption. There is no industry in which there is fiercer competition for trade—both domestic and foreign—than in flour milling, and it is safe to say that the average profits per year are materially less than 10 cents per barrel. A number of years ago my attention was called to the singular fact that a company was saved from having a deficit by using a barrel containing two less hoops than formerly. It is right that the chief food of a nation should be made not only as cheaply as possible, but also as good as possible.

What is most needed at the present time is that more attention be paid to the production of good wheats, particularly those of high protein content. Since flour enters so largely into the dietary it cannot be made too good. Professor Mendel[1] aptly says: "Of all the food stuffs the proteins offer the most serious problem. They represent the indispensable staple for tissue construction; they are produced at the greatest expense." While in the case of some persons too much protein may be consumed, as when meats are used to excess, any trouble would be obviated and a better balanced and cheaper ration secured by the use of more bread and less meat. It is not intended to convey the idea that one "should live on bread alone," any more than that we should live on any single food material, but if a person had to live on any one food, bread would be the best to use. Any attempt to lessen the protein content of flour and increase its starch or carbohydrate content must be regarded as a serious menace to the nutritive value of our chief article of diet. Professor Mendel[2] notes a tendency for a bread and potato diet to be deficient in protein. In speaking of the industrial workers coming from the country to the city, he says: "They cannot well get along with their former simple diet, because the cheap food materials which one easily obtains, as bread and potatoes, contain too little protein. They undoubtedly need an increase of proteid material." There is certainly no need for any increase in starchy materials to combine with bread.

BREAD-MAKING

Another important need is a better understanding of the principles of bread-making, and a wider diffusion of our present knowledge of the subject. There is too much poor bread and this is due to a lack of knowledge. Bread-making is an art founded upon scientific principles. Rule-of-thumb methods for bread-making should give way in our Domestic Science Courses to a study of principles, so that the manipulator will vary the method of procedure and the amount of ingredients to conform to the character of the flour used. It is just as necessary to make slight variations in the process of bread-making as it is to make slight changes in butter-making.

Generally the quantity of bread consumed is regulated by its quality. Good bread is eaten with a relish, poor bread with indifference or not at all. If it is desired to economize in the cost of living, the amount of bread used in the dietary must be increased, because there is no food at ordinary market prices that furnishes such a large amount of valuable nutrients in a balanced form and at such a low cost as flour. Hence it is economy to encourage in every way a wider use of bread and flour in the dietary. There are other gains beside economy. Mendel[1] quotes Rubner as saying: "Long ago the medical profession started an opposition to the exaggerated meat diet, long before the vegetarian popaganda was started. It was maintained that flour-foods, vegetables and fruit should be eaten in place of the over-large quantities of meat."

Flour milling problems and nutrition questions are closely related and demand the best thought and attention that science can give. These questions must be approached in a broad way and in the right spirit. They are not questions for the charlatan, or the zealot food reformer to toy with. They are of such importance that they are destined to be studied until correct scientific conclusions are obtained. Science cannot be fooled permanently. Adulterated science has been attempted, but like other forms of adulteration it is detectable. Chemists must keep up the ethics of their profession. There should be but one scientific standard for all things. Any business or practice which is not right, or which will not stand the closest scrutiny has no claim to continue its existence.

It is to be regretted that occasionally men possessing some scientific knowledge are willing to use it for selfish ends. Such persons cannot be called scientists, because true science will not be polluted. Scientists may, and often do, differ, but when a person will distort facts, disregard the welfare or general good of the public, or by stealth or cunning injure an industry and knowingly commit unethical acts, such a person rightfully forfeits the respect of scientists. Both government experts and those employed by manufacturers should be above such practices. They should leave those who wish to follow such lines, in the language of Kipling:—......"Sweating and stealing a year and a half behind."

MINNEAPOLIS, MINNESOTA

MANUFACTURED FEEDS FOR LIVE STOCK

By C. S. MINER

Manufactured feeds for live stock are known in the trade by a variety of names, *viz.*, Horse, Dairy, Stock, Horse and Mule, Hen, Chick, and Scratch Feeds and usually are composed of mixtures of by-products, mixtures of grains, or mixtures of grains with by-products. The industry is one whose growth has been so recent and so rapid that most of us neither appreciate its magnitude nor realize the part which chemists have come to play in its control. The annual output of manufactured feeds has grown steadily until now it is measured in millions of tons and since practically all of it must be produced under chemical supervision this industry is an important one from the standpoint of the chemist.

The question of chemical control, as it happens, is by no means optional with the manufacturer. In the feed industry in its early days there were many abuses of public confidence. The use of improper ingredients, deceptive labeling, and other fraudulent practices indulged in by the unscrupulous resulted in the passing of State Feed Control Laws designed to protect not only the consumer but the honest manufacturer as well. There are now laws of this sort in over forty states—which means in all the states where there is any market for manufactured feeds—and the large majority of them are ably and energetically administered. Although the variations in the details of these

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[1] "Changes in the Food Supply and Their Relation to Nutrition," p. 20.

[2] *Loc. cit.*, p. 25.

[1] *Loc. cit.*, p. 24.

laws are such as to constitute a source of considerable annoyance to manufacturers the essential requirements in all of them are substantially the same. They require that each bag of feed shall be labeled to show the ingredients of which it is composed and the minimum per cent of crude protein, crude fat, and maximum per cent of crude fiber which it is guaranteed to contain. A very few states require the label to show the guaranteed per cent of carbohydrates and there are isolated cases where guarantees of nitrogen-free extract or starch and sugar are required. In consequence it has become the almost universal custom of manufacturers to stamp on their bags the per cent of crude protein, crude fat, crude fiber, and carbohydrates and the list of ingredients. This is done in order to be able to use one bag for all states. It may seem to some of you that the determination of carbohydrates presents so many difficulties as to make it practically impossible as a routine determination. This difficulty is avoided by a ruling of the Department of Agriculture which permits the sum of the crude fiber and nitrogen-free extract to be considered as carbohydrates for the purpose of the guarantee. That this saves work for the chemist and worry for the manufacturer is true—but it is equally true that it is highly inaccurate from a chemical standpoint. Since the literature previously recognized the term "nitrogen-free extract," which is at least definite in its meaning, and covers the same constituents with the exception of crude fiber as are now permitted by this rule to be called carbohydrates, the recognition of this inaccurate use of the term carbohydrates appears ill-advised at least.

In this connection it is of interest to note how the Federal authorities have acquired jurisdiction over the feed guarantees. The Federal Food and Drug Act does not require any more of an animal feed than of human food, merely that both shall be truthfully labeled and free from poisonous or deleterious ingredients. It does not require any statement of chemical composition or list of ingredients. The State Laws do and the manufacturer must label his feed to conform to their requirements. Consequently he becomes responsible under the Federal Food and Drug Act for the truthfulness of this label the instant his product is shipped across a State line. Since most of his shipments are interstate, the result is substantially the same as though the requirements of the State Laws had been written into the Federal law and the weight of Federal authority is added to that of the States to compel the manufacturer of feeds to maintain the standard which he sets for himself by his label. It will be evident from the foregoing that the chemist's position in the feed industry is the consequence of laws which practically make it obligatory upon the manufacturer to utilize his services. Competition forces him to make high guarantees for his feeds and the laws compel him to keep them always up to these guarantees. Since the standard is a chemical one, the chemist's services are indispensable. The problem of the feed chemist is, therefore, so to control the manufacturing process as to keep the finished feeds invariably above guarantee and yet not so far above as to make the cost prohibitive from the standpoint of competition. To do this there must be accurate analyses of all the raw materials going into the feed and of all the finished feeds. The problem consequently resolves itself into the production of the largest possible number of accurate determinations of crude protein, crude fat, and crude fiber, in the shortest possible space of time and to accomplish this the routine of the laboratory must be worked out with the same regard for efficiency that obtains in a well regulated factory, for the laboratory where thousands of samples are analyzed annually does in fact become a factory for the manufacture of analyses.

Fortunately, since the whole question is one of routine analysis, there are available the methods of the A. O. A. C. which are accepted and used by practically all chemists connected with the industry and where these methods are rigidly adhered to there is surprisingly little variation in the results obtained by different laboratories. There are, of course, exceptions to this condition but most of them are due to the apparently inevitable bookkeeping errors which occur where thousands of similar samples are analyzed, and to differences in the samples for which the chemist is not responsible. The A. O. A. C. methods are on the whole excellent but they are not fool-proof, especially when applied to a wide range of materials on which they were not tested before being made official.[1] By simple expedients, however, it is possible to apply the official methods satisfactorily to all of the very numerous materials which are used for the manufacture of feeds.

Since the manufacturer must guarantee not only crude protein, crude fat, and crude fiber, but also ingredients, the feed chemist is expected to be something of a microscopist, but in actual practice it is only the official chemist who examines large numbers of feeds microscopically. The manufacturer's chemist knows what goes into the feed and it is not necessary for him to examine it. He should, however, make certain that the raw materials are true to name and while normally this is the case there are plenty of instances where materials purchased by manufacturers in good faith have been used in manufactured feeds and later found by state officials to have been adulterated. Screenings in malt sprouts, bran, or linseed meal constitute one of the commonest examples of such a possibility. Since screenings are almost invariably present in such products the question of determining whether to accept or reject a shipment oftentimes becomes a difficult one especially because of the lack of quantitative methods of microscopic analysis. This situation is a typical one and the result is that in most cases the chemist makes very little effort to control the raw materials by other than chemical means or visual examination, and adulteration unless gross is therefore not likely to be detected.

You may have judged from what I have said that the feed industry demands only routine work of its chemists. I do not want to leave that impression. In this industry as in others routine analysts are valuable as a class. As individuals they are readily replaceable and not highly valued. What is highly valued here as elsewhere is the ability to apply specialized training and experience to the solution of practical problems and the chemist who can do this will find himself very soon occupying the position, not of routine analyst, but of chemical director to his company. He will be consulted on all chemical phases of the business just as the attorney is consulted on all legal phases. He will pass upon the scientific accuracy of the advertising matter, upon the wording of contracts for raw materials, upon the value of new raw materials, and he will be expected to evolve new formulas or pass judgment upon those suggested. In fact it will be his business to give an expert judgment upon every problem involving chemistry which arises in connection with the manufacture and marketing of feeds.

The future of this industry holds even greater possibilities for chemists. Our rapidly increasing fund of information concerning the factors involved in nutrition and growth, such as the amino acids, the mineral constituents of foods, and the accessory diet factors—vitamins and the like—is certain to be applied in the development of the feed industry with the result that a much more complete and accurate form of chemical control will become necessary. And not only routine control but research as well, for the feed manufacturer will not always be content to depend upon State institutions for research as at present. The industry, therefore, both for its present and future possibilities is one which I can conscientiously recommend to the consideration of the young chemist looking for his place in technical chemistry.

CHICAGO, ILLINOIS

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[1] To cite a single example we have found that peat or feeds containing considerable percentages of it give erratic results for crude fiber because of the slow filtration. By the simple expedient of centrifuging, decanting, or otherwise partially separating the dissolved from the suspended matter before filtration and passing the nearly clear liquor through the filter before the suspended matter is added, satisfactory results are obtainable.

CURRENT INDUSTRIAL NEWS

LEATHER TRADE IN NIGERIA

The demand for leather in Nigeria, says the *Leather World*, 8 (1916), 388, is limited to the varieties used for slippers and saddlery. The southern districts are not so well adapted for tanning materials but in the marshes along the coast there is an abundance of mangrove and its exploitation would, it seems, be remunerative, considering that labor is cheap. The natives work well in their way for 12 to 24 cents per day, but resent being ordered about too much. The population of Nigeria is about 6,000,000.—A. McMillan.

NEW INSTITUTION

According to *Engineer*, 122 (1916), 33, what is described as an "experimental workshop and industrial laboratory," has been established by the recently founded Aeronautical Institute of Great Britain. The laboratory is situated at 45 Horseferry Road, Westminster, and according to information received concerning it, is intended to form a link between "an invention in its primitive stage and its scientific application and commercial development." It has, further, been gathered that its work will not possess the minute accuracy of exact scientific investigation but will aim simply at ascertaining whether any practical purpose would be served by submitting a new device to systematic and frequently delicate and costly scientific research. In short, the laboratory, it is claimed, will afford means of producing and testing under good conditions, new ideas, and of quickly obtaining results which can give reliable indications as to the practicability of the proposed devices. It will specialize on aeronautical work but will be open to deal with inventions outside this sphere.—M.

VEGETABLE DYES

Samples of dyes have been received at the Board of Trade, London, from the Consul at Szechuan, as follows:

Red: *Lithospermum officiale* L; *Rubia cordifolia* L; and *Carthamus tinctorius* L (Safflower).
Blue: *Strobilanthes flaccidifolius;* Nees (Indigo).
Green: *Polygonum orientale.*
Yellow: *Curcuma longa* L (turmeric); *Sophora Japonica;* and *Gardenia florida* L.
Black: *Rhus Semialata Murr; Quercus. Mongolica* or *Sinensis* (silkworm or chestnut oak) and *Stillingia sebifera* (tallow tree).

Information regarding preparation and employment of above may be obtained at Board of Trade Offices, London.—M.

PARAFFIN AS A PETROL SUBSTITUTE

In view of the abnormally high price of petrol and the difficulty of obtaining it, an article in *Engineer*, 122, No. 3158, will be read with interest. A description is given of the Binks vaporizer and carbureter, by the use of which paraffin may be substituted for petrol in motor-driven vehicles. A small tank is fitted for the supply of petrol for starting the engine and paraffin is used after the vaporizer has become sufficiently hot. The carbureter has two float chambers, one for petrol and the other for paraffin and has a main jet and two pilot jets. The sprayed paraffin enters the vaporizer which consists of two concentric tubes, between which the exhaust gases from the engine pass and thus heat the walls of the inner tube. The latter tube contains a worm which causes the mixed air and paraffin to whirl as the mixture transverses the inner tube. There is thus a tendency to throw any unvaporized paraffin into contact with the hot walls where vaporization is completed. With present prices, application of this and similar devices may reduce the cost of fuel for motor engines by 50 per cent.—M.

SWISS DYE INDUSTRY

A report has been issued by the Basle Chamber of Commerce dealing briefly with the position of the dye manufacturing industry in Switzerland. It seems that all the firms formerly engaged in the production of coal-tar dyes have had to enlarge their plant in order to manufacture the intermediate products used in the industry, most of which had previously been imported from Germany. The supply of raw material seems to be the chief cause of anxiety, but reference is made to the assistance given by the British Board of Trade in facilitating the transport of crude tar products from that country to Switzerland. The various color makers are making negotiations with a view to erecting a large plant for the production of mineral acids. The report further states that synthetic indigo has been produced on a small scale only, owing to the difficulty of obtaining raw materials, but it has been found possible, notwithstanding, not only to supply the demands of the Swiss market but also to export a moderate amount. Owing to complaints raised by Swiss dyers that they were not receiving a fair share of the output, the dyestuff manufacture has been placed under the control of the government to some extent and export licenses are now necessary. These are granted only to countries which are supplying raw material to Switzerland and the amount of color exported is in proportion to the amount of raw material supplied. At the present time and under these conditions, England is the only country receiving dyes in any quantity.—M.

LAC EXPORTS FROM BRITISH INDIA

The *Indian Trade Journal* of May 19 contains a communique, issued by the Commerce Department of India, which states that the Collectors of Customs have been instructed to permit exports of lac to all allied countries under license. Permission has also been granted, under license, for the exportation of lac in normal quantities to the usual consignees in neutral countries outside Europe. Applications to export to neutral countries in Europe should be submitted to the Government of India through the Collector of Customs at the port of shipment.—M.

JAPANESE CHEMICAL PRODUCTION

Official returns of the production of chemicals in Japan during 1915 contain the following figures (lbs.):

Benzol	128,000	Naphthalene	1,170,000
Ether	549,000	Alcohol	7,600,000
Aspirin	50,000	Hydrochloric acid	4,819,000
Sulfuric acid	153,420,000	Acetic acid	723,000
Caustic soda	240,000		

The exports of camphor last year amounted to 5,044,000 lbs. valued at $1,737,500 and showing a steady increase.—M.

COPPER INDUSTRY IN AUSTRALIA

Considerable interest, says *Engineering*, 102 (1916), 104, is attached to the recent developments in the copper industry in Australia. The Hampden Cloncurry copper mines instead of sending metal overseas for conversion into the pure metal as heretofore, now sends the whole of its output to be refined at the works of the Electrolytic Refining and Smelting Co. of Australia at Port Kembla. The refinery is not yet able to refine the whole of the company's output electrolytically and the excess is pre-refined and is being disposed of at satisfactory prices. A company has also been formed to manufacture all classes of copper wire, copper tubes, sheets, etc., with works adjoining the electrolytic works at Port Kembla. The consumption of manufactured copper goods is a growing one and after exhaustive investigation and on assurances of support from the commonwealth authorities, its inauguration seems to be commercially justified. The capital of the Company is $1,000,000.—M.

SCIENTIFIC SOCIETIES

FIFTY-THIRD MEETING AMERICAN CHEMICAL SOCIETY
NEW YORK, SEPTEMBER 25 TO 30, 1916
PROGRAM OF PAPERS

PUBLIC MEETINGS

Addresses of Welcome. Dr. Haden Emerson, Health Commissioner of New York City, and Nicholas M. Butler, President of Columbia University.

Response. Charles H. Herty, President of American Chemical Society.

Outline of Colloid Chemistry. W. D. Bancroft.

Coal and Coke By-Products as a Source of Fixed Nitrogen (Illustrated). H. C. Porter.

Chemistry and the National Welfare. Gen. William Crozier, Chief of Ordnance, War Department.

Chemistry and Banking. J. E. Gardin, Vice-President of National City Bank.

Chemistry and Conservation. Gifford Pinchot, President of National Conservation Association.

Expanding Relations of Chemistry in America. Charles H. Herty.

INDUSTRIAL CONFERENCES

Electric Furnace Steels and Alloy Steels. J. A. Mathews, Chairman.

American Dyestuff Manufacture. C. H. Herty, Chairman.

American-Made Chemical Glass and Porcelain. A. H. Thomas, Chairman.

Industrial Alcohol, Acetone, and Acetic Acid. Arthur D. Little. Chairman.

Manufacture of Paper Pulp and By-Products. R. B. Wolf, Chairman.

Medicinal Chemicals. Harold Hibbert, Chairman.

Miscellaneous Chemical Industries: Convertibility of Plant. W. H. Grosvenor, Chairman.

Oils and Motor Fuels. R. F. Bacon, Chairman.

AGRICULTURAL AND FOOD CHEMISTRY DIVISION

L. M. Tolman, *Chairman* G. F. Mason, *Secretary*

1. **Chemical Factors in the Deterioration of Raw Sugars.** C. A. Browne.

2. **Maple Products, IX: On the Composition of the Soluble and Insoluble Portions of the Ash of Maple Syrup.** J. T. Snell and Mr. Van Zoeren.

3. **An Increase in the Sucrose Content of Sugar-Beets after Their Removal from the Soil.** Dr. F. G. Wiechmann.

4. **Determination of Minute Quantities of Metal in Organic Substances with Special Reference to Lead in Urine.** Halsey Durand.

Determination of Added Water in Milk.

5. **The Relation of the Fat in Milk to the Solids-not-Fat.** Lucius P. Brown and Clarence V. Ekroth.

6. **Chemical Quality of New York City Milk.** Lucius P. Brown and Clarence V. Ekroth.

7. **The Use of Hard Water for Cannery Purposes.** W. D. Bigelow and F. F. Fitzgerald.

8. **Detection of Watered Milk, by Means of Simplified Molecular Concentration Constants.** L. W. Ferris.

9. **The Estimation of Total Solids in Evaporated Milk by Means of the Babcock Formula.** O. L. Evenson.

10. **Detection of Added Water in Milk by Means of the Freezing Point.** J. T. Keister

BIOLOGICAL CHEMISTRY DIVISION

C. L. Alsberg, *Chairman* I. K. Phelps, *Secretary*

Part I—Colloid Chemistry Symposium (Theoretical and Applied)

Irreversible Adsorption of Dyes. D. B. Lake.

Phase Relations in Biological Systems. G. H. A. Clowes.

Displacement of Equilibrium by Catalytic Agents. W. D. Bancroft.

Stabilization. E. F. Farnau.

Shower Proofing. E. L. Mack.

Selective Adsorption and Differential Diffusion. J. Alexander.

The Photographic Developer. J. M. Ball.

Structure of Liquids with Particular Reference to Surface Tension. I. Langmuir.

Electrical Endosmose. T. R. Briggs.

The Reaction between Potassium Permanganate and Ferrous Chloride.

A New Method for Preparing Colloidal Hydrous Ferric Oxide. Marks Neidle and John H. Crombie.

Studies in Dialysis. II. The Dialysis of the Chlorides of Iron, Chromium and Aluminum, Particularly in the Hot. Marks Neidle and Jacob Barab.

The Colloid Material of Clay. Guy C. Given.

Terminology in Colloid Chemistry. A. W. Thomas.

Refining of Oils. C. Baskerville.

Relation between Chemical Composition and Electrical Resistance. C. G. Fink.

Paints. T. R. Briggs.

Yellow Bricks. L. A. Keane.

Vulcanization of Rubber. D. Spence.

The Splitting of Fats. W. D. Richardson.

Adsorption of Chromium by Hide Powder. A. W. Davison.

Asphalt. C. Richardson.

Plaster of Paris. L. A. Keane.

Emulsions and Suspensions with Molten Metals. H. W. Gillett.

The Purification of Kaolin. C. L. Parsons.

Colloids in Glass. Alexander Silverman.

Fritting and Fusing. W. D. Bancroft.

Part II—Additional Papers Not Read in Symposium

1. **Carbon Monoxide, Occurrence Free in Kelp** (*Neurocystis Leutkeana*). S. C. Langdon.

2. **The Oxidation of Sulfur by Micro-organisms.** J. G. Lipman.

3. **A Comparison of Barbituric Acid, Thiobarbituric Acid and Malonylguanidine as Quantitative Precipitants for Furfural.** A. W. Dox and G. P. Plaisance.

4. **An Accurate Aeration Method for the Determination of Alcohol in Fermentation Mixtures.** A. W. Dox and A. R. Lamb.

5. **A Direct Reading Potentiometer for Measuring Hydrogen Ion Concentrations.** F. E. Bartel.

6. **The Separation and Estimation of Butyric Acid in Biological Products.** I. K. Phelps and H. E. Palmer.

7. **Investigations of the Kjeldahl Method for Determining Nitrogen. A Qualitative Study of the Hydrolysis of Amines.** I. K. Phelps, H. W. Daudt, C. L. Alsberg and H. E. Woodward.

8. **On the Proteins of the Peanut, *Arachis Hypogaea:* 1. The Globulins Arachin and Conarchin.** C. O. Johns and D. B. Jones.

9. **On Kafirin, an Alcohol-Soluble Protein from Kafir, Andropogon Sorghum.** C. O. Johns and J. F. Brewster.

10. **On a Saponin from *Yucca Filamentosa*.** L. H. Chernoff, A. Viehoever and C. O. Johns.

11. **On a Saponin from *Agave Lechiguilla*.** C. O. Johns, L. H. Chernoff and A. Viehoever.

12. **On the Chemistry of the Cotton Plant, with Special Reference to the Upland Variety. *Gossypium hirsutum* (First Paper).** A. Viehoever, L. H. Chernoff and C. O. Johns.

13. **Urease of the Soy Bean and of the Jack Bean.** I. F. Harris.

14. **Needs and Requirements of Modern Toxicology.** E. E. Butterfield.

15. **A Rapid Method for the Removal of Organic Matter in Blood, Feces, Tissue and Foods.** H. H. Willard and C. H. Laws.

16. **The Availability of the Insoluble Calcium Phosphates when Present as a Constituent of Infant's Food.** A. W. Bosworth.

17. **The Chemical Changes Produced by the Addition of Lime Water to Milk.** A. W. Bosworth.

18. **Chemistry of the Liver in Acute Yellow Atrophy.** M. Kahn and V. L. Andrews.

19. **A Method of Testing the Function of the Liver by Means of Sulfo-Conjugation of Thymol.** M. Kahn and C. S. Foster.

20. **An Improved Nephelometer-Colorimeter (a demonstration).** P. A. Kober.

21. **Improvements in the Copper Method for Estimating Amino Acids (a demonstration).** P. A. Kober.

22. **The Efficiency of the Aeration Method for Distilling Ammonia; in Answer to Certain Criticisms (a demonstration).** P. A. Kober.

23. **Cholesterol and Cholesterol Esters in Human Blood.** W. R. Bloor and A. Knudson.

24. **The Formation of a Phenol by *Aspergillus niger*.** C. L. Alsberg and J. F. Brewster.

25. **A New Reagent for Volatile Amines and a New Reagent for Volatile Tertiary Amines.** C. L. Alsberg and H. E. Woodward.

26. **Elimination of Malates Following the Subcutaneous Injection of Sodium Malate.** L. E. Wise.

27. **Isolation of Cyanuric Acid from Soil.** L. E. Wise.

28. **The Isolation of an Organic Colloid of the Gel Type from a Soil. A Complex Carbohydrate.** E. C. Lathrop.

29. **The Carbohydrate of Thymus Nucleic Acid.** George Peirce.

30. **The Inosite-Phosphoric Acids of Cottonseed Meal.** J. B. Rather. (By Title.)

31. **Gossypol, the Toxic Principle of Cottonseed.** W. A. Withers and F. E. Carruth.

32. **A Device for Measuring the Reaction of Solutions (Lantern).** W. T. Bovie.

FERTILIZER CHEMISTRY DIVISION

J. E. Breckenridge, *Chairman* F. B. Carpenter, *Secretary*

1. The Utilization of City Waste for the Manufacture of Fertilizers. J. W. Turrentine.

2. Variation in the Composition of City Garbage. W. J. O'Brien and John R. Lindemuth.

3. The availability of Nitrogen in Garbage Tankage. James P. Schroeder.

4. The Availability of Nitrogen in Fertilizers: Some Modern Lights Thereon. Charles B. Lipman.

5. Fertilizer Sampling Methods in the United States. F. S. Lodge.

6. Note on the Results of Analysis on Samples Taken with Different Styles of Samplers. F. B. Carpenter.

7. Results of Further Co-operative Work on the Determination of Sulfur in Pyrites. H. C. Moore.

8. A Summary of the Potash Situation. H. A. Huston.

9. Note on the Recovery of Molybdic Acid. Paul Rudnick.

10. The Action of Calcium Carbonate on Acid Phosphate. E. W. Magruder.

11. The Effect of Changes in Temperature and the Sulfuric Acid Radical on the Pemberton Volumetric Method for Determining Phosphoric Acid. P. McG. Shuey.

12. The Volumetric Determination of Phosphoric Acid by the Molybdate Cold Precipitation Method. W. P. Heath.

13. The Preparation of Concentrated Fertilizers. Albert R. Merz and W. H. Ross.

14. Results of Recent Investigations with Methods of Analysis on Samples of Commerical Wood Ashes. R. E. Rose.

15. The Relative Availability of Acid Phosphate and Raw Rock Phosphate in Indiana Field Tests. S. D. Conner.

INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS DIVISION

H. E. Howe, *Chairman* S. H. Salisbury, Jr., *Secretary*

Part I—Symposium on Occupational Diseases in the Chemical Trades

1. Introduction. Prof. Chas. Baskerville, Chairman, Committee on Occupational Diseases in the Chemical Trades.

2. The Occupational Hazard in the Chemical Industry; the Need for Prophylaxis. Dr. J. W. Schereschewsky, Surgeon, U. S. Marine Hospital Service, Pittsburgh, Pa.

3. Aniline and Other Coal Tar Products. George P. Adamson, Baker & Adamson Chemical Co., Easton, Pa.

4. Some Abnormal Effects on Workmen Engaged in the Manufacture of Port Orford Cedar Lumber. Dr. H. K. Benson, Professor of Chemistry, University of Washington, Seattle, Wash.

5. Bureau of Mines Studies on Occupational Diseases. Dr. W. A. Lynott, Bureau of Mines, Washington, D. C.

6. Dangers other than Accidents in the Manufacture of Explosives. Dr. Alice Hamilton, United States Bureau of Labor Statistics, Chicago, Ill.

7. Discussion. Dr. W. Gilman Thompson, Professor Physiology, Cornell University Medical College; Dr. Frederick L. Hoffman, Statistician Prudential Insurance Co. of America; Mr. John B. Andrews, Secretary American Association for Labor Legislation; and others.

Part II—The Nitrogen Industry

1. Conditions Affecting the Establishment of the Nitrate Industry in the United States. Lawrence Addicks.

2. By-Product Ammonia for Fertilizers and Munitions. J. W. Turrentine.

3. The Oxidation of Ammonia. J. W. Turrentine, W. J. O'Brien and Harry Bryan.

Part III—Additional Papers

1. Why the Brewing Industry Demands Recognition by the Universities. Carl A. Nowak.

2. The Present Status of the Potash-from-Kelp Industry of the Pacific Coast. J. W. Turrentine.

3. The Preparation of Oxalic Acid and Citric Acid by Fermentation. James N. Currie.

4. The Manufacture of Benzaldehyde and Benzoic Acid. H. D. Gibbs.

5. Noviol, a New Glass for Absorbing Ultraviolet Radiation. W. C. Taylor.

6. Single and Multiple Effect Evaporators. Otto Mantius.

7. The Problem of the Cheap Production of Alcohol. Arthur N. Breckler.

8. The Specific Heat and the Heat of Hydration of Wheat Flour. Farrington Daniels, B. H. Kepner and P. P. Murdick.

9. The Use of the Cottrell Precipitator in Recovering the Phosphoric Acid Evolved in the Volatilization Method of Treating Phosphate Rock. W. H. Ross, J. N. Carothers and A. R. Merz.

10. The Influence of Moisture on the Yield of Products in the Destructive Distillation of Hardwood. R. C. Palmer and H. Cloukey. (By Title.)

11. The Effect of Incomplete Distillation on the Yield of Products in the Destructive Distillation of Birch. R. C. Palmer. (By Title.)

12. The Effect of Catalyzers on the Yield of Products on the Destructive Distillation of Hardwoods. R. C. Palmer. (By Title.)

13. Teaseed Oil, Properties, Tests, and Possibilities. Charles V. Bacon.

14. Peanut Oil as a Southern Asset. Charles V. Bacon.

15. The Recracking of a Cracked Oil. Gustav Egloff and Thomas J. Twomey.

16. The Effect of Temperature and the Time Factor in the Formation of Gasoline in the Gas Phase at Constant Pressure. Gustav Egloff, T. J. Twomey and R. J. Moore.

17. An Experiment in the Training of Chemical Engineers; the 25th Anniversary of the Audubon Sugar School. Charles E. Coates.

ORGANIC DIVISION

C. G. Derick, *Chairman* H. L. Fisher, *Secretary*

1. The Hydrazion Diacids. J. R. Bailey.

2. The Use of Cyanic Acid in Glacial Acetic Acid. J. R. Bailey.

3. The 5,5-Dimethyl-3-R-2-thiohydantoins. J. R. Bailey.

4. The Formation of Cyclopentadiopyridazines and Proof of Their Structure. William J. Hale.

5. The Formation of Aromatic Hydrocarbons from the Thermal and Pressure Decomposition of Pentanes and Hexanes. Gustav Egloff.

6. Application of the Nitrometer for the Determination of Constitution and Estimation of Nitrogen in a Class of Nitrocompounds (Nitroamines). W. C. Cope and J. Barab.

7. The Preparation and Ionization of the Isomeric Benzenedisulfonic Acids. W. A. Drushel.

8. Carbon Monoxide, Occurrence Free in Kelp (*Nereocystis Luetkeana*). Seth C. Langdon.

9. Studies on Derivatives of Trihalogen Tertiary Butyl Alcohols. I. The Acetic Ester of Tribromotertiary Butyl Alcohol or Brometone Acetic Ester. T. B. Aldrich and C. P. Beckwith.

10. The Constitution of Xanthogallol. F. J. Moore.

11. Di-*p*-nitro-benzoyl Malonic Ester. C. G. Derick and F. C. Hahn.

12. The Scale of Influence of Substitution. The Diad Oxygen Atom. C. G. Derick, St. Elmo Brady and R. W. Hess.

13. The Scale of Influence of Substitution. The Phenyl Radical. C. G. Derick and P. M. Dean.

14. The Electronic Formula of Benzene and the Molecular Volumes of the Chlorobenzenes. H. S. Fry. (By Title.)

15. A Correlation between the Electronic Formulas of Monosubstituted Derivatives of Benzene and the Quantities of the Isomers Obtained upon Nitration. H. S. Fry. (By Title.)

16. On the Mechanism of Replacement Reactions in the Benzene Nucleus. H. S. Fry. (By Title.)

17. The Preparation of Alkyl Hydroxyurea Chlorides and Their Relation to Esters of Carbon Dioxide Oxime, $R - O - N = C = O$. Lauder W. Jones and Leonora Neuffer. (By Title.)

18. Hydroxamic Acids Related to α-Hydroxy Acids and to Acrylic Acid and a Study of Their Rearrangements. Lauder W. Jones and Leonora Neuffer. (By Title.)

19. A Study of β-Benzylformhydroxamic Acid and Hydroxamic Acids of Substituted Acetic Acids. Lauder W. Jones and M. Cannon Sneed. (By Title.)

20. Unnecessary Use of Potash Compounds in Making Organic Preparations. Herbert Coith and James R. Withrow.

21. The Determination of Small Amounts of Nitrogen and Its Presence in Petroleum. C. F. Mabery.

22. Some Measurements with a New 4-Range Variable Inductance. F. M. Beegle, S. F. Acree and Edward Bennett.

23. A Correction Formula for Conductivities Measured at Different Frequencies in Cells with Bright Electrodes. H. P. Hastings, W. A. Taylor, Edward Bennett and S. F. Acree.

24. Some Corrections for Conductivity Measurements with Kohlraush Slide-Wire Bridges. F. M. Beegle, Edward Bennett and S. F. Acree.

25. Some Spectrophotometric Measurements on Sulfonphthaleins and the Quinone Phenolate Theory of Indicators. J. Sam Guy and S. F. Acree.

26. The Influence of the Partial Pressure of Hydrogen on the Potential of the Hydrogen Electrode. N. E. Loomis and S. F. Acree.

27. A Study of Tipase. Hilton Ira Jones.

28. Identification of Phenols. E. Emmet Reid.

29. The Isomeric Octacetates of Gentiobiose. C. S. Hudson and J. M. Johnson.

30. Researches on the Action of Sulfuric Acid on Certain Nitrocarbocyclic Compounds. M. L. Crossley.

31. The Use of General Formulas in Teaching Organic Chemistry. M. L. Crossley.

32. A Hydrate of Anthraquinone 2.7 Sodium Sulfonate. M. L. Crossley.

33. On the Use of the Oscillograph for Measuring the Resistance and Capacity of Conductivity Cells. G. H. Gray, Edward Bennett and S. F. Acree.

34. The Action of Butyl Chloral on Benzene and Its Homologues in the Presence of Aluminum Chloride. G. B. Frankforter and E. A. Daniels.

PHARMACEUTICAL CHEMISTRY DIVISION

John H. Long, *Chairman* Geo. D. Beal, *Secretary*

1. Aromatic Sulfuric Acid, U. S. P. W. B. D. Penniman, W. W. Randall, C. O. Miller and L. H. Enslow. (Printed in this issue.)

2. The Registration of Proprietary Remedies. Louis Hogrefe.

3. A Bill to Regulate the Use and Registration of Professional Degrees in New York State. Louis Hogrefe.

4. Chemicals Admitted into U. S. P., IX. Otto Raubenheimer.

5. A Demonstration of Standardized Colored Fluids. H. V. Arny.

PHYSICAL AND INORGANIC CHEMISTRY DIVISION

Irving Langmuir, *Chairman* James Kendall, *Secretary*

1. The Calculation of the Vapor Pressure of a Liquid. J. E. Mills.

2. The Specific Heat of the Elements. J. E. Mills.

3. The Action of Ammonia on Arsenic Iodide (with Lantern). Charles H. Herty and C. B. Carter.

4. The Thermodynamic Properties of Silver and Lead Iodides. H. E. Taylor.

5. The Inconstancy of the Solubility Product, II. Arthur E. Hill.

6. Studies on Catalysis, II. J. E. Booge and James Kendall.

7. The Catalytic Reduction and Oxidation of Solutions of Iron Sulfate by Colloidal Platinum (with Lantern). Farrington Daniels and R. H. Kienle.

8. The Laws of Plastic Flow (with Lantern). Eugene C. Bingham.

9. Determination of Silver from Cyanide Solutions (with Lantern). A. S. McDaniel and L. Schneider.

10. The Influence of Pressure on Solubility. Herbert F. Sill.

11. Experimental Physical Chemistry (with demonstration of apparatus in Room 605, Havemeyer Hall, by J. E. Booge, K. P. Monroe and J. C. Andrews). James Kendall.

12. Emulsions. R. E. Oesper and Leo Roon.

13. The Disgregation Constant of Saturated Vapors. F. P. Siebel.

14. The Thorium-Mesothorium Ratio. Herbert N. McCoy and H. M. Henderson.

15. The Evidence of Physical Properties of Isotopes on the Nature of the Atom. Charles Wadsworth, 3d.

16. The Determination of the Specific Heats of Some Cadmium Salts at Low Temperatures and Their Use in the Calculation of Electromotive Force. F. M. Seibert, G. H. Hulett and H. S. Taylor.

17. Inflammability of Carbonaceous Dusts. H. H. Brown. (By Title.)

18. Inflammability of Carbonaceous Dusts in Atmospheres of Low Oxygen Content. H. H. Brown and J. K. Clement. (By Title.)

RUBBER SECTION

J. E. Weber, *Chairman* J. B. Tuttle, *Secretary*

A Revision of Wesson's Method for the Direct Determination of Rubber. J. B. Tuttle and L. Yurow.

Wet Combustion in the Nitrosite Combustion Method for the Direct Determination of Rubber. L. G. Wesson.

The Aniline Method for the Determination of Fillers in Rubber Goods. Otto H. Klein.

Increase of Resins in the Vulcanization. L. E. Weber.

The Second Report of the Joint Rubber Insulation Committee. William E. Del Mar, Secretary.

The Rubber Industry. H. C. Pearson.

A symposium on "The Accelerated Life Test of Rubber Compounds." Discussion to be opened by W. C. Geer, with contributions from C. D. Young, C. R. Boggs, L. E. Weber, Dorris Whipple, J. B. Tuttle, and others.

WATER, SEWAGE AND SANITATION DIVISION

Edward Bartow, *Chairman* H. P. Corson, *Secretary*

1. Value of the Sanitary Survey. W. P. Mason.

2. The Present Status of the Mineral Water Industry. (Lantern.) F. L. Rector.

3. The Alternate Use of Bleaching Powder and of Copper Sulfate for Sterilizing the Water of Swimming Pools. (Lantern.) Frederic Bonnet, Jr.

4. Storage Reservoirs as a Factor in the Purification of Surface Waters. S. T. Powell.

5. Reaeration as a Factor in Stream Pollution. Earle B. Phelps.

6. The Chemical Composition of the Water of the Yukon River, Alaska. R. B. Dole and A. A. Chambers.

7. Thermocline Studies at Kensico Reservoir. Frank E. Hale and John E. Dowd.

8. The Relation of Micro-organisms to the Loss of Head in Rapid Sand Filters. J. W. Ellms and S. J. Hauser.

9. The Treatment of Sewage Sludge with Filter Effluent. H. W. Clark.

10. Is the Recovery of the Nitrogen in Sewage Sludge Practicable? W. R. Copeland.

11. The Treatment of Residential and Small Community Sewage. L. C. Frank.

12. Water Meters in Their Sanitary Relations. Henry Leffmann.

13. A Source of Error in the Standard Methods for the Determination of Nitrates in Sewage and Sewage Effluents. Stephen DeM. Gage and Henry H. Anderson.

14. The Determination of Small Amounts of Methyl Alcohol Vapor in Air. Elias Elvove.

15. An Experimental Study of Muscicides. A. F. Stevenson.

16. Some Remarks on the Biochemical Treatment of Sewage, with Especial Reference to the Activated Sludge Method. George T. Hammond.

17. A New Battery Fermentation Tube Holder. W. F. Wells, U. S. Public Health Service.

AMERICAN ELECTROCHEMICAL SOCIETY, THIRTIETH GENERAL MEETING, NEW YORK CITY

SEPTEMBER 27 TO 30, 1916

The Thirtieth General Meeting of the American Electrochemical Society was held at New York City, September 27 to 30, 1916, with headquarters at the Hotel Astor. In order that as many members as possible might get together at the Exposition, Wednesday, Sept. 27th, was set aside as Electrochemical Day and the morning session was held at Grand Central Palace. Thursday and Friday mornings the technical sessions were held at the Hotel Astor. About 500 members and guests were registered.

The social features of the meeting held were in conjunction with the American Chemical Society.

PROGRAM OF PAPERS

The Protection of Iron by Electroplating. O. P. Watts and P. L. DeVerter.

Atmospheric Corrosion of Commercial Sheet Iron. E. A. and L. T. Richardson.

The Electrolytic Recovery of Lead from Brine Leaches. O. C. Ralston and C. E. Sims.

Electrolytic Zinc Dust. H. J. Morgan and O. C. Ralston.

Electrolysis of Vanadium Salts. S. Fischer.

The Electro-deposition of Nickel. L. D. Hammond.

Current Efficiencies in Nickel Plating Baths with Rotating Cathodes. F. C. Mathers and F. G. Sturdevant.

Deposition of Copper in Electrotype Baths. W. Blum, H. D. Holler and H. S. Rawdon.

Characteristics of Small Dry Cells. C. F. Burgess.

Effect of Temperature on the Performance of the Edison Storage Battery. L. C. Turnock.

High Temperature Heat Developed during Electrolysis. Carl Hering.

The Possibilities of Developing Super-refractory Materials for Incandescent Lighting. F. A. Fahrenwald.

Composition of the Ionization Currents Due to Equal Quantities of Radium Emanation. T. H. Leaming, H. Schlundt and Julius Underwood.

A New Method for the Study of Silver Peroxynitrate. M. J. Brown.

The Equilibrium between Bromine and Potassium Bromide Solutions at 0°. Grinnell Jones and M. L. Hartmann.

THE CHEMICAL SOCIETIES IN NEW YORK CITY

1916-1917 SEASON—RUMFORD HALL, THE CHEMISTS' CLUB

October 13—American Chemical Society. Joint Meeting with Society of Chemical Industry and American Electrochemical Society.

November 10—American Chemical Society.

November 24—Society of Chemical Industry.

December 8—American Chemical Society. Joint Meeting with Society of Chemical Industry and American Electrochemical Society.

January 19—Society of Chemical Industry. Perkin Medal Award.

February 9—American Electrochemical Society. Joint Meeting with American Chemical Society and Society of Chemical Industry.

March 9—American Chemical Society. Nichols Medal Award.

March 23—Society of Chemical Industry.

April 20—Society of Chemical Industry.

May 25—Society of Chemical Industry. Joint Meeting with American Chemical Society and American Electrochemical Society.

June 8—American Chemical Society.

SYMPOSIUM ON OCCUPATIONAL DISEASES IN CHEMICAL TRADES

Abstracts of Papers and Discussions at 53rd Meeting of the American Chemical Society, New York City

Occupational Diseases in the Chemical Trades. Dr. Chas. Baskerville, Chairman of the Committee on Occupational Diseases in the Chemical Trades. Dr. Baskerville outlined the work done so far, beginning with the First Congress in Milan in 1906. Great Britain is very much in advance of the U. S. in industrial disease investigations. The A. C. S. Committee has been as active since its appointment as the entire absences of funds would permit. The establishment of a National Museum of Safety in Washington was suggested.

The Occupational Hazard in the Chemical Industry; The Need for Prophylaxis. Dr. J. W. Schereschewsky, *Surgeon*, U. S. Marine Hospital Service, Pittsburgh, Pa. The specific hazards provided by the nature of chemical substances add to the complications of the chemical industries. The value of the products of these industries increased 53 per cent in the period from 1909 to 1914. The industry has been little studied in this country from the point of industrial hygiene. The Illinois Commission on Occupational Diseases and the New York State Factory Investigation are notable, however, in the face of discouraging conditions. Some of the ordinary hazards of the industries are classed under superficial poisons, blood poisons and poisons of remote, delayed and cumulative effect. Poisonous fumes and dusts are a danger not to be neglected.

Aniline and Other Coal Tar Products. Dr. George P. Adamson, General Chemical Co., Easton, Pa. This paper brought out the necessity of handling aniline with unusual precautions since the poison is absorbed through the skin, through open sores and from fumes; even leather shoes permit infection. Absolute cleanliness and special care of the health are essential for those working with it. A weak solution of acetic acid has been found to remove the material from the skin better than any other wash, the oil being almost insoluble in water. Poisoning is ordinarily indicated by a bluish appearance of the mucous membranes but occasionally even this sign is not evident, so that a factory physician and close watch of the employees is absolutely essential. Poisoned patients, if properly cared for, recover in a short time.

Bureau of Mines Studies on Occupational Diseases. Dr. W. A. Lynott, U. S. Bureau of Mines, Washington. This paper was abstracted from recent Bureau of Mines bulletins.

Dangers Other than Accidents in the Manufacture of Explosives. Dr. Alice Hamilton, U. S. Department of Labor, spoke of the extreme lack of statistics concerning the dangers and accidents due to occupational diseases in this country. In her investigations Dr. Hamilton has encountered from 30 to 35 poisonous substances; they include the mineral acids, benzene and toluene and their many derivatives, the aromatic nitro-compounds, phenol and phenolic compounds, nitrophenols, ammonium picrate and a great many of the dye materials. Also quite a number of the explosive materials are dangerous from the poisonous side as well as the explosive. There is an increasing number of deaths from hydrogen sulfide. Deaths from nitrogen oxides are also increasing. The dangers from nitrous fumes is particularly great as they are neither irritating nor corrosive as are other acid fumes, and men may easily obtain fatal poisoning without realizing that anything dangerous is happening. Picric acid as manufactured in this country is particularly dangerous, probably due to the hastily and poorly constructed temporary plants in which the men are working. The symptoms of various poisons were described.

DISCUSSIONS

Dr. W. Gilman Thompson, Professor of Medicine, Cornell University Medical College, New York City, complimented the American Chemical Society on taking up this question, as it is the first organized scientific body to do so and is only about three years behind the special consideration by even the medical profession for occupational diseases.

Dr. F. L. Hoffman, Chief Statistician, Prudential Insurance Company of America, Newark, N. J., called attention to the mistakes that can be made by ignorant treatment of the subject of occupational diseases, as is especially illustrated by the findings of the Selby Smelter Commission.

Dr. Francis D. Patterson, Department of Labor and Industry of the State of Pennsylvania, suggested that much could be brought about at the present time by requiring physicians to report to the state the details of occupational poisonings, which would necessitate, of course, pay for the physicians if the work is to be properly done. In the State of Pennsylvania there are 1000 industrial accidents for every working day.

Dr. Lester L. Roos, Medical Inspector of the Division of Industrial Hygiene, New York State Industrial Commission. The fallacy of the statement by capitalists that labor is unwilling to use hygienic safety devices is indicated by the fact that cases of poisoning and illness were decidedly cut down when a "comfort house" accommodating 50,000 men was installed in a large white lead plant. The necessity for the study of occupational diseases by physicians was illustrated by cases. An amendment to the labor laws requiring occupational illnesses to be reported by law is now being considered.

Mr. Newell T. Gordon, Department of Labor of New Jersey (in place of Miss Erskine), plead for frankness between the manufacturer and employees and stated that many manufacturers did not explain the dangers of their industries to employees because they were afraid to do so.

Dr. Tracy H. Clark, Medical Director, The National Union, Chicago, suggested that the American Chemical Society should bring about coöperation between insurance inspectors and plant physicians, as this would be the quickest way to secure results.

Mr. Meeker, U. S. Commission of Labor, called attention to the very limited facilities of his department and prime need for revision of the list of industrial poisons given in Bulletin 101 of the Labor Bureau. All the poisons need to be listed by Industry and Occupation and the coöperation of every physician and chemist in the United States is necessary.

Mr. C. I. Johnson, Goodyear Tire and Rubber Company, stated that they had changed from a 12- to an 8-hr. day in their aniline manufacture and had found that the health of their employees was greatly improved. Alcoholics are more susceptible to the poisoning than others. The speaker thinks there should be some way to separate the extremely susceptible people from others and put them where there would be less danger of infection.

Mr. Goodwin called attention to the use, suggested by a German, of a few drops of chloroform in a glass of water as an antidote for nitric oxide fumes. He criticized an Italian book for saying that the manufacture of T. N. T. is not dangerous and reported his own experience in being poisoned by working on this. He also called attention to the dangers from nickel carbonyl poisoning.

Dr. Johnson stated that the poisonings from the aromatic nitro-acids came from the lower nitrated compounds that were formed during the process and were volatile.

Mr. William P. Mason testified concerning *bona fide* cases of immunity and said they are of no subsequence whatever in treatment of the occupational diseases subject.

[A vote of thanks was extended by the Division of *Industrial Chemists and Chemical Engineers* to Dr. Baskerville for arranging the symposium. The papers of the symposium will appear in full in our next issue.—Editor.]

INDUSTRIAL CONFERENCES

Abstracts of Discussions at the 53rd Meeting of the AMERICAN CHEMICAL SOCIETY, New York City

ELECTRIC FURNACE STEELS AND ALLOY STEELS

JOHN A. MATHEWS, *Presiding*

Grand Central Palace, September 27, 1916

THE CHAIRMAN: Dr. Burgess, who is unable to be here today, suggested that this conference state in what way the Bureau of Standards in their metallurgical division can be most useful to the industry and in what line of investigation they would be most likely to get valuable and important results along iron and steel lines.

PROFESSOR RICHARDS: I would suggest first of all that Dr. Burgess determine some of the new physical constants of pure iron. They should include not only the mere composition but also the latent heats of fusion, the specific heats in the solid and in the liquid states, so that we may know the heat required for superfusion, the electrical conductivity in the solid state and in the liquid state and the latent heats of fusion.

THE CHAIRMAN: The Bureau is already working along that line and has made elaborate arrangements for the manufacture of pure iron and the study of its properties. Nevertheless, the industry wants to know a great deal about the properties of alloys, and it will be a long wait for us if we have to determine the properties of pure iron first; it would, perhaps, be better to go along with the investigation of these two matters side by side rather than to wait for the complete information, regarding pure iron.

RELATIVE QUALITY OF ELECTRIC FURNACES AND THE CRUCIBLE OR OPEN-HEARTH, AND HOT AS COMPARED TO COLD REFINING

PROF. RICHARDS: The electric steel industry has nearly doubled itself within the last two years, and it is probably going to proceed at that rate until the electric furnace steel industry will equal in size some of the other large steel propositions. One serious question is of getting the refractory material best suited for the electric furnace. Those which use the arc are continually troubled with the melting of the roof. Attempts to find more refractory material than silica for the roof are being made in a number of places. Chromium oxide is being tried as substitute for silica, and perhaps other materials. Undoubtedly Dr. Mathews does not agree as to its entirely monopolyzing the field for alloy steels, because I have heard him say that some steels can be made better in a crucible than in an electric furnace. My own view is that it is largely a matter of skill in pouring. The difference between the present quality of alloy steel made in the electric furnace and in the crucible is in many cases the result of the pouring of the steel very carefully from the crucible, and not so carefully from a large ladle when it is made in an electric furnace.

Another phase of the question is the use of the liquid metal; because of the usually high cost of power, the use of liquid metal saves an immense amount of the power required to melt the cold charges. The extension of the electric furnace as an adjunct to the Bessemer and open-hearth for the final refining of the liquid metal at a minimum cost is a very rapidly growing use of the electric furnace. Not only will we have the electric furnace used in connection with the Bessemer and open-hearth, but already I believe it is being used in the triple process of first the Bessemer, where the metal is commenced in process, and then the open-hearth, and finally the transferring to the electric furnace, which is known as the triplex process to get the electric furnace to the point where it can be used to the best advantage. The time is probably coming within a not distant future when nearly all the steel made will be put through the electric furnace before it is put into ingots.

PROF. HOWE: I would like to ask you if you think that for certain purposes crucible steel is still decidedly better than the electric steel because of the higher heat of the crucible method.

THE CHAIRMAN: In the paper already referred to, I say that in the furnace the conditions are such that the metal in the ladle, ready to pour, is not materially different from well-melted crucible steel. The principal difference, as Prof. Richards has pointed out, is that one is made in small quantities—in smaller ingots—and that the second has not the advantage of the small ingots that the crucible-makers make. I do not consider that the metal itself, ready for pouring, is superior to the electric steel.

The triplex process is being tried out at South Chicago by the U. S. Steel Corporation. A 15-ton furnace has been in operation, and there are three additional furnaces—the 15-ton furnace to receive the open-hearth metal. It will take the product of the 20-ton furnace and is actually in construction at the present time.

MR. HOFFMAN: What is the percentage of loss in the alloy compared, say to the tungsten and chrome and to the crucible method?

PROF. RICHARDS: I have no direct experience, but it has been said to me that there is less loss in the rare alloy metal in the electric than in the crucible. In fact in some cases, if the rare metal becomes oxidized and gets into the slag, it can be reduced back again into the metal in the electric furnace, which is impossible in the crucible.

ALLOY STEELS EMINENTLY SUITED TO THE ELECTRIC FURNACE

THE CHAIRMAN: The crucible furnaces are primarily not suitable for making alloy steels and as yet we can't get out the high carbon alloys; in the electric the cost is materially lower and you can add what is necessary in the furnace itself. You can heat it as long as you wish without any material loss. You couldn't do that in a furnace with exposure to the atmosphere.

MR. SMITH: Then it would be particularly suitable for hyper-chrome?

PROF. RICHARDS: Is it not true that all the alloy steels which have been made in the crucible are being made with equal facility in the electric furnace?

THE CHAIRMAN: I think it is.

PROF. HOWE: Mr. Chairman, would you consider high-speed steel made in an electric furnace equally as efficient as the same steel made in the crucible furnace.

THE CHAIRMAN: I have seen no test running side by side, but I know that half the high-speed steel is made one way and half the other, and I would hate to pick out which was made which way. The advantage the electric method has for making high speed is not as marked as in the cheaper alloys.

MR. JOHNSON: Concerning the triplex process at South Chicago, I might say that last month I went through the Illinois Steel plant there and the second furnace had been operating about a month. Both that furnace and the old 15-ton furnace are running on triplex when they can get enough open-hearth to run them, otherwise they give the product to the Bessemer. They are also using chrome brick with good success.

MELTING COLD CHARGES IN THE ELECTRIC FURNACES

THE CHAIRMAN: We have had very little experience on that because our original furnace was not suitable for melting cold product; it was intended as a refining process and we have only recently started on cold product. But a large percentage are operating on cold charges. Greater power is put on the old style furnace, but no higher voltage.

MR. HUBBARD: Practically all the smaller furnaces use cold melting—2, 3, 6, and 1 ton are on cold melting. The bigger furnaces, like the 15- and 20-ton, are working on the liquid.

Trouble in getting started on cold melting depends upon the charge. Many furnaces can regulate it at the very beginning, at the starting of the current, and the regulators have taken care of the current very well.

PROF. RICHARDS: In a Norwegian plant, steel ships are broken up and melted in an open-hearth furnace and then the charge is transferred to the electric furnace and although they found that they could get electric power at $6.40 per H. P. per year they found it cheaper to operate with coal at $6 a ton and to melt in the open-hearth furnace and refine in the electric.

MR. TUCKER: It has generally been conceded that the product that is made from cold charges is better than that made from hot charges. Why should this be so, provided you can heat to the same temperature and under the same conditions?

THE CHAIRMAN: I don't think there would be any difference between the finished product whether it is started from a cold charge or a liquid charge; if it is deoxidized it will get deoxidized just as well one way as the other. We have several furnaces working on coal scrap and on hot metal and so far as I have been able to find out there is no difference between the two finished products.

MR. JONES: In ordinary carbon steel, with the same analysis, the statement has been made that steel made in an electric furnace is of much superior quality as regards physical quality compared with steel made in an open-hearth furnace. Can anyone tell me what the scientific reason for that is, if that is true?

PROF. RICHARDS: I think the solution of that has been found, and it is because there is a chance to deaden up the steel in the open furnace; you can keep the steel melting in an electric furnace without oxidizing it, but it is kept melting under oxidizing conditions in the open-hearth. There is also opportunity during dead melting in an electric furnace for the settlement of the slag inclusions in the steel. That is the real difference between crucible metal and the open-hearth, the small amount of slag and foreign matter included or suspended or diffused or emulsified in the steel. Crucible steel and the electric furnace steel are alike in that they are freer from foreign materials than either open-hearth or Bessemer.

THE CHAIRMAN: Electric furnace steel, when properly melted, pours fully as quietly as the best crucible steel you ever saw poured, even down to eight or ten carbons. It is quiet in the ladle and it is quiet in the furnace. It can be agitated in the furnace by various means, but it doesn't have to be. It is quiet in the ladle and in the ingot. One gentleman, a large consumer as well as maker, wrote me at considerable length on this subject.

"Whether it is oxygen or something else provided—there are those who will not admit the injurious effects of this element—there certainly is a difference between open-hearth and electric furnace steels in three respects: *First:* Electric furnace steels are generally freer from non-metallic inclusions than open-hearth or Bessemer. It is not necessary to go into the reasons for this beyond the fact that it is held for a longer time in the final finishing stages at temperatures which maintain the bath in so thin a state as to allow the slag and non-metallic compounds to rise to the surface.

"*Second:* The electric furnace steels seem to have a considerably wider forging range, that is, they can be put through forging operations at a higher temperature than open-hearth steels without permanent injury.

"*Third:* Electric furnace steels seem to have a wider hardening range than open-hearth or Bessemer steels, that is, they may be reheated for their quenching to higher temperatures in the latter grades without becoming overly coarse-grained. Just why these two latter conditions hold true, I am at a loss to say. It has some times appeared to me that the oxygen or whatever is not removed in the open-hearth process acts as a catalyzer or as a stimulator to grain growth."

This gentleman (Mr. Zimmersheath of the General Motors Company) is responsible for the specifications in use for a very large quantity of alloy steel.

MR. JONES: Mr. Chairman, may I inquire how large a charge is used in an electric furnace?

THE CHAIRMAN: From $^1/_2$ to 20 tons, which is the largest now being installed.

MR. JONES: Assuming an average ton why couldn't you get the same in the one as in the other?

THE CHAIRMAN: Tentatively you will—but 10 tons of crucible steel is very considerably more than 10 tons of electric.

MR. WATERHOUSE: I don't think I understood what Professor Richards said about electric pouring but I do understand his other proposition about the continuity or elongation of the production period. We have in our laboratory a decidedly large tonnage of electric steel and we have never found the difference he speaks of. What particular visible property or change takes place, provided the test is of the same steel? What is the visible property that changes when you make the same steel with an electric furnace?

THE CHAIRMAN: Principally in advancing the ductility; not in the maximum strength. Since that has been done in the electric steels it has been done in the open-hearth as well and the open-hearth is a great deal better than it used to be, since the electric steel came into the field.

MR. WATERHOUSE: What would you expect of 25 elongation carbon, open-hearth steel? In steel made as well as it can be made in the open-hearth and made as well as it can be made in the electric, would you expect the elongation to be different, or the chemistry? We have found practically no difference.

THE CHAIRMAN: I have no experience with it in plain carbon steel and I cannot tell you what elongation you will get. Mr. Zimmersheath has demonstrated that by a range of temperatures without destroying the ductility.

MR. WATERHOUSE: Professor Richards some years ago took out a patent on the use of an acid lining in electric furnaces. I remember some years ago a gentleman who claimed great things for acid linings and I would like very much to know if that has been followed up recently. Perhaps Professor Richards can tell us just how the acid lining is coming on. It seems to me there is a great chance for it in the triplex process if it is going to work. We can start with the basic as there is need for a basic lining to remove sulfur and phosphorus.

PROF. RICHARDS: Most electric furnaces have been run with basic lining because it is economy of refining improper material in the furnace and making high grade steel from low grade material. But, where good material which does not need refining is to be put in the furnace, a slag lining is quite practicable and is being used to a large extent. I must disclaim my patent for a lining—that must have been someone else—but the acid lining is in considerable use at the present time.

POWER COSTS

MR. MORGANSMITH: It is the ambition of the Detroit Edison Company to furnish electric power for steel plants at a price that will put the water power people out of business. I don't know how we are going to do it, but we are on the way. We have on paper boilers which exceed 45,000 kilowatt capacity. What horse power a year can the electric furnace industry stand?

PROF. RICHARDS: It is generally understood that the power cost in running a small furnace and making steel castings is a minor part of the cost of making the steel. There is an electric furnace where I live in Easton, Pa., that I think had been running for about four years making steel castings from cold charges. They buy the power for melting the charges and pay 1 cent per K. W. hour or $88 per kilowatt year. That firm is making a profit and is satisfied with the business. There are firms refining metal or making steel on a large scale who need power much cheaper than that to operate. But I think the power question is a secondary one with most electric furnaces. The horse power is practically negligible. But if you are making low carbons, plain steel to compete with open-hearth steel, then the cost has to be considered and I think that possibly somewhere around $^1/_2$ to $^1/_4$ cent per kilowatt hour or lower may be required.

Mr. Berry: I think the figures are about correct. I think one of the great mistakes of the power companies in this department is lack of appreciation of the value of this industry to them. I am only a consumer of electric furnace steel and I would like to speak in a neutral way. In the first place it is an ideal load for any power plant. All alternating current plants need contracts to tide them over certain periods in the day and by well-made contracts I think the power company, whatever they charge, would get most of the money if the plant was installed without any cost of installation to them. I know of three instances due to the lack of appreciation of this very fact where the steel manufacturer is building his own power plant, which is a great economic waste.

Mr. Crosby: The question of the electric furnace situation is one that has been thoroughly covered. I think the central stations throughout the country in the past three or four years have been bending every effort to get all the information possible upon this class of business with the idea of making a rate commensurate with the service. We have in Detroit two Héroult furnaces, one a 6-ton and the other a 3-ton, operating on our system, and another 15-ton and a 10-ton Kronholdt coming in. This has supplanted the converter process and the operators are perfectly satisfied with the result and I believe that we are convinced that they are producing a superior casting at a much lower cost than they did by the converter process—in fact, the company making the steel ingots at the Kronholdt furnace is erecting a plant which will have room for five ingots eventually. These consumers all have a rate between $^3/_4$ and 1 cent per kilowatt hour. The larger the consumption and the greater the number of furnaces the lower the rate per kilowatt hour. But the idea of operating electric furnaces is an awfully big schedule. The theory that the furnaces should get the power cheaper because they use it at a time when others do not use it, is wrong. A manufacturer has no right to expect a cheaper price because the other fellow pays the overhead.

Prof. Howe: Most of us know that there is a difference between light and power—why not charge two rates?

Mr. Crosby: The people who are using central station power to-day on the basis of what the traffic will bear will not be doing it 5 years from to-day. There is no distinction between light and power other than a distinction between classes of service. A man who is utilizing lighting under the Edison service 10 hours a day can get the power rate. As a matter of fact they have lighting circuits in their plants directly connected with the power meters. The distinction comes only in the load of the factory and the character of the service. Electric lighting service has to be regulated and the distribution cost is infinitely greater than the distribution cost of power. Consumers of large amounts of power up to 10,000 kilowatts involving less overhead expense and no transmission expense can get it at a lower rate, but there is no distinction between light and power and none between power and heat. The electric furnace load is not necessarily better than an industrial load and some industrial loads are better than the electric. There are large factories in Detroit which use from two to five thousand kilowatts perhaps throughout the twenty-four hours with no more than twenty to twenty-five per cent variation, while the electric furnace goes from no load to 1500 or 2000 kilowatts. There are several central stations throughout the country supplying the modern arc furnaces, and of course, if the modern arc furnace is properly installed, it should be better than the average motor proposition.

RELATIVE QUALITY OF ELECTRIC FURNACE STEEL WITH REFERENCE TO CRUCIBLE STEEL USING MUCK IRON

The Chairman: When the electric furnace was first introduced the impression obtained that you could start with anything and make first-class steel. I don't think that is the case. In order to get good steel out of an electric furnace you have got to use good material and you are taking a chance when you start with inferior steels. I think the wrong impression was created at the start that you could make tool steel out of anything.

Prof. Richards: I want to make one prediction, and that is that when the steel workers who are working on electric furnace steel have accumulated as large an experience as has been accumulated in the making of crucible steel, there will be no more crucible steel made. (Laughter.)

Mr. Berry: I would like to say something on the Army and Navy question. We have got from Washington all of the specifications for steels used by the army and navy and as a starting point are making a very careful study, with these specifications as the basis, to see what special preparation we can make to meet the demands of the government inspectors.

Mr. Waterhouse: Can you control an electric furnace more uniformly than the open-hearth? It is well known to the men on the furnace—in the open-hearth—that you never have any one temperature.

Mr. Young: I think it is a little easier to control your source of heat with electric furnace than it is with either a gas furnace or an oil. It can be done quicker. It is largely a question of the skill of the operator in observing temperatures and watching the conditions.

Mr. Waterhouse: Is not that the reason the one type of furnace sells better than another?

Mr. Young: That is a selling point for electric furnaces.

USE OF URANIUM

The Chairman: We have all heard more or less about uranium steel, but I have done nothing personally.

Mr. Hoffman: The American Steel Company at Pittsburgh has been experimenting with uranium steel. Possibly our experiments would coincide with those of others. The uranium flux calls for 5 per cent tungsten and 3 or 4 per cent chrome—in other words, the same high speed composition, with the exception of, say, 12 per cent less tungsten, to do the same work. Our experience was that it made a very good tool and did very good work, say for two grindings. The second or third time we used the tool we would have to get it hardened again—in other words, it didn't seem to hold its efficiency.

The Chairman: Two-tenths uranium was supposed to take the place of 12 per cent tungsten?

Mr. Hoffman: Yes, sir.

Dr. C. M. Johnson: I have had some little experience in the manufacture of experimental uranium steel—a little only. Our own experience was that in preparing the uranium so that we have a strictly uranium steel as the starting point, after considerable experimentation we were able to produce from the ore a uranium cast of less than 1 per cent, the tungsten 5 per cent, chrome 3 or 4 per cent, the other constituents being iron. Then the next step was in alloying the uranium with the iron in the ordinary method of making crucible steel. This was found to be quite difficult. The extreme affinity of uranium for oxygen caused in the first experiments the entire loss of the uranium. There was none there at all, put in in the ordinary way. But we finally succeeded by protecting it in the crucible by diffusing the ferro-manganese and other particles; we actually succeeded in getting uranium steel—the carbon under 40, the manganese between 30 and 40 and the uranium about 0.3; the steel was very disappointing. It was short of the ordinary forging heat and altogether uninteresting from a practical standpoint. It seems to me that the most interesting part of the whole thing is the extraordinary affinity of uranium for oxygen, so much so that I think it is pretty safe to class it as having the strongest affinity for oxygen of any element alloyed with steel that we know of in the groups of ordinary alloys of steel. In endeavoring to make metallic uranium by the thermic method we soon found that there was no reaction between the metallic aluminum and uranium—no thermic reaction. The gist of the whole thing is that a uranium steel containing only 0.3 per cent did not promise to be of any value.

In this connection I have seen quite a few advertisements in which uranium steel is spoken of as the last word. Of course that is an advertisement. It is like the claim for liquid heating in an electric furnace. The furnace sellers claim everything and the manufacturers of uranium seem to do the same thing. Our tests were very disappointing as far as they went, though we had to stop to take up other matters, but as far as we went first-class chrome-tungsten steel was better by 200 per cent than the tests we made. Of course that does not show that there may not be some combination of percentages of uranium at ordinary high-speed characteristics which may prove a benefit, but so far as we were concerned we did not feel encouraged. Such low carbons as between 30 and 40 apparently do not harm the steel and we succeeded in making a very good set, but it was a pretty expensive set, and in that respect was a "set back" also.

In this connection I have in mind this, that we have a conference here from which we hope to have some good results and undoubtedly already have had—we have gotten together, if nothing else—and what occurs to me is that we are here for each other's good rather than to carry away information without giving any. Can we not consult as to how we can make standard high-speed steel better than it is being made at the present time? Now, those of us who are interested in high-speed steel have combinations and analyses of uranium, tungsten and so forth, and we might see which is best. Now, what can we do to improve this best, what alloys can we add? At the present time I don't feel encouraged with the conditions of uranium for high-speed work. With the other alloys which are cheaper, is there not one that we have which will give us an immediate improvement in high-speed steel? One that is not so hard to get as uranium. Uranium, I believe by recent quotations in small lots, is something like $7 per lb. and American tungsten has been rising in price but it won't stay there. I might say, too, in this connection that there is a party going about representing what is supposed to be a reputable firm in Chicago whose one ambition seems to be to find uses for tungsten, because they claim that they have such large deposits of it. Of course we all have heard these claims for tungsten; someone comes along and says he has found a big deposit, so big that it would become a drug on the market. Now, these parties are claiming something along that line and making statements that tungsten ore in large quantities is in sight and that they can get it if there is a sufficient market for it, and can make a large profit by selling it at $5 a unit, which we all know is probably the lowest price ever made for tungsten concentrates. Their aim and worry and hustle at the present time is to find a wider market for tungsten and they say that they are not worried about where they are going to get the tungsten from. I told the party that I didn't believe he had it and his answer was "No, I don't suppose you do, for nobody ever produced such a quantity before." At any rate I don't believe it, but they are still traveling around. The theory I have is that the best way to improve high-speed steel is to work on some of those elements which we know improve high-speed steel. The element in my mind is tungsten, and that is the thought that I wanted to bring out in this connection, if we are going to get any good out of this congress, if we are all to take away an idea, and none of us will carry something off without benefitting the other.

The Chairman: The question is on high-speed steel, the kind of materials to be used.

Mr. Jones: I should like to inquire if any of the gentlemen present have had any experience with an alloy steel recently put on the market which runs from 16 to 17 per cent chrome and has no tungsten whatever. I have recently had a run-in with it against high-speed steel.

The Chairman: I have known of something of that kind. It was first introduced a number of years ago. We haven't heard very much of it since. If anyone has had any experience with it I would like to hear from him. The cobalt method has been abandoned by almost every maker. It caused quite a controversy in Sheffield running in competitive tests with the best Sheffield steels, but it was finally found that cobalt was not worth while and it was abandoned.

Dr. Johnson: Mr. Chairman, in the matter of cobalt steel you will find some people who insist on it emphatically at this time, but others seem to have lost interest. It seems to me that the cobalt high-speed steel has a special field and will, perhaps, continue to have it for some time to come.

The Chairman: I don't mean to say that it has altogether been discontinued, but it is not the great improvement it was expected to be.

Mr. Berry: To what extent has the electric furnace been used for the recovery of deleterious elements? And what furnace is considered best for that? And another point is the effect of these deleterious elements on the product.

Dr. Johnson: I can say in regard to electric tin that the effects are to render the steel red-short, and the use of it seems to make the steel brittle if it is there in sufficient quantities. If I were making specifications I would insist that the tin content should not be more than 10 per cent at the outside, and you know that copper is something along the same line. My theory is that the higher the melting point of the added the better the results. If we went on the basis of using a whole lot of good material we would get better results still, as, for instance, molybdenum and a higher per cent of tungsten—would be a fine proposition, for instance, with 20 per cent of tungsten, and I think that really the only reason that we don't put in 18 or 20 per cent of tungsten is that it costs too much money. At the present time my pet theory is to put more tungsten in steel.

The Chairman: You would have to start clear of some of the high ones, if you want uranium.

Dr. Johnson: Yes, I suppose we must take good things in small doses. It will not do to go too far; if we carry it too high, we may get it to where we won't speak of the melting point but rather of volatilization.

Mr. Waterhouse: Can you say anything about my question as to furnaces?

The Chairman: I have had no experience myself in regard to the matter of recovery in smelting operations of any kind.

AMERICAN DYESTUFF MANUFACTURE

Charles H. Herty, *Presiding*, Chemists' Club, September 27, 1916

The Chairman: What are we going to do about the dyestuff legislation that was passed recently at Congress? We want in this case a common council. Let the chemists and commercial manufacturers of this country show that they have the same view and prove to the country that they are entitled to coöperation. There may be quite a wide difference of opinion on certain points, yet at the end let us feel that we have taken a definite decisive step that will mean something to us.

MR. WIGGLESWORTH: The first consideration in the dyestuff problem this country has had to face since the war was whether the economic conditions permitted the establishment of the industry. Abroad quite a large number of manufacturers had found it impossible of manufacturing and disposing of their goods profitably without some understanding, and various methods were employed to control prices enabling them to have a great power, not only in their own country, but in the entire world, and whatever methods were necessary in the various countries were taken by the citizens of those countries. In England and France it was done by making certain concessions to France and other countries, but in this country we have not established the industry and it was not necessary to make any concession. The tariff was the one serious factor that might be made to work in favor of the establishment of the industry and prevent a monopoly of the American market.

We have to recognize that a business of $15,000,000, which is the amount of dyes imported in the U. S., is a very trifling sum of money, and when we read the amounts of the European purchases in America it seems almost infinitesimal, and it would not offer any great commercial inducement to the large manufacturer. We have been given the privilege since the Exposition opened of examining the Department of Commerce's analyses and statistics covering the importing of dyes previous to the war. Dr. Norton estimates in the neighborhood of 6000 of these dyes and as near as I could get at it, it comprises not less than 2000 difficult commercial processes that would involve 9, 10 or a dozen steps in each process and various complete apparatus, much of which is not manufactured in this country. After the dyestuffs bill was passed by the Senate an exception was introduced, we understand, and Dr. Herty has reason to know that this was at the instigation of one single consumer, the largest buyer of indigo in the world. For some reason he was not satisfied to limit the exception to indigo, but must include other articles.

DR. NORTON: Personally, I feel that the tariff has a slight role in this connection. It will be a help to us temporarily, but we must be absolutely certain of freedom from unfair competition in order to build up our dyestuff industry. I am sure that our President, and that Dr. Hesse and Mr. Wigglesworth will feel that I am violating no confidence when I state that in the U. S. there are not three other men who have had more influence in crystallizing public sentiment in the form of this revenue bill. A census of dyestuffs has been compiled for your use. It is the first instance in any country that there has been an attempt to put in complete form this question of quantity, and classification of our dyestuffs. In the course of a few weeks it will be entirely at the service of the gentlemen who were planning for the rational economic evolution of our American dyestuff industry.

MR SCHOELLKOPF: When the European war broke out we were fortunate in having enough imported intermediate products on hand to keep our plant running for about three months. During this period we hastily improvized temporary plants for making important intermediates such as benzidine, H. Acid, and Dinitro Benzol. With the aid of these we were able to continue the manufacture of such important colors as Direct Black, Direct Blue, Acid Black and a number of others. Previous to the war we produced approximately 120 colors. As our stock of intermediates gradually became depleted we were soon only making about 15.

In the spring of 1915, after the English blockade became effective, there was a panic among the users of dyestuffs, and they all turned to the American manufacturers and expected them to fill their wants on very short notice. Our Company proposed to meet the demands made upon it by erecting the necessary plant and selling the output on contract. On this basis we went ahead and by January 1, 1916, were producing colors at the rate of about one million pounds per month. To give you an idea of what this means I wish to say that before the war we were capable of producing only 3,000,000 pounds annually. So that in the short space of a year and one-half we had quadrupled our output.

Early this year, we proposed not only to increase our production but also to increase the variety of colors on the same basis as we did in 1915. The consumers again responded in a most encouraging way with the result that we now have in the course of erection in Buffalo a plant which will be capable of producing approximately 30,000,000 pounds annually or one-half of the tonnage which government statistics say is used in this country under normal conditions. To summarize them, we have increased our production from 3,000,000 to 30,000,000 since the war began, and will make after January 1st approximately fifty colors, whereas early in 1915 we were making only fifteen.

We, as well as the other manufacturers of dyes, have been criticized for not making a greater variery of dyes. Some people seem to have an idea that it is so very simple to produce almost any shade or quality desired. To those people I say they haven't the slightest idea of what they are talking about and usually I am right. To be perfectly frank I think the progress both as to quality and variety made in the last two years is truly remarkable if one stops to consider the difficulties which it has been necessary to surmount. In time and with the proper encouragement the American manufacturer will produce every color that is necessary and do it just as well as our foreign competitors ever did.

In quality our products are absolutely identical with those formerly imported from the other side and in some cases better. As to the poor quality of American dyes, the 50 or 75 dyes that are made in this country cannot possibly do the work of the 300 or more which were formerly imported. The manufacturers do not claim they will, but many dyers try to make them do that work. The results are bad and the dyer blames the quality of the dyes when as a matter of fact he knows better.

For purposes of National Defense it is absolutely vital that this industry should be developed. It is not just newspaper talk about dye factories being converted into ammunition plants on short notice. It is a fact, and a very reasonable one, too, because the same materials are used in producing dyes and ammunition. After the war I believe you will see the industry established in all of the warring countries, and the governments will, if necessary, even subsidize the manufacturers in order to keep the plants in operation. England and Japan have already done this and the others are sure to follow.

We have established a research laboratory under the able direction of Prof. C. G. Derick. Laboratories such as this have been a source of much of the success achieved by the large factories abroad. No research work such as this has ever been done in this country because the industry has been, as I have said, unable to support it. Conditions having now changed, let us hope that so vital a necessity to the success of the industry may be accomplished.

The Tariff Bill, passed a few weeks ago by Congress, is far from perfect for a number of reasons:

First: It does not provide for the duties as recommended by your Committee in that it provides for a surtax of only 5 c. instead of 7$^1/_2$ c. on finished colors, and only 2$^1/_2$ c. instead of 3$^3/_4$ c. on intermediates.

Second: It exempts alizarin colors and indigo. These colors have never been made in this country before because they were always on the free list, but if we are to have a self-contained dye industry we must also make these. Under the new law I do not think this development will take place.

Third: Why should the duties be gradually reduced after five years? The bill provides for a Tariff Commission. Why not let the Commission decide when and how much the duties should be reduced or even raised? Isn't that what the Commission is for? Furthermore there is the clause which states that if 60 per cent in value is not produced in this country within five years that the surtax shall be removed. This is highly objectionable particularly inasmuch as Alizarin and Indigo colors are exempted, because these colors make up 29 per cent in value of the imported colors and the remaining 10 per cent is taken care of by patented colors which cannot be made here under any circumstances. Unless these latter are made here it will be difficult if not impossible to fulfill this part of the law. The unfair competition clause is in my opinion very weak. It puts the burden of proof on the American manufacturer and not on the importer as it should be. Furthermore, if goods are dumped in this country it is necessary to prove that it is done with the *intent* of destroying or injuring an industry in the United States. Doesn't it seem impossible to prove such intention if it is denied?

Taken all together, I do not think that this bill will encourage very many people to invest their capital in the dyestuff industry, particularly if they have had any experience in it.

MR. DOW: The omission of the specific five-cent duty from indigo, whereby the only remaining protection is 30 per cent *ad valorem*, puts indigo-makers in a very unenviable position as compared with the other dye-makers, for the reason that a specific duty automatically loses its protective feature at the very time it is most wanted because a lowering of the price abroad during trade war also lowers the amount of duty and makes it relatively easy for the foreigner to compete, and put the unexperienced, new American industry out of business.

Mr. Dow also explained the present status of their indigo plant at Midland, Michigan, and stated that the plant would be turning out indigo commercially about the first of the year.

RESOLUTIONS ADOPTED

On motion by Dr. Alexander, a committee was appointed, consisting of Dr. Alexander, Mr. Wigglesworth, Dr. Mathews, Mr. Schoellkoph and Dr. Beckers, to express the sentiment of the meeting on the recent Dyestuffs Revenue Bill. The resolutions follow:

WHEREAS, the Revenue Bill (Title V, Dyestuffs), which recently passed the Senate after hearings of representatives of producers and consumers, accorded to *all* classes of dyestuffs without exception an *ad valorem* duty of 30 per cent and a specific duty of 5 cents per lb., and

WHEREAS, in the final conference between the House Ways and Means Committee and the Finance Committee of the Senate, and without further hearings, "Natural and Synthetic Alizarin and dyes obtained from Alizarin, Anthracene and Carbazol, Natural and Synthetic Indigo and all Indigoids whether or not obtained from Indigo, and medicinals and flavors" were made exceptions and to carry no specific duty and to have only the 30 per cent *ad valorem* duty;

The Dyestuff Conference of the American Chemical Society, in a meeting held in New York Sept. 27th, without a single dissenting vote, condemns the exception of these dyestuffs from this specific duty as this exception undermines the very foundation upon which it was hoped that the American Dyestuff Industry might be built. It makes it impossible for the American manufacturer to meet the requirements of this Bill "if, at the expiration of five years from the date of the passage of the Act, the President finds that there is not being manufactured or produced within the United States as much as 60 per cent in value of the domestic consumption of these articles, he shall by proclamation so declare, whereupon the special duty imposed by the Section on such articles shall no longer be assessed, levied, or collected;" and

WHEREAS the value of these excepted classes of dyes amounts to approximately 30 per cent of the dyes consumed in the U. S. A., without considering the dyes patented by foreign manufacturers;

Therefore, be it Resolved that we condemn the removal of these dyestuffs from the special tariff accorded then by the Senate as detrimental to the establishment and development of the American Dyestuff Industry and subversion of the best interests of the American people.

DR. DOW: Coöperation among the manufacturers of dyestuffs would be against the Sherman law. It could not be done among Americans. Foreigners can do it to Americans, but Americans cannot do it to Americans themselves.

The following resolutions, read by Dr. Mathews, were adopted:

WHEREAS, Director Ralph, of the Government Bureau of Engraving and Printing, declares in a statement to the *Oil, Paint and Drug Reporter*, in the issue of October 2, 1916, that while he is in sympathy with the idea of purchasing dyes for the use of his Bureau from American manufacturers, he has found it "impossible to obtain supplies, although during the past two years he has made every effort to get them;" and

WHEREAS, Director Ralph declares himself ready to-day to purchase large quantities of reds if he could get them; and

WHEREAS, Director Ralph has placed an order with a German manufacturer for the delivery of "Printing Red" (Lake Red No. 1), 40,000 lbs.; "Permanent Red" (Lake Red No. 6), 20,000 lbs.; "Chinese Blue," 25,000 lbs.; and "Prussian Blue," 60,000 lbs., which can only be delivered by authority of the British Government in temporarily raising the embargo now existing to allow such shipments from Germany to the United States Government;

Be it Resolved: That we believe it the province of the American Chemical Society to investigate the status of the American dyestuffs manufacturers as possible source of such dyes for government use, and that the matter be referred to the previously appointed "Legislation Committee" for investigation and reported as a guide to the American chemical dyestuffs industry in thus meeting the demands of the United States Bureau of Engraving and Printing.

MR. WIGGLESWORTH: The Government has never inquired whether they can get those colors or not.

MR. MATHEWS: These colors are no doubt alizarin lakes. The Government wants 145,000 lbs., a considerable item, and quite a line for the American dyestuff industry to go into.

THE CHAIRMAN: Just at the time the Dyestuff Revenue Bill legislation at Congress was pending there suddenly appeared in the papers of my state in big headlines an article regarding a tremendous development that was going on in North Carolina, a $5,000,000 dyes and munitions plant was to be erected within the next twelve months, and the remarkable thing about it was that, a week after that statement appeared in the papers, the same published statement was used on the floor of the Senate as an evidence that we needed no particular legislation for this industry in this country!! That we were coming along fine! The company has already failed and yet they had this influence in the U. S. Senate.

AMERICAN-MADE CHEMICAL GLASS AND PORCELAIN

ARTHUR H. THOMAS, *Presiding*

DR. FREAS: Porcelain and glassware for laboratory work has been in a rather bad way for two years now since the war; practically very little has come through since February after the war began, and the stock that has been on hand has been pretty well used up. There was considerable for the first half year scattered in the warehouses of the country, but in the last year and a half that stock has been usedup. Institutions in most cases have had a good stock on hand so that the situation has not been as critical as it might have been otherwise. The quality of glassware used in the laboratories is quite different from the quality used elsewhere for other purposes. It must be resistant to alkali, to chemical use, to heat and to ordinary laboratory bumps. Chemical porcelain and glassware has been put out by some manufacturers similar to that found in cheap restaurants, in all respects—simply something to hold solids. At Columbia University we were fortunate enough to get in a $20,000 shipment before the war began. We have not had in any of our laboratories any of the new porcelain and very little of the glassware. I would state that the glassware situation is one of the most encouraging things to me that we have had in the past two years, in the way the manufacturers have improved the situation, but they have not gone far enough yet. Quantities are rather limited yet and deliveries are not prompt. Variety will, of course, as you know, be extended as time goes along. It is foolish to say that we can start out and make porcelain without any training scientifically. You have got to come back to the laboratory and laboratory men; they have got to have control of it. As you know, all educational instructions are entitled to duty-free importation of glass. With the institutions dollars are dollars. We will import the thing from abroad, regardless of what the effect may be on the neighboring factory that would like to get the business to build up that business. Are the men that have started in the manufacturing of these goods going to be protected after the war ends? There certainly should be some method by which we could encourage the industries and not handicap knowledge.

There is a great deal of knowledge required for the building of microscopes. During peace times instruments of that kind are not for military purposes but for educational and medical purposes. It is worth while to foster these industries, simply because when the time comes we cannot get these things from abroad. I am just as much in favor of building the industry for building microscopes and it is just as important as our Nitrate industry.

Mr. E. C. Sullivan, Chief Chemist Corning Glass Works: I think it is within the possibilities that the American manufacturer can compete with the Germans in time. Although that you cannot do to-day. Manufacturers are making very vigorous efforts to meet the demand and within a reasonable time we shall catch up. In the case of the firm with which I am connected we have increased our facilities largely, and it is only a question of time. We cannot pay a high rate at 8 hours per day in competition with the foreign labor, and expect to give our ware to the universities on the same basis that foreigners can import it. Industries are in the business of making money.

Mr. Cooper, Syracuse University: Universities are warranted in buying liberally. We are going to be educated up to buying a better quality of glassware, finding that breakage is less and that it really pays us. We ought to be in a position to compete with Jena glassware. Glassware imported from Germany is cheap and fragile.

Dr. Freas: You cannot pay 40 cents an hour for help to turn out the same product at the same price that you can when you pay 8 or 10 cents an hour. I do not agree with Dr. Cooper that the glassware we have been importing from Germany is cheap and fragile. We had been getting a very fair quality of glassware before the war. There is considerable doubt what will be the actual conditions after the war. We must control duties or bounties. What the conditions will be abroad depends on how long the war lasts.

Mr. Smith, Case School of Applied Science: Our Technical School has had to buy quite some apparatus, but are free to buy whatever they want to. It is a fact though that a great many state universities are compelled to get comparative bids and get the goods from the lowest bidder. We should have those laws changed so that they would read "the cheapest American-made goods." When the war is over I intend to keep on buying all apparatus that it is possible to get from American makers. But these state universities cannot do this, and I think they are legally prevented.

Dr. Freas: I would like to know if Prof. Smith four years ago had wanted $1000 worth of glassware, what he would have done, if American glassware had cost him $1300 and imported would have cost $1000?

Prof. Smith: Four years ago I was not aware of the lack of patriotism I was exhibiting, but I am to-day, and expect to be in the future.

Mr. Davis, Eli Lilly & Co.: Most of us have tried at various times to blow glass in the laboratory, and I have seen several skillful chemists try so simple a thing as welding of two pieces of tubing together and say "I cannot do that. That is something for a professional;" also, "Something I was never expected to do in my work." These things I regard as fallacies, and it is time that we rid our minds of them. Some think that glass blowing has to be taught over a period of years; that it requires a large outfit; that we must have special glass. I know that glass blowing can be taught. In teaching glass blowing I should start the student with some very simple problems. For instance, the bending of glass tubing. After he had learned the bending of a tube, might try bending of larger tubing; then I should give him the blowing of a bulb. Then he can learn to close the end of the tube. With a week's practice he can become perfect in any one of these operations. Then he can put the lip on the tube; blow a bulb in the center of a tube; try an internal joint. A week's practice will make the student practically perfect in that. He may then learn to make a base so as to put a base on a test tube. The student will shortly find out he is then able to make any piece of glassware that is demanded. I see no reason whatever why the student in the average college could not take up glass blowing and learn it. There is no necessity for a large outlay of glass tubes for glass blowing. My equipment consists of a blast lamp, old pair of scissors and an old file. There are no blue bottles made in America from which you can blow tubing and blow glass.

Mr. Weiss, Chief Chemist, Barrett Co.: We have had pretty good luck in getting most everything we need as far as our requirements are concerned. The American grade of glassware is equal to others, equal to if not better than Bohemian. One gentleman said that they have been having a lot of trouble in getting a creosote oil retort. We have not found anybody in the United States who can make them; they do not seem to know how or do not want to make them. There will not be a stock of retorts to last another two months. We are anxious to get some one who would make them or could make them.

Dr. Thomas: I am interested in the advisability or practicability of having our American training schools take up the question of glass blowing as a trade. No matter how much money there is at the present minute, there is nobody to do the work. Someone in the German laboratories has done something on the order of what Mr. Davis has shown us.

Dr. Eldredge: I think that Dr. Thomas' suggestion in regard to training schools a very good one. Before Mr. Davis came into our laboratory it was quite an undertaking for anybody to make anything. Probably half a dozen or more of our chemists now think nothing at all about blowing glass since Mr. Davis has come. He blows all his own glass that he cannot buy. After the war consumers will continue to buy American-made apparatus, even though foreign ware will be made more cheaply.

Dr. Freas: I believe there is foreign-made apparatus in considerable amount being sold in America to-day, and in competition with the men who are trying to get out American apparatus at this very time. I do not believe that any amount of reasonable appeals to the purchaser is going to avail very much.

Dr. Davis when asked how long a time was required for a man to become a glass blower, said: "twelve weeks' time, devoting one-half hour to an hour each day, would make a man proficient in the twelve first stages, and with these stages you can work up the other pieces of apparatus."

Dr. Scholes, Fry Glass Co., Pittsburgh: There are a number of points in connection with duty-free importation. One thought is that a large part of the income of the colleges and universities is on manufacturers' profits, and it seems only fair that the universities should help to foster the industries all possible. It seems to me entirely inconsistent that universities and colleges should get their scientific apparatus (very small part of their expenditure) duty-free, whereas they do pay the regular price for everything else they use. If the university is building new chemical laboratories they make a great outlay for steel, but it has never been suggested that steel should be furnished to them duty-free, or that paper should be furnished duty-free to schools and colleges. It is rather inconsistent that the schools should expect to get their glassware at a reduced price and at the same time pay regular prices for the large number of other supplies they are made to pay duty on, that are higher in this country than they are abroad. Regarding the manufacturing of glassware, a great deal depends upon experience before starting out. Germany has had various experiences. Our experience dates from the beginning of the war. Users should be lenient with us a year or two until we are able to train our men. We value criticism. We are glad to know wherein we fail so that we can make improvement. There is no reason why American glassware cannot be made as good as it can any place in the world. But we are back on experience.

Dr. Davis: Of all the tubing I have ever worked I prefer the blue lined Jena. It works best in the fire. It is a special glass and it is very difficult to obtain it in all sizes. It is almost impossible to obtain it now. Before the war our glass was almost exclusively Goulak. Since the war I have been getting Goulak. American concerns are putting out a glass that is equal to Goulak. Specializing in particular lines of glass blowing is being carried out in this country, one man doing a certain thing, and another a different sort. I visited a factory here in New York, and as I was being shown around I was interested to note that here was a man winding coils, and was told that "This man winds all our coils. Here is another that makes all our stopcocks."

W. A. Long, Corning Glass Works: One of the most particular things in this country in the matter of glassware is the optical glass. How much would the 14 in. gun amount to if we had no field telescopes or range finders? At the present time in the U. S. we have practically no manufacturer who is able to turn out sufficient glass to cover this field or to make it of sufficient quality, because they have no protection.

Mr. Thomas: The porcelain problem has so far proved difficult. It seemed to a number of manufacturers that a good chemical porcelain can be produced very quickly. It took the Germans (?) 150 years. Japanese have been making porcelain for 4000 years, one kind or another. It is a very complicated adventure and we must not claim too much before we get there. There is no question but that the work is going to be done and it deserves support. We have not made porcelain equal to that in Berlin.

INDUSTRIAL ALCOHOL, ACETONE, ACETIC ACID

Arthur D. Little, *Presiding*, Chemists' Club, September 28, 1916

The Chairman: I suppose it is not too much to say that those of us who expected an immediate enormous development of alcohol consumption in the arts have been disappointed by the comparatively slow way in which its introduction has grown. One obvious reason, perhaps the only vital one, is that the price of industrial alcohol has never reached a point which has made it broadly available, especially as a fuel. I believe that the great development of industrial alcohol which we still feel sure of for the future is bound necessarily to come. The production of denatured industrial alcohol for the year ending June 30, 1912 was 8,094,000 wine gal.; in 1913 this had risen to 9,831,000 gal; in 1914, a total of 10,404,000; and in 1915, 13,987,000 gal.

Another reason for lagging development is undoubtedly still the government restrictions. You can't do in this country as they do in Germany, arrange things so that any small farmer may set up a still and run his product over into a sealed tank in which it remains until the government finds it convenient to come around and denature it. Any modification of those restrictions which would tend to greater simplicity would be of vast help in this particular industry and it would seem that there ought to be some possible way, although I have never heard one suggested, of denaturing the mash so that there need be no subsequent supervision.

I believe that the great development in industrial alcohol will not come until it reaches a price of 35 c. per gal., which I believe is well within the range of our vision.

The raw materials for alcohol production in a large way are corn, potatoes, molasses, wood waste, and waste sulfite liquor. The last two, although in some respects the most suggestive and interesting of all, are at present of almost wholly negligible importance. It is worth mentioning however that with the exception of the wood waste and the waste sulfite liquor, all the other materials mentioned are substances that are highly valuable as human food and it is, I believe, and I think it won't be long before it is realized, that to use material which is valuable as food for the production of alcohol is an economic, if not a commercial waste.

The potato distilleries are located principally in Europe, very largely, as you know, in Germany. The distilleries using corn are found principally in our middle western states. The molasses distilleries are along our southern seaboard and the eastern coast of the United States. The production of alcohol from wood waste is carried along commercially, so far as I know, only at Georgetown, South Carolina, and at Fullerton, Louisiana, and the production from the waste liquors of the sulfite process for pulping wood, which was originally initiated commercially in Scandinavia, is now carried on at only one plant in this country, which is at Mechanicsville, New York—the plant of the West Virginia Pulp & Paper Company.

I might say in passing and as showing how slowly these things develop, even when they are obvious, that I remember very well that at the Chicago Exposition in 1893 the Waldorf-Zelsdorf Fabrique in its very fine exhibit there had a five gallon bottle, or more, filled with a high grade of alcohol derived from its waste liquor. Then, because of its rather unique character I want to call attention to the great plant of the Curtis Bay Chemical Company at Baltimore, which I understand to be connected with the United States Industrial Alcohol Company where they are producing on a large scale alcohol made from molasses merely as an intermediary product for the production of acetone by way of acetic acid.

The war has, of course, proved an enormous stimulus to the production of acetone and to a very considerable extent to the production of alcohol as a solvent for the manufacture of smokeless powder.

Some years ago the electrical testing laboratories in this city carried on an interesting series of tests in which they showed that gallon for gallon, burning the alcohol in a mantle lamp and the kerosene in an Argand burner about a little more than twice as many candle power hours were derived from the alcohol as from the gallon of kerosene. That was not a directly comparable test, but yet in each case the fuels were burned under the conditions which give the best results.

Then there is a growing use of alcohol as a heating agent in special cases. You are all familiar with the very wide introduction of solid alcohol, so called, "Steero" and the other products of that kind, which find their market because of their convenience. I was told not long ago that every buffet car coming into the Pennsylvania Terminal was required to use no other fuel than alcohol. Also in the case of many of the heaters used for heating freight cars, it has been found in many classes of freight that alcohol is the best fuel for those heaters, because the products of combustion do not tend to contaminate the materials in transit.

ALCOHOL AS FUEL, PRIMARILY IN INTERNAL COMBUSTION ENGINES—The number of automobiles in the country is I suppose not far below 3,000,000. At 24 H. P. per car, which is certainly low enough, you have about 60 million horsepower in gasoline internal combustion engines. That is more than the total potential horsepower in water power in the United States, and it is very much more than the total steam horsepower. Obviously there is not going to be enough gasolene to go around. Some people speak of the possibility of replacing gasolene with benzol. Benzol would not keep the cars going more than a few days. Kerosene is never going to come into use in pleasure cars, because of its tendency to crawl and leave an oily surface over its container and everything around.

So we must come, I believe, to the conclusion that the only fuel in sight which promises to replace gasolene and to hold down the price of gasolene, which has already risen in some parts of Canada to 39 c. per gal., is alcohol, and fortunately it has already been demonstrated that in those processes having the production of alcohol from waste cellulosic raw materials, we have a method which promises by its development to furnish alcohol ultimately at a price which will enable it to compete with gasolene.

In this connection it may be interesting to hear a telegram which has just reached me from Mr. Groves who has been in charge of the plant of the du Pont Powder Company, making grain alcohol from yellow pine wood waste.

> "Your letter forwarded to me from Wilmington did not reach me until yesterday. Sorry I did not receive it in time as it would have been a pleasure to have been present. Trust that those interested in ethyl alcohol from wood wastes realize that the process is a great commercial success and that the interest in this subject will grow accordingly."
>
> (Signed) J. STUART GROVES

That is intensely agreeable to me and I hope will be of interest to many of you.

I have already at different times pointed out the enormous amount of wood waste which is available for the production of ethyl alcohol in the yellow pine districts alone and referring only to yellow pine waste and eliminating all the larger waste which might be available for paper making or other purposes, there is still enough left there and wasted every day to make 600,000 gals of. 95 per cent ethyl alcohol from that one raw material, and of course the process is one which lends itself to many forms of cellulosic waste.

It is claimed, but with what right I have not determined, that yields approximating those of wood may also be obtained from peat and that straw is also available as cellulosic raw material. At any rate, I think it is safe to say that nature produces something like ten billion tons of such material every year and that our future supply of alcohol would seem to be reasonably secure.

The particular process to which I am referring has since 1819 developed from the use of 141 parts sulfuric acid to 1 part cellulose down to somewhere about $2^1/_2$ per cent acid; the time of treatment has also been greatly reduced. In its elements the process now consists in taking saw-dust or wood waste and spreading it over with diluted sulfuric acid, preferably putting it into a digester or converter which has a protective lining, a heat insulating lining, and then bringing it quickly up to the critical temperature, corresponding to about 85 lbs. pressure. Approximately 25 per cent of the wood is converted into saleable products, a considerable proportion of which are sugars and of those sugars a large part are fermentable. The cooked chips are extracted with water and lime added to neutralize the acid; the sulfate of lime settles and the liquor is drawn off and then treated almost precisely as with molasses. The process is really one for producing fermentable sugars from wood, and the rest of the operation is that of the molasses distillery with special ferments.

I have not been able to obtain the exact figures of the acetone production. It has been enormously stimulated by the war and it must be in the neighborhood of 10,000 tons or more per annum. The raw materials for its manufacture are the hard woods, acetone of lime and calcium carbide through the intervention of sulfuric acid and mercury salt, and a special bacillus (*bacillus macerans*) which has been analyzed in a work in Germany. There are a number of methods of wood distillation and the separation of the acetone from the alcohol distilled.

Dry distillation with lime is the regular and most practiced method. Steam injection is sometimes used at the end of the process.

It has been found that acetic acid even when diluted in the form of pyroligneous acid, can be easily converted into acetone by passing through a tube or a chamber heated to about 500° C. over a catalyzer. Dr. Squibb, as you may remember, did this fifteen years or more ago. Another process for making acetone passes the pyroligneous acid over a tube heated to 575°. Benson and Darrin, of Seattle, have studied this process and in a recent article in THE JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY claim the following advantages for this method: Higher yields, lower operating expenses, the elimination of the large consumption of lime, under-drying of the acetate, continuous operation, low cost of apparatus, easier control.

Finally we have the process for the manufacture of acetone from carbide, the carbide being first converted into acetate, the acetate then being oxidized to acetic acid, and the acetic acid then converted into acetone either by the catalytic process or by the distillation of the acetate of lime.

The Freer Company have patented a process for acting on sugars in the presence of inert and neutral material by the *bacillus macerans* and thereby producing ethyl alcohol and acetone. This process was mentioned at the time of the Eighth International Congress of Chemists here.

Acetone is used principally in the manufacture of smokeless powder as a solvent, particularly, in the cordite manufactures and it has various other solvent uses, which you may call "peace" uses in connection with cellulose nitrates. It is used as a basic raw material in the manufacture of chloroform, for low grade as an absorbent for acetylene, and for other minor uses. The use first mentioned is the most important one and has been temendously increased by the war. The others have not been appreciably affected, if we except the manufacture of chloroform, and so far as the use of acetone as a solvent for acetylene goes, there has been a great diminution owing to the substitution of electric lighting on automobiles, in place of the acetylene being carried in the Prestolite tanks, where, as you know, it is dissolved in acetone. Also a certain cheaper class of acetones have been substituted.

There have been as a result of the war large additions to the manufacturing capacity for acetone; particularly the great plant of the Curtis Bay Chemical Company at Baltimore, and there has been an especially interesting development through Dr. Matthewson of the Shananigan Falls Power Co. in the synthetic production of acetone from calcium carbide by way of acetylene.

I have here a resolution passed by the Canadian Manufacturers Association at its last meeting at Hamilton, which is of interest in connection with the subject of industrial alcohol.

> "WHEREAS alcohol in pure or denatured form is a necessary raw material for a large variety of industrial processes, and
>
> "WHEREAS some of the processes for which it is a necessity are already being carried on in Canada, but with only moderate success, due to the lower cost and easier conditions under which manufacturers in other countries can obtain this material, and
>
> "WHEREAS the equalizing of conditions would not only stimulate the growth of existing industries, but would lead to the establishment of new ones to the obvious advantage of the country as a whole; and
>
> "WHEREAS, many other countries have found it to be to their

advantage to reduce greatly and sometimes to remove altogether the excise on alcohol when employed for industrial, scientific and humanitarian purposes, and

"WHEREAS, we believe that the legislation and regulations governing this matter should be so formed as to encourage the distillation of alcohol in Canada by making it profitable for the community to use the domestic rather than the imported article; Therefore be it

"*Resolved:* That the Canadian Manufacturers' Association place itself on record with the federal government as requesting the removal of the excise duty or the inland duty, provided the alcohol always is under suitable regulations and restrictions:

"(*a*) When employed for manufacturing purposes under which the alcohol would be lost or unrecoverable;

"(*b*) When used by hospitals and asylums and infirmaries for bathing purposes;

"(*c*) When used by laboratories or educational institutions for purposes of scientific research;

"(*d*) When used by hospitals and museums for the preservation of specimens."

DR. MATTHEWSON: We have been working on the process for 8 months now in an experimental way and it has been successful so far. We are making now in the neighborhood of 100 lbs. of formalin per day and an equivalent amount of acetic acid and acetone. A large plant is fairly well finished and we hope to start operating in about three weeks' time.

We have met principally mechanical difficulties in the process, and have finally gotten a material to stand the action of sulfuric acid.

In the oxidation of the formaldehyde with acetic acid we found very many difficulties. We experimented there with oxygen, and we found that both are fairly successful. One of the greatest difficulties there is is the danger of explosion of the formaldehyde, but with proper regulations and proper material for the containing vessel, the danger of explosion is almost entirely eliminated. Both in the first and the second stages we are able to get over 90 per cent yields in the third stage; we are making catalytically acetate of lime by passing it through hot tubes. We expect to turn out by Christmas time 10 or 15 tons of acetone per day.

It is doubtful if the process is likely to be persistent under peace conditions. Of course, as far as acetone is concerned we know it won't be. The over-production of acetone has been too much. The acetone will have to go, but I believe we can compete successfully, as raw materials are quite cheap and our method of production is comparatively developed.

DR. BATES: There is one process which Dr. Little omitted and which is now being placed on a commercial basis in Canada at Toronto. As you know Ontario has recently gone dry and that has left the whiskey distilleries without much to do. One of these distilleries has been transformed and is now manufacturing acetone, using corn as a raw material.

You referred to the bacterial action on sugar, producing ethyl alcohol and acetone. This process is also a bacterial action on corn or starch, as raw material, giving alcohol even in larger amount than acetone along with CO_2 and hydrogen. This is a most interesting process and one that could not be predicted theoretically. It originated in England with the Syndicate Products Company and has now been practically established in Canada on a commercial basis. The process of using acetylene as the raw material generated from calcium carbide—if it turns out to be a commercial success as expected—will be a real technical triumph for Dr. Matthewson in particular and for Canada in general. In the past Canada has not had the privilege of developing many new processes and industries along the chemical line. The war is not what you might consider a benefit to Canada or anybody else taking part in it, but it has been a stimulus to several branches of chemical manufacture.

As to the acetone business after the war, I am not big enough to predict anything about it. We want acetone and more acetone. Naturally the tendency is to produce as much as possible in Canada and to make Canada and the rest of the Empire as independent of outside sources as possible; but if we have to buy any elsewhere it will be from the United States.

One other process which I spent some time on developed in the fertile brain of a certain French-Canadian who claimed that by mixing starch and lime in certain proportions and heating this under pressure in a retort he could obtain a very high yield of acetone; in fact the yield of acetone claimed was 70 per cent—more than the theoretical possibility with the use of starch as a raw material. Nothing has yet been done with the 10-ton order which was given him. I might say, however, that I tried the distilling of a mixture of starch and lime, and there was actual acetone produced in small amounts.

DR. COMEY: Alcohol and acetone is practically altogether used as a solvent for gun cotton in the explosives industry.

THE CHAIRMAN: There is a use for acetic acid anhydride which promises to become important enough to be of interest and that is in connection with the production of cellulose acetate. Cellulose acetate has many of the physical properties of nitrate of cellulose and would undoubtedly replace nitrate of cellulose for many purposes were it not for the fact that it is somewhat more expensive. Nevertheless, some war uses for cellulose acetate have been found, for example it is being used in the manufacture of a varnish for aeroplanes. It has the advantage of giving a surface which is non-inflammable and waterproof and I presume preservative. We have seen in the newspaper accounts of aeroplanes with transparent wings and those wings, if such aeroplanes ever flew, were undoubtedly of some special form of cellulose acetate, probably the form known as cellate, but cellulose acetate is finding a current demand in special lacquers and the cellulose acetate sheets are coming into use in situations where the explosive quality or a higher degree of inflammability of the nitrate would make it dangerous. For example, automobile goggles are now being made with cellulose acetate, the upper portion of the goggle being stained a fairly deep brown so that the wearer of the goggle, if he suddenly comes upon an automobile with blinding light, merely inclines his head a little so as to look through the upper portion of the shield and have the light cut down to something that does not disturb his vision.

Still more recently the production of a waterproof artificial silk from cellulose acetate has been accomplished on a commercial scale and a plant of considerable size, which will make initially 100 lbs. per day of such artificial silk, is now under construction in South Boston, Massachusetts. A possible development of its use may call for rather large quantities of acetate anhydride. Cellulose acetate ought to be and would be the basis of every moving picture shown in the world if the public were sufficiently enlightened to demand it, because the film has been proved wholly suitable for this purpose. It has been made in very large amounts, and several hundred million feet have been put out, but it is slightly a little more expensive—and it is that slight increased cost per foot which still exposes our theatre audiences to the danger of theatre fires from the explosion of moving picture films.

It is made by treating purified cellulose with acetic anhydride and a little sulfuric acid. If nothing else is present except acetic acid as a diluent, the acetate is formed and goes into solution and then when the mixture is poured into water the acetate separates out in a sort of curd which is broken up and washed and dried. The great disadvantage is that the dry curd is heavy and holds on to particles of acetate and it is almost impossible to get it out. In the process invented by Merrick, the one this silk company uses, the product is formed in the presence of benzol and, being insoluble, preserves all the characteristics of the original cotton just as it does in the usual process of nitration.

Can we hear from somebody who represents the Curtis Bay Chemical Company?

PROF. WHITAKER: I was somewhat surprised to hear our concern referred to as a producer of acetone because for several months I have been listening to the consumers and the inference is that we are not producing any.

I don't know that there is anything new of interest, technically, about the plant. The manufacture of vinegar is carried out in the usual way. The building used for this purpose covers something over ten and a half acres of ground and the vinegar is neutralized in the form of calcium acetate which is retorted in the usual rotary retorts.

THE CHAIRMAN: I have no definite knowledge regarding the process used by the West Virginia Pulp & Paper Company but I understand that the usual sulfite liquors contain a very small proportion, less than 1 per cent, of fermentable sugar, and that after the liquors are neutralized with lime the yeast is added and fermentation carried forward and the distillation then of the beer and the high wines is carried out in the usual way. I do not know the technical details of the process, however, with any degree of accuracy.

DR. WILLCOX (of Pennsylvania): I might add that the sulfite liquors under proper conditions of production run something over 2 per cent sugar and it is possible with proper conditions and proper technical handling of the liquor to get a beer containing about 1 per cent of alcohol, which, of course, brings it within the range of probable commercial use.

THE CHAIRMAN: I have been very much struck with the quality of the alcohol produced by that process. In Norway the reports were that it was always seriously contaminated with sulfur—that does not seem to be the case here.

DR. WILLCOX: It varies from one cook to another. At times a liquor will give all sorts of sulfur compounds and even free sulfur, but it is possible in the still to get rid of it.

THE CHAIRMAN: If a purely personal reference is to be forgiven, it may interest you to know that I began my career as a chemist, and a little later was superintendent of the first sulfite pulp mill in America. We struggled along to make 4 tons a day with a 10-ton plant and finally failed for $2,000,000. Mr. John Luke was superintendent of the paper mill at that time, and with his brothers organized a company with about sixty thousand dollars of real money and took a plant that cost $137,000, and made $90,000 in the first 6 mo., and for a long time I think that out of every two dollars they received one dollar was profit, and the prediction to-day is that they are producing 6,000 tons a day. I would like to give you a résumé of the trials and tribulations that attended the development of the sulfite process—it would sound like an Odyssey.

DR. PHILLIPS: Reference was made a little while ago to acetic anhydride. I remember a good many years ago that acetic anhydride was being used for the extraction of essential oils, and it was found to be very effective. I wonder if that method is being used, or if it has been developed further? I have heard nothing of it in recent years.

THE CHAIRMAN: I don't know anything of that. Of course it is often used in the manufacture of vanillin.

DR. GIBNEY: As a representative of the Ordnance Department of the United States Army, I am interested in the subject of alcohol, and I was interested in your account of the synthetic manufacture of alcohol from cellulose waste. I would like to ask with regard to the purity of the alcohol which is produced. For our purpose the alcohol should be of the highest degree of purity and the highest degree of strength. I would like to ask as to the purity of that alcohol and also as to the possibility of producing an alcohol commercially higher than 95 per cent.

THE CHAIRMAN: It is perfectly feasible to produce from wood waste a 95 per cent alcohol which is of the grade of cologne spirits. You can readily see that you are much less likely to get fermentations than when dealing with a thing like corn. There is no more difficulty in producing alcohol of any strength by that process than in the case of any other raw material.

DR. KYRIDES: I have been interested for several years in alcohol and acetone, not as an adjunct of war but rather as the means of carrying out pacific trades. I believe that if you can produce alcohol as cheaply as gasolene you would be able to prepare rubber synthetically. I have worked on it about three years. I know if you had acetone cheap enough you would be able to. I was talking to a gentleman yesterday who said he was working on magnesium and he said that it would be possible to obtain magnesium for 14 c. per lb. and on that basis the price of magnesium could be brought down to about 4 or 5 c. —if you can get alcohol you can get acetone—if you can obtain alcohol at a reduced cost. As to when we can obtain alcohol cheaper, it is up to the chemists. Twenty-five cents would be fairly cheap.

THE CHAIRMAN: Do you see any prospect for the production of synthetic rubber at a price below that which it is now being grown at on the plantations, which I understand is not over a shilling a pound?

DR. KYRIDES: I have not thought of that proposition very deeply. At the time I was working the price of acetone was rather high, but I think it can be produced for less than 25 c. a pound.

MR. BRECKLER (of Louisville, Kentucky): I have been associated with the alcohol business now for about twelve years and have been very much interested in some of these facts that have been brought out to-day. It is not generally known that one of the greatest troubles in the alcohol industry is the fact that there are so many internal-so-called-political troubles that actuate the different distillers in their dealings. For instance, one of the large alcohol concerns which was mentioned to-day is now obtaining molasses from Cuba for the manufacture of alcohol. Molasses to-day on the open market is selling for about fourteen cents, when you can get it, but the trouble seems to be that it is not to be had. This concern, very frequently at the time when the Cuban planters were in a great deal of difficulty, obtained molasses at quite a low figure. Now the total molasses produced in the United States and Cuba would supply about 50 per cent of the present demands for all purposes. This molasses, of course, gives the concern that can use it a big weapon in the hands of a few distillers against the distilling industry. The possibility of producing alcohol at a lower price primarily must come from the distilling industry, I believe, because with all due respect to the Ewing and Tomlinson process it has been operated for about seven years and there is only one plant that produces it and it has not played a very great figure yet in the alcohol market, though of course the future possibility is still a matter of some doubt. But the concern that can produce this alcohol has a club over the heads of the rest of the industry, and they might think it desirable at times to furnish alcohol momentarily at quite low prices. Of course I don't say it will be done or has been done, but the situation has simply become this, that the rest of the industry waits on what the molasses alcohol people are going to do. Now, then, there is only one hope for alcohol that I can see, and I have figured the question over very frequently, and that is, as was mentioned, the sulfite liquors. Here we have a liquor that contains 2 per cent of fermentable matter and very possibly could be made by evaporation to contain 6 or 8 per cent, a medium which would produce alcohol very economically. On the other hand, the unfortunate part of that industry has been that the process requires special skill and training to operate. The Swedish process requires the acclimation of the yeast to the liquor and that is a matter of some little difficulty. The Norwegian process carries difficulties, as it primarily depends upon the casein from skimmed milk for nitrogenous matter, and the percentage is too small to have the fermentation take place in regular fashion. With the high price of nitrogen, or nitrogenous matter in this country, that in itself is somewhat of a problem. However, I must say, that after seeing a process of this kind in operation I feel a great deal more confident in the process itself than I ever did before and it is absolutely the only hope because it is the only process with interested parties, and what I mean by that is that parties interested in foreign processes cannot hope to control. That is something where as many mills as want to put in the alcohol process are at liberty to put them in. Any other process is bound to be shut up sooner or later by interested concerns. As regards denatured alcohol, outside of the fuel industry there were about 25,000,000 proof gals. of denatured alcohol, of which an estimated quantity of 5,000,000 gals. went into the explosive industry for export. Now, had that paid taxes the administration in Washington might have found a little redress from their present deficit. The Commissioner of Internal Revenue has suggested that some effort should be made to tax it because the industries in which it has been used have not cheapened their price to the ultimate consumer, and the Government is suffering a loss in gauging this alcohol. I might mention, of course, the industry we see the most—the ether industry. It has resulted in great reductions, but that forms a comparatively small part of the consumption of alcohol.

THE CHAIRMAN: I would like to bring out one or two points in reply. I am rather sure that if the representative of the West Virginia Pulp and Paper Company had been present he might not have agreed with the last speaker in the wide-open situation as to patents. I have made some rough figures here which may be of value—they may be a little off—they are made on the basis of 6,000 tons a day, 25 gals. of waste liquor per ton and 2 per cent of sugar. There would seem to be, roughly, enough waste liquor in the country to produce about 200,000 gals. of alcohol a day. Some of the mills, of course, are comparatively small.

I do not think there is any probability that molasses will ever again be as cheap as it used to be before the war, because of the possibility of its consumption in making alcohol, and before the war there was a rapidly increasing diversion of molasses into that field.

I would like very much to inquire how cheaply molasses alcohol can be produced, say with molasses at 4$^1/_2$ c.

MR. BRECKLER: You can add 3 c. for overhead, per proof gallon. This does not allow for containers and freights carried through containers, or for overhead and interest and depreciation—including that, I should say about 10 c. per proof gallon or twenty cents roughly for wine gallons.

A VOICE: The people who say that alcohol can be produced at 25 c. absolutely are dreaming.

MR. BRECKLER: That is my opinion. I would like to say something else in regard to that. My figures are based on the production of 4 billion pounds of sugar per year. That represents 1 billion tons of hydrocarbon that was not used for sugar and could be utilized. That only produces 650,000,000 proof gallons per year or about 5 per cent of what the production must be to supplant gasolene.

THE CHAIRMAN: Here is an interesting fact in connection with the sugar industry. One-eighth of the entire sugar crop of Louisiana is sent to the burners with the back ash; so that one-seventh of the world's production of sugar is burned up. Now that sugar is there in the cane perfectly available for fermentation to alcohol. Furthermore the cane itself is there suitable for conversion to alcohol by a process like the Ewing & Tomlinson process; if it is permissible I would like to correct the last speaker to this extent that there are now two plants running under the Ewing & Tomlinson process and the plant at Fullerton is producing about 2,000 gals. a day, and sometimes 2,500 or more.

MR. BRECKLER: How long can it run with the modern prices of alcohol?

THE CHAIRMAN: That is what we are trying to find out. We have faith enough in its possibilities to keep calling upon our friends for more money. It is one of those things which is certain, however, for it has gone so far that the other alcohol producers may just as well make up their minds that the people who are back of it are going to keep at it until there is no question about its commercial success. I don't know how many of you may have read that inspiring book of Robert Kennedy Duncan's on the Chemistry of Commerce as to the benefits that cheap alcohol would afford the community. The day is coming when alcohol can be had by the small user at 25 c. per gal., and when that day comes the consumption is going to be multiplied by a very great factor. I have referred to the use of alcohol in internal combustion engines. Now, of course, nobody claims that alcohol has the same potential energy that gasolene has, but on the other hand it may be used under far more favorable conditions and up to a pressure of 180 lbs. without backfiring. There is no danger of explosion. The fire risk is reduced almost to nil, because a bucket of water will put it out at once. So that on the basis of equal prices, I believe that alcohol will begin to displace gasolene.

DR. JOHNSON: I would like to ask a question. I have been surprised to hear nothing said about wood alcohol for any purpose for which wood alcohol is used. Are there any uses of ethyl alcohol that cannot be replaced by methyl alcohol? The gentleman representing the United States Army spoke of making alcohol of 100 per cent purity. It is very well known that ordinary industrial ethyl alcohol cannot be produced at more than 95 per cent, and you can produce methyl alcohol at 100 per cent, or practically chemically pure. I have great curiosity to know what is the field of uses of those two materials in which one is limited from the other.

THE CHAIRMAN: Is it not a fact that the normal price of wood alcohol is so much greater than that of denatured ethyl alcohol that the wood alcohol would not be likely to replace the ethyl?

DR. JOHNSON: That I do not know—whether it is for some chemical reason or simply a matter of price.

THE CHAIRMAN: I think it is simply a matter of price. I wonder if Dr. Reese would say anything.

DR. REESE: I think it is largely a matter of price, not of purity.

MANUFACTURE OF PAPER PULP AND BY-PRODUCTS

ROBERT B. WOLF, *Presiding*

Grand Central Palace, September 29, 1916

THE CHAIRMAN: Chairman Fletcher in asking me to open this meeting suggested that a discussion on the scientific control of industries would, perhaps, be the best thing to start with. I would like to make a plea for a more definite control of organizations from the scientific point of view, and a scientific effort to organize and study the problems of management scientifically.

The mill as a whole should be one vast laboratory for doing qualitative and quantitative work. Processes should be so recorded throughout the entire organization that all the variables that enter into manufacture have to do with the quality and quantity of the output should be recorded, and so recorded that comparisons can be made easily.

In the manufacture of wood pulp in our own organization we have been able to effect a saving of 17 per cent in the yield from a cord of wood by simply studying and applying the laws that had to do with the structure of the cellulose; the reason we could do that in a comparatively short time was that the organization as a unit was doing this work, and not a group of individuals. The organization as a whole had a definite memory and the data of things that had to do with organization were recorded in such a way that those laws could be studied.

You must have an organization memory apart from the individual memory. Everything affecting the organization must be recorded at a definite central point in such graphic form that results can be studied and used by everyone.

Retention is a thing that can be plotted daily in the mill. You know the amount of filler that is being furnished, and if there is an accurate record kept of the retention and then plotted alongside of that figure, say, plotting it mathematically, the percentage of retention, 30 or 40 or 50 per cent, plotting in all these things, the percentage of calcium carbonate in the filler, the kind of filler used, the amount of lime, the amount of sizing used and the character of the sizing, all that could be plotted in a definite way with relationship to the retention and in a short time the organization would find itself in possession of an enormous amount of information, and then, when we come to the February meeting we will have something worth talking about.

MR. CARRUTH: There are so many variables in any consideration of the retention of clay, some of which Mr. Wolf has touched upon and some of which he has not, that under the present organization of our mills (as most of them are organized) cannot be recorded. But my belief is that that is the only way to do it; but it takes time to convince those who have been brought up in another school that that is the way to accomplish results and in the end to make the biggest profits.

One phase of the filler retention problem that was not yesterday touched upon at all, and in one way it has nothing to do with filler retention, yet in another way it is a very important phase, and that is the other ash-forming ingredients that go into the paper. We have, for instance, so much china clay added to 100 per cent of stock. In a simple case of that kind it is easy to determine the retention; but, if in addition to that hundred per cent of fiber we had as a part of that fiber, we will say, 10, 20 or 30 per cent of old paper, which in itself contains varying quantities of filler, we have introduced a variable which is very hard to control. This results in very curious retention figures. We are getting now in our mill a retention figure on every lot of paper made that contains any filler at all, and it is not at all unusual to find 160 or 180 per cent of filler in it. And of course we know where it comes from and without a great deal of very careful work, but with these old papers coming into the stock, the retention figures which we obtain are almost utterly valueless.

MR. GRIFFIN: If you are going to make a large and uniform product, you can control it very easily. A large corporation making a comparatively simple number of products cannot very well undertake to make small quantities of specialties. The small mills will have to add to the selling price of their goods in order to make a profit. A large mill should not undertake the making of small orders and specialties.

Inequalities will exist in the paper business as long as we make paper, because the paper maker will necessarily always be obliged to use paper from back orders and slutches, as we may call them, the clay slutches or the filler slutches, and unless we use filler papers you would hardly be able to make the same kind of finish. It is no discredit to have an order sent back because of the amount of clay in it—if there is a paper that contains a large amount of filler for a super-calendared paper, the manufacturer is bound at times to get a larger amount than he planned.

But the real thing to do is for the mill to study its own problems and develop its own individuality and to keep the records and keep the memory of these records and it will soon work out the best scientific control for the retention of filler that I know anything about.

THE CHAIRMAN: Mr. Griffin made a statement awhile ago about the finding of fault with a man for what he was supposed to have for finish. I have found that the very best thing to do is not to find fault with the man but to give him the record of what he is doing and let him find fault with himself. If we can do that, the desire on the part of men to do good work is what prevents your organization from having down hill slips, as I heard a man express it.

MR. POPE: I hope that the manufacturers of paper in trying to perfect their industrial problems in the plant will not lose sight of the finished product. It seems to me that a uniform industrial organization which will have control of the finished product and make the finished product always of uniform quality would be a problem solved that would be gratifying to the printer.

MR. NIXON: Mr. Pope says that the object of all this work that we are putting our time in is that they may benefit by the things that we intend to benefit by in the mill. If it were otherwise we would not be having this conference. We are endeavoring to make the mill 100 per cent perfect so that there will be a return to the man who is using the product, and we hope to do it.

THE CHAIRMAN: It may interest Mr. Pope to know that the more we organized, the less the paper-users kicked about the product. Our pulp has always presented a color problem involving much discussion and dispute between buyer and seller. Particularly is this true of sulfite pulp. The usual custom is to refer to the standard or contract sample; but this is unsatisfactory, because such samples change and fade. Another difficulty has been the texture of our pulp which made it difficult, if not impossible, to produce a permanent standard which could be used by comparison. The disc idea has been modified and developed by the Burgess Sulfite Fiber Company by replacing paper discs which I have in mind by brass discs surfaced with mixtures of plaster of Paris and various shades of material made of bichloride of potash. These discs have been worked up into a standard system for checking the color of their birch bark pulp and now constitutes an original controlled method in their mill. Our own laboratory has adopted their system and we are now checking the color value of all birch pulp received. The system seems to have worked perfectly satisfactorily and it may be of interest to you that since we have started this scheme we have been able to recover quite a sum of money from the dealers who have supplied us with a low grade pulp which we would not have been able to do under the old system. They said they were giving us the same thing that they were before, but the last sample didn't show it. We are trying to work back to pulp paper discs in place of the Burgess brass and plaster discs for our soda pulp tests and unbleached sulfite. The reason we are doing it is because the Burgess method requires a very large number of discs and a considerable outlay of money, space and power, which our laboratory space does not allow us to make.

There seems to be a possibility of getting away from this difficulty and confusion. Professor Ira H. Monsel, of Boston, has given his life to the perfection of a system of color, or a nomenclature for color.

Professor Monsel's system states color in three dimensions: hue, value and chroma. Hue (*e. g.*, the difference between red and green) depends upon the wave length of light; value depends upon the quantity of the light irrespective of its color; chroma is the intensity of the light and the intensity of the color and depends upon the height of the wave crest. These three dimensions should be susceptible of experimental demonstration. Professor Monsel has placed on the market a tintometer: ours expresses values to within 2 per cent. The other dimensions are not so easily made. The hue can be obtained accurately with the spectroscope, and the chroma value by some arbitrary scale, I am a little hazy about that. It would seem that something is needed to make this system of universal value and if the demand arises undoubtedly this instrument would be forthcoming. Prof. Monsel's charts are being used as the basis of color study in a number of our public school systems, of which I believe New York City is one.

There are other instruments on the market for the determination of color. The Ives tintometer is one. This system should have a very large field of usefulness. Our experience with it is too slight to warrant any attempt at discussion.

Dr. Kress: At the Forest Products Laboratory we are of course interested in determining as closely as we can all of the physical qualities of the papers that run over our machines. We have done a little work with Ives' tintometer. We started out by making dyes in which we use a varying amount of colors per thousand pounds of stock, and by making our readings through the red, green and blue, and plotting the results, we found that we could give a numerical expression to color, accurate within 4 per cent. Two matches made from dissimilar colors compared under the Ives tintometer gave the same result. We then made a few dyes on different combinations of color under natural light, and they changed under artificial light. It is interesting that under the Ives tintometer both of these papers which matched under ordinary daylight matched while under the Ives tintometer.

The difficulty with any color instrument so far is not to get the readings but to interpret the results.

Mr. Carruth: The Monsel charts which have been produced, of course, are not complete. It is almost inconceivable for anyone to make out a set of complete charts; there would be an infinitude of shades. By taking these charts even as they are to-day you can very nearly state the color of any sample which you have. The difficulty for the paper men is that these charts are not complete in the higher values wherein paper values lie. The paper man who is going to use the chart will have to do some work on his own account to give numerical expression to color—but the hue will hold absolutely no matter what the color may be.

Mr. King: I would like to say a few words about coöperation between the manufacturers of color as it is manufactured more or less to-day and the users. We are coming to a point now where we are having to use anything that we can get. I would like to see if some form of committee could not be appointed by this association with, say, a couple of members from our American dyestuff manufacturers, and members of the German firms who have made color in the past, and also men from the mills where a great deal of color is used, that would help us to know more about the new colors. We knew about the German dyes before, we know the proportion of the strong basic dyes, and we know about the sulfite—but you might bring out my point that you should not hide the effect of hydrolysis on American dyes if they are to be used in the future—we should come together and try to find out as many points as possible about these dyes and thus promulgate the use of them in our mills in the next two or three years while these chaotic conditions exist.

Judge Moore: I found when the question came up of protecting the dye industry in America that there were scarcely a dozen voices raised among the paper manufacturers as to the wisdom and advisability of doing so. I hope you will not think of me as suggesting politics. So far as the paper industry is concerned, both parties are alike, so that there is nothing political about it. In the first place our product is put on the free list; we have got to meet the competition of the world in selling our paper. On the other hand, the things we buy they are proposing to protect. Now, has it not occurred to you that the foreign maker of paper can take these foreign dyes and put them in his paper and send them in free of duty and beat us in our home product; that at the same time we must compete with him in his colored papers, but are not permitted to buy the cheap dyes? I do not say that dyes should not have protection, but I do say that we are obliged to compete with the world in selling our product and we ought to have the privilege of the world's market in buying our materials.

Dr. Schutz: I know that some mills have a set of enamelled plates for any kind of material, white in different tints or shades, some of them more or less blue or pink: and they use the plates as factory standards. They use them as well in the bleaching plants as in the paper plants. They are absolutely reliable because they do not change. Bleached sulfite will change very quickly, say within a few months, if the particular pulp should contain even a small percentage of lignum.

Mr. Hatch: Some four years ago the mill that I am connected with was using in the vicinity of 60 colors to produce about 16 shades. So I started a little investigation; we reduced our number of colors from the vicinity of 60 to probably 15.

EFFECT OF THE TEMPERATURE OF THE WATER USED IN THE BEATING OF PAPER STOCK

Cellulose is a colloid and as such is affected by the general reactions or processes which affect colloid substances. In general, we know that pure cotton cellulose when treated with alkalies tends to hydrate and swell up. This is the action which is desired in the process of treating cellulose in the manufacture of paper. The mechanical rubbing of the cellulose in the presence of water produces a certain amount of hydration which aids in the remaining together of the fiber and in the production of a stronger sheet of paper.

We are situated on the Connecticut river and have the difficulty of loss in strength in our paper in the summer.

We plotted curves showing the strength of our paper over the entire year, and the temperature of the water we use; we found that as the temperature of the water in the river rose above 75° F., the strength of our paper began to take a decided drop. By arranging a source with uniform water temperature under 75° we succeeded in straightening out that curve greatly.

The Chairman: I would like to ask Mr. Hatch whether he attributes this loss or gain in strength to the temperature of the water or whether it is directly or indirectly caused by the weather, or whether he made any tests on the sizing qualities of the paper when made with colder or warmer waters.

Mr. Hatch: We found that as the temperature rises the sizing is not so good. We attributed that in part to the fact that cellulose hydrate is not so rapidly formed at the higher temperatures and we get less of the cementing quality of the cellulose hydrate which is in itself to a certain extent the sizing agent.

The Chairman: We took some pulp that was made in the winter time and used that pulp in the summer and got the same falling off in strength as when using the summer pulp.

Mr. Carruth: I might possibly add that in making a paper where the hydration effect is carried to the limit, we have noticed that a pulp made in the winter will produce apparently a parchmentized effect more rapidly than a pulp made in the summer and that effect we found and proved to be due to the pulp, not all of it, but in part, to the pulp, because some pulp of the same manufacturer who had not been running in the summer but which had been stored and was actually made the previous winter, gave us more nearly the desired results. Of course there might have been other elements in that—there might have been a difference in the manufacturing process although it was pulp of the same manufacture. But there is no question that the results as given by Mr. Hatch are absolutely correct.

WASTE SULFITE UTILIZATION

MR. WALTER H. DICKSON: The utilization of refuse from industrial processes has of course attracted a great deal of attention within the last two years since the war started in Europe, and the scientific world in this country and the scientific societies and mining technologists have been looking into it and I do not think it was appreciated what was going to waste in this country, not alone by the layman. Last year something like 9,000,000 lbs. of sulfite pulp were produced per day. Two causes bring about the utilization of waste material or refuse. The pollution of water courses and streams may force mills to do something with their liquors, or some phases of the war have necessitated the utilization of what was formerly waste, such as the recovery of the products of the distillation of coal in this country. This condition of absolute necessity of utilizing refuse in this country is really not pressing the paper mills all over the country but in some places it is, and I believe that was the condition in one or two mills, which was the beginning of the use of sulfite liquor in this country. The Robinson Process Company people were the first to use the liquor waste in this country. Another was the Rogers plant and a third the Covington plant of the West Virginia Pulp and Paper Company. Their first work was the utilization of these liquors in binding compounds or adhesives, and from that followed the development of tanning extracts. Next, my own company developed tanning extracts and also binding compounds. Some five different companies in this country at the present time are interested in this, more or less. The Muskegon Extract Company and the International Paper Company have done some work. The West Virginia Pulp and Paper Company have developed some work for the recovery of alcohol and the Cumberley-Clark people have also taken up the alcohol recovery problem. The utilization of the waste liquors in Europe did not find very rapid progress until very recent years. They were forced to become more active in this because of stream pollution and there are quite large developments abroad now. They are producing very large quantities of the material known as cell-pitch which is concentrated sulfite liquor brought down to the solid mass. This product is shipped in very large quantities, and is being used for various binding purposes. The tanning industry abroad is using very large quantities of this material. That has been brought about because of the necessity of utilizing low grade fuels. There is very little in this country of that production, but there are certain developments now which may open up some use for it in this country, as you all know who have kept in touch with it. In Sweden there is quite a large development in the way of producing alcohol. But the production of alcohol from sulfite liquor does not take care of the pollution of the stream conditions which some of the mills are confronted with. It is only a partial result, and it is my information that the best results can be obtained where alcohol is produced in connection with the production of other products.

In Europe recently there has been considerable work on producing cattle food from this material, with more or less success. It contains, as you know, the basis of food, the question being the getting rid of the sulfur compounds. It has also been proposed in the manufacture of explosives—I cannot say with what success—and I understand that abroad they are using large quantities as a substitute for resin in the charging of shrapnel shells.

The principal products being produced in this country to-day are tanning extracts and binding compounds. It was a long, hard fight to establish these products on the market but they are now thoroughly established. I think the failures in the beginning for road work and adhesive purposes have been due more or less to not having analyzed the conditions under which they had to be used.

The possible products which can be produced of waste sulfite liquor are quite numerous. We have in sulfite liquor all the chemical elements to produce a numerous range of products. It is a question of work and a lot of it. I might mention with good authority that the Robinson Process Company before they got to their turning point spent something over $500,000, and I know that my own company spent $200,000 before we got to the turning point. There are to-day being produced quite a large amount of color compounds and dye compounds from waste sulfite liquors, and it has great possibilities. There has recently been a number of patents taken out disclosing a method of precipitating out certain of the elements in the sulfite liquor as solids, and they have been used in combination with oxychloride cement, as loading. I have seen such floors which looked very good indeed. I, myself, have recently succeeded in separating the sugars completely from the sulfite liquor, from the rest of the organic compound. Also I have been able to obtain, by combining certain other matters, a resinous compound absolutely resistant to all acids and alkalies. It is in a very crude condition and it will require a great deal of work to get it in commercial shape.

PROF. MCCUE: There is another possibility in connection with the use of waste liquor. I have been educated as a lumberman and having had considerable experience in that before I went into chemistry I feel that some use must be created for this material which will not require such an enormous effort and expenditure of money in the way of introduction and that this consumption must be exceedingly large. If we take the figures of the total production of sulfite and see what is running down the streams in the form of organic matter, whatever use can be developed that can generally be adopted must require an enormous consumption. It is not the fault of the paper manufacturer that he is not recovering it. I do not doubt that to-day there are other sulfite manufacturers in the country who would be gathering this material if you could show them a market. There must be an enormous development possible in its use by roads, or some other use may be developed.

Now, if the stumpage value of our timber goes on and increases at its present ratio from year to year and approaches anything like the stumpage values in other countries, then there may be the possibility of our using less valuable trees, such as the hemlock and the quick-growing pines of the South, by transferring the organic matter and putting it into these inferior woods. It may not alter the structure, the wood structure, but the mere fact of filling the pores and solidifying it entirely alters the working properties of the material. Yet that is not a chemical problem or an engineering problem; it is really a lumbering problem.

I do not know whether you are aware of it or not, but the manufacturers of Kraft papers in Europe, as far as I know, always select metallic sulfite for hydration and give it very much less time for hydration than the ordinary sulfite; but not only that; even if it is hydrated to the same extent, it makes a more transparent paper. We all know that sulfite makers make a pulp more hydrated at one time than another. One maker can make the cellulose if it is fresh, but if it is kept for six months and dries out until it becomes dehydrated it becomes more difficult. Manufacturers of dressed pulp always got the best results with fresh material which had not been dried. The difficulty of hydrating and drying pulp imported into this country is exceedingly great compared with the demand for that price of material, and the problem of hydration and dehydration is such a variable one. The manufacturers use such various methods—I have seen manufacturers making Kraft paper put steam into the beater and expect to benefit in that way—they wanted to make it free and wanted it dehydrated. The problem is one which has to be considered under a number of conditions.

MR. DICKSON: The normal sulfite production in this country is from 4500 to 5000 tons a day with a total solid material in the waste sulfite liquor between 75,000,000 and 100,000,000 tons a day. That has to be taken care of. Whatever use or uses are going to solve this problem, it is not going to be the dyeing industry or the high-class adhesives, but some use or uses which will consume a large tonnage at a very small margin of profit.

A VOICE: What is the ratio in the finished sulfite liquor between the sulfite itself and the organic solids in the waste liquor?

MR. DICKSON: In the amount of production of sulfite, I believe the figures are surprising, something like 15 per cent cellulose: 47 per cent is thrown away.

THE CHAIRMAN: What can be recovered is 47 per cent.

MR. DICKSON: To a ton of sulfite you ought to recover 1200 to 1500 lbs. of solids from the waste liquors.

MR. MCNAUGHTON: In the waste sulfite liquor, which is the combination of the sulfite materials in the wood together with the inorganic chemicals used in the digesting process, I think it could be taken as a safe figure that approximately 180 to 200 lbs. of sulfur per ton of pulp produced could be found present in the waste liquor, and from 150 lbs. and upward of lime combined in various ways, depending on the quantity of lime used in the manufacture or cooking of the liquid for the reason that in the cooking process the sulfur retained is that combined with the lime and organic material, whereas the lime is not volatile and is retained in the waste liquor regardless of how great a quantity is used in making the cooking liquor. From what I have been able to read and gather from conversation the preparation of the waste sulfite liquor for use as road binder is a case of straight evaporation, where the inorganic matter is evaporated with the ligneous; in case of the tanning process the inorganic particles such as lime and magnesia must be separated out. The difficulty in preparing a good tanning is in getting the lime and magnesia precipitated out, leaving the resultant material of a nature which does not injure the texture of the leather.

MR. BENJAMIN HORNER: I have some samples of wire—perhaps you would like to look at them—sixty-five mesh. You will notice that in the cracks formed there is a spot of some material which is probably caused by the crack. The practical paper-makers in our mill attribute it to pitch. It does not seem to be that because other spots that are smaller than that would be more likely to be pitch and still they have not caused the cracks as indicated by larger spots. Perhaps some of the men here have had some experience on that line and can explain that. It is a problem that has caused a great deal of difficulty with us.

THE CHAIRMAN: I am glad to hear him say that he does not think these spots are caused by pitch, because we always get blamed for them.

MR. GRIFFIN: I would ask this gentleman if he has made any attempt to analyze the substance in those spots?

MR. HORNER: No attempt has been made to analyze them at all. You will notice that the spots have been steamed off so that there is practically none of the material which caused the spots originally.

MR. GRIFFIN: I think it would be very instructive if you would make an investigation of what you find in the spots. Sometimes something has happened as the process went along.

MR. LIPSCHUTZ (Sugar Chemist): I would like to know what loss is sustained in the separation of the mineral element of the sulfite waste from the organic matter. The organic matter in the solution, is valuable and the inorganic matter is not. Has anything been done for the separation of the elements? I am engaged in the sugar industry. I think the subject should be investigated separately from the mineral side, especially in sugar refining.

In the sugar industry the molasses is circulated in stills formed by parchment paper outside of which there is a circulation of warm water. Supposing the mineral elements are carried off by the water and that there is a concentration of the organic matter in the stills formed of parchment paper. The other industries are amplifying the system for treatment of this kind. I never saw a sample of sulfite water but I think it would be very interesting. If the members of the Chemical Society have access to the solution they might work on the subject and interest the paper-makers in their line. Of course you must have the chemical section interest the paper section, it seems to me, but I do not want to take your time. It is a subject that came to my mind, that it might be interesting in that line. I myself have tried to think of a method sometimes, although I am not a paper-maker, but a chemist—tried to find a method of separating ink from paper. I have succeeded in getting a process for the mechanical separation of carbon—of the ink from the bulk—a mechanical process, and working on that line, I came into the meeting of the paper industry to see if I could find some information about that point.

MR. MILLSPAU: I think you paper people have a problem a great deal more important to you than some of your chemical problems. Mr. Wolf has spoken about the human element in your mills. It is very easy to get a cost system and a rating system that tells you your cost, but it is not worth the time taken unless it is taken intelligently. You have in your own ranks, every one of you, one or two young fellows, who have some education, high-school or otherwise, whom you could send somewhere for special training, to some college where they have a system of scientific management and training, where they could get all the details of how to put the system into the plant, and who would know how to operate it after it got there. We have a splendid system of cost-keeping, but to get the men for it that know something about the business in itself is another matter. I am going to make a suggestion that you start a scholarship—each mill—and provide every year for one or two of your young fellows, who will come back to you under contract. I have been following the paper mills for a great many years and I am frank to say that I never saw such a sloppy method of conducting costs as the average paper mill has—they simply *hope* they are getting ahead.

MR. GRIFFIN: I think the paper-makers should pay their chemists more before they establish scholarships. I have no complaint to make, but I am speaking for a lot of others.

MR. MILLSPAU: It is not the technical man, the chemist, he is more able to take care of his end of the game, it is the fellow who graduates out of the ranks into a clerical position who is able to analyze and keep track of your costs and show the other fellow how he is coming out—not merely a recorder of what is on the time card.

THE CHAIRMAN: Following Mr. Millspau's suggestion I found it profitable to look upon our organizations as a whole as an educational institution. If you can't take the men at the plant and teach each man to do his job more intelligently you have failed in one of the main requisites.

MR. STEVENSON: I want to endorse heartily the last point that Mr. Wolf has made that it is up to the mill to educate its men and from my own experience I want to state this simple instance. I came pretty nearly getting fired from one position because I was found in another department seeing how the material was handled before it came to mine. I think attention paid to giving the men in one department an idea of the processes, no matter how simple they may be, will help them to carry out their own end of the shop more intelligently-

THE CHAIRMAN: If we are going to make progress in the plant each man must know the whole scheme of the thing. If he knows only one department he can't help the organization ahead. We encourage this in our organization and a great many other organizations are doing the same thing. Every man knows his place in the organization.

MEDICINAL CHEMICALS IN AMERICA

Harold Hibbert, *Presiding*
Chemists' Club, September 29, 1916

The Chairman: The list of articles placed on the prohibited list early in the war by the British Government embraces the majority of the products which we, in this country, would be compelled to replace by home manufacture in the event of war.

If we examine the situation that confronted us in the chemical field in 1914, the outstanding feature is that the quantity and quality of highly trained chemists, and especially of chemical engineers, was quite inadequate. For the rapid development of a new chemical industry, even one in regard to which considerable data is available in the literature, there is required highly developed research ability, enabling the works manager to be placed in early possession of the scientific information necessary for the erection of a semi-industrial installation. This, in turn, demands the services of an efficient chemical engineer, thoroughly conversant with sound engineering practice and possessed especially of plenty of common sense. There has never been a time when the American capitalist was more willing to invest his money, or, so to speak, "take a chance" on the development of some one or other chemical industry. It is to be regretted that, in a number of cases in this particular field, such failures as have occurred are, it is to be feared, directly attributable to the poor training received, either by the chemist in the scientific research work or by the chemical engineer on the industrial side.

A true coöperation between the university and industry can find no better exemplification than that shown in the development of the manufacture of salvarsan by the Synthetic Drug Company of Toronto. Immediately on the outbreak of the war, the Toronto General Hospital found itself practically without any of this material, and at once applied to Prof. McCallum, professor of biology in the University of Toronto, for his assistance in this predicament. The matter was taken up by Mr. McCallum, Jr., with the assistance of the university and of financial backing obtained in Toronto, and thanks to the fine spirit of coöperation shown by the university medical staff, the hospital force and the chemical workers, after some twelve months they were in a position to place on the market a product called by them diarsenol, which is claimed to be the equal of the German product. It is in this sense that we may look forward confidently to an increased coöperation between the medical departments of the universities and the workers in the industrial field. Furthermore, it is surely not an unreasonable request to make that those firms whose profits have been so abnormally swelled by the prevailing conditions of the last two years, should now come forward and subsidize such universities as are willing to devote some portion of their time and equipment to the development of the purely scientific, as contrasted with the commercial side.

At the outset, there were many difficulties to be overcome before progress could be made in the manufacture of new products in this field, but thanks to the efforts of several firms a supply of equipment (glass-lined autoclaves, containers, etc.) suitable for this purpose was soon available. It may, however, be noted incidentally that the price of such apparatus will have to be reduced very materially, if these firms expect to be able to compete with foreign manufacturers after the war.

What then is to be the future of the industry? It must at once be admitted that here also we shall have a case of the survival of the fittest, and it would seem that such survival will be conditioned by several factors: (1) The ability to manufacture all the raw products required. (2) A highly efficient technical staff. (3) A capable sales organization. (4) The existence of adequate home or foreign markets, or both. (5) Suitable tariff protection.

With regard to the first item, there ought to be no question, in view of the enormous increase in the output of coke oven by-products, of obtaining an adequate supply of raw materials at a nominal price, and the industry might well begin to consider if it is assured of satisfactory safeguards along these lines.

Mr. T. Narodny: No country, with the exception of the United States, has so favorable conditions for chemical industry as Russia, as there is hardly a raw product that is not to be found in abundance in its territory. There are vast amounts of Glauber's salt, saltpeter and aluminates unexploited in the Caucasus, Ural and Altai Mountains. There is no mineral or metal that cannot be found there. Russia has imported, imports now, and will import chemicals of distinctly foreign origin, medicinal novelties, mostly all the patent medicines, medical instruments, hospital supplies and products of this nature. Russia will continue to import dyes and dye substances, drugs of tropical nature and novelties. Russia has a high protective tariff on certain chemicals, expensive drugs, medicinal instruments, patent medicines, etc., while the tariff is low in fertilizers, chemicals needed for industrial purposes, etc., varying from 15 cents to $5.00 per lb. The export of general chemicals to Russia is pretty simple, but that of medicines requires a special permit if the same is not handled by a Russian wholesale drug store or agent of chemicals.

As to the possibility of American chemical trade with Russia, I should think that the export of medicines, high-priced chemicals, patent medicines, novelties, dyes, surgical instruments and hospital supplies would pay. I do not believe that an American manufacturer of low-priced chemical products can stand the high ocean freight, the slow delivery, and the tariff, as compared with Russian-owned or European manufacturer. It requires at least three weeks for a shipment to reach Russia from here. Even should the freight become $10.00 a ton from New York to a Russian port and $3.00 from a port to Moscow, it certainly cannot compete with the freight of $3.00 from Germany or $6.00 from England, to Moscow, that can be delivered in a week.

If the American manufacturers of certain medicines are able to keep down the price, supply first-class goods, and comply with the Russian trade traditions, they, to my mind, have the biggest chance for a future trade with Russia. If started right away and carried on systematically, the American manufacturers of medicines, surgical instruments, hospital supplies and patented novelties could establish a permanent and large trade with Russia. For the coming ten or twenty years, Russia will be internally more interested in developing the steel and machinery industry, or the industry of such commercial chemicals as soda, ammonia, sulfur, etc., but will hardly have an opportunity to pay due attention to the production of medicines and goods connected with it.

As Russia has vast resources of all kinds of raw materials that are needed for chemical industry, cheap fuel and labor, it would be perhaps most profitable that the American firms establish branch factories over there. There are certain lines of chemical products which it would pay to undertake, particularly those of the coal-tar, crude oil, wood, etc.

A Russian drug store is quite a different establishment from an American. It looks more a semi-official than a private business concern. Instead of glaring signs, the Russian drug stores—aptekas—have the gilded eagle of the official establishments, and the name of the firm in small letters on the door or the window. Every drug-store manager must be a graduate of the pharmaceutical faculty of a university, and is considered a highly respectable public functionary, like a doctor or a judge. He sells nothing but actual drugs either to the prescription of a physician or independently. He cannot deal in stationery, soda water, cigars, dyes or products used for industry.

The Russian wholesale drug trade is carried on through large jobbers, commission houses or agents in the first place, and then through the provincial and district wholesale houses, in the second and third places. A country with 180,000,000 inhabitants offers a large field of trade for the drug industry. Medicines are perhaps the most lucrative items of the chemical industry to export to Russia. The Russian drug and chemical market is now all exhausted and, as soon as the war is over, and the freight and exchange conditions get normal, there will be a rush for those drugs which the country needs most. If the United States and Canada are ready to grasp the opportunity of the Russian chemical trade right now, they can absolutely control it. The Russian Medical Department is ready to furnish the list of what is most urgently needed, and coöperates with the foreign importer of drugs and chemicals. It is said that Russia needs now most of all medicines connected with war hospitals.

Russia offers a special opportunity for the sale of surgical and clinical instruments, thermometers, rubber goods and hospital supplies. These were mostly imported from Germany and France, though there are a few establishments in Russia who produce some surgical instruments.

There is a big market for the rarer alkaloids such as atropine, scopolamine, aconitine, etc., in Russia.

Russia has very much crude oil but the oil industry is very primitive. The machines in the factories are driven by crude oil. They also need paraffin and gasolene.

Editor of the Oil, Paint and Drug Reporter (*Paper read by the Chairman*): The drug producing trade of the United States is in the midst of a transition period, the full extent of which cannot be realized until there shall have been made some comprehensive and definitive census of the number of establishments engaged, the number of workmen employed, the amounts of materials used and the valuation of the output, particularly for the past two years, or since the beginning of the European war in August, 1914.

It is perhaps unfortunate that the latest obtainable summarized statistics of the industry are those of the census of manufacturers of the United States for 1914—the first war year—but up to that time the growth registered in the output of druggists' preparations, patent and proprietary medicines, and compounds, and similar articles coming within the scope of the term "drug trade" was persistent. From a truly "infant industry" in 1850—sixty-six years ago—with 143 establishments, 827 workmen, $1,427,375 invested, and an output of $3,508,465 in products, the industry has grown to the more than respectable total of 4,082 establishments with a valued product of $172,008,946 in 1914.

The fact that our manufacturers can not only supply their domestic demands—which have increased at least proportionally with the decrease of foreign importations since consumption has continued on an increasing scale here—but have been enabled to ship during the fiscal year ending June 30, 1916, $129,666,580 worth of chemicals and drugs to foreign buyers is amply indicative of the new importance of the industry to this country.

Conditions have been abnormal, it is true, but such was the normal growth of the drug trade prior to the war, and so great have been the changes and development of productive ability during the two war years, that it can be deduced with perfect safety that when the war shall be brought to its conclusion, products of American manufacturers for the drug trade will be marketed in every country in this hemisphere, Latin and Pan-American, Asia, Africa and even Continental Europe.

Dr. Coblentz: The Food and Drugs Act has not succeeded in curbing the patent medicine trust. Tremendous lots of concoctions are consumed but they have received a very serious setback since the Food and Drugs Act. The values sold total a greater amount than foodstuffs consumed.

Mr. C. E. Vanderkleed: The sale of biological products such as serums, antitoxins, etc., would greatly exceed $6,000,000 in 1913.

Mr. Hibbert: An examination of the papers contributed to scientific literature discloses the astounding fact that 46 per cent of the total contributions were on biological subjects. Thus the need of coöperation of the medical schools with the industry. There is considerable difficulty in getting suitable containers and glassware for storing drugs.

Dr. Coblentz: There was no line of industry that was so hard hit by the war as the manufacture of medicinal chemicals. As soon as the supply ran out there was a general division of what was left in order to supply the demands. The market was soon supplied with a lot of low-grade and highly adulterated raw materials. The Central Powers took up all the barium and strontium in sight. Recently there was a lot of strontium offered on the market, which was found on examination to contain 50 per cent clay. Barium peroxide was on the market but could not be used, except in making a low-grade technical peroxide. In attempting to supply the wants, some of our American manufacturers are inclined to underrate the value of high-grade chemicals and without the aid of chemists will slam together anything and think that will answer. We have to be just as careful as the foreigners. The Germans are able to supply high-grade material, and we cannot afford to supply low-grade quality.

Belladonna and digitalis should be cultivated in this country at a profit. Another difficulty we encounter in endeavoring to supply organic medicinals is to get the manufacturer to manufacture raw materials, such as phenol and salicylic acid. What will become of us after the war comes to an end? Will we have tariff protection? We need phosphorus compounds. Where are we going to get these? We cannot get bromine. There are quantities of bromine in this country. If our own manufacturers could manufacture and import less we might be able to establish this line of chemicals and relieve some of the prices. This war has brought out chemical glassware superior to Jena ware, not only in resistive powers but in regard to weight. We are receiving to-day American ware that can be made of any degree of thinness and will stand any amount of rough usage. We are to-day doing better than Germany was ever able to do before. But we deal with many alkali substances and all have an erosive action on glass. Here are some results of some tests I have made:

Area in sq. mm. converted into sq. decimeters. Alkali content given as Na_2O in milligrams per sq. decimeter surface. Time 50 hrs. Temp. 90° F.

Ampoules, Resistive Glass	0.23 to 32 mg.
Ampoules, Unknown	1.7
Amber, Unknown	1.1
Resistive Tubing	0.43 to 0.47
Resistive Glass Tube, Ampoule	0.36
Amber Packers	1.2 to 1.6 mg.
Amber Packers, after washing with dilute acid	0.6 to 0.72 mg.
Amber Packers, another lot	6.0 mg.
Amber Bottles	1.2 to 1.5
Amber Bottles	3.6
Amber Bottles, washed with acid	0.13 to 0.8
Green Packers	1 to 2 to 9.2
Flint Packers	2.0

Mr. Pierce: If bromine is so much desired, why is the price so low at the present time?

Mr. Coblentz: Try to buy it.

Mr. Pierce: I had the experience of having been called in in the preparation of bromine. We got the bromine all right only to find that the price had dropped to $1.15, which is the last quotation I know of.

Mr. Raubenheimer: Amber ware is really more soluble than the flint ware. Among chemists it is so understood. The manufacturers in this country do not pay as much attention to the alkalinity of glassware as they do in other countries. Every ampoule before using should be washed with diluted hydrochloric acid. Regarding supply of chemicals, I have frequently had the same experience. You cannot get bromine, even in small quantities. The same thing holds true with a great many chemicals. A short time ago I wanted 100 lbs. of precipitated sulfur and could not find a firm in greater New York who could supply it.

MR. MINER: When an effort was made to meet the demands of the canning industries in this country by furnishing glass enamelled ware, it was usually the case that the first demands were rather arbitrary. Slight changes in design would result in less cost. If an effort is made in this country to protect this industry in which we are all interested a standardization of process is necessary to permit the establishment of the apparatus industry. When you come to a tonnage basis you get down to figures that are satisfactory. For apparatus made on a jobbing basis, you must pay the price.

MR. McKEE: Investment has been so heavy in many cases that the manufacturers have stopped. It is not worth while to go into the manufacture in a case where your units have to be large and where you have to move away from a community in order to avoid nuisances, such as in the case of sulfur dioxide. It requires a large investment if we are going to use our by-products, and it is questionable whether it be worth the fight in some of these cases.

DR. COBLENTZ: It is the duty of Congress to take some action in regard to protecting these embryonic industries in this country, but no one is willing to invest time or money or trouble because of the everlasting question of tariff and protection. If the trade had been assured that there would be sufficient tariff to allow for a marginal compensation, the various factories now would increase their output and add to the number of articles produced. Most factories are putting up very cheap places and with an idea of using them to some other purpose after the war.

MR. YOCUM: It is difficult to establish what the commercial value of some of the supplies are. There is no reason that we should be dependent upon anybody outside of such a country as this. We have been in a hurry. The price of creosote oils has advanced greatly with no apparent reason. At the present time we are not importing in all probability as much as we did in 1914.

DR. COBLENTZ: It has interested me for some years why we imported so much and did not make more. There is no longer any beechwood creosote brought in from abroad. It is impossible to get a creosote that will come up to the U. S. Pharmacopoeia. We would like to see a real beechwood creosote once more.

MR. YORK: The specific gravity as given is very difficult to ascertain in the U. S. P. Nothing specifies what apparatus should be used or where the thermometer should be placed or anything about it. The next writing be more explicit in regard to this particular line.

MR. HIBBERT: Is it not possible for a manufacturer to compete after five years with other countries if they have succeeded in getting out a good material?

DR. COBLENTZ: We have cheap raw materials. It is a question of labor.

MISCELLANEOUS CHEMICAL INDUSTRIES: CONVERTIBILITY OF PLANT

WILLIAM H. GROSVENOR, *Presiding*

Grand Central Palace, September 30, 1916

THE CHAIRMAN: The men criticising the works, those planning the works, and those utilizing the material from the works have a broader perspective frequently than the chemist who is engaged in some particular phase of the plant work, or than the corporate officer who is engaged in the overhead. Each of us can glean something from the other.

Convertibility of plant means convertibility not only to a pacific occupation, but such convertibility to a pacific occupation as will permit, if possible, the re-convertibility into the munitions of war. Our Government is taking very much more active steps, largely through non-Governmental agency at first, but taken up now by a definitely appointed Government Bureau —to preserve so far as possible and to develop as far as possible the plants which are necessary for this country to have to preserve itself in case of trouble, so that convertibility from the war basis to the peace basis may expect to have such coöperation from the Government as can reasonably be expected in a democracy.

What we are all interested in, perhaps, is the specific instance, and as this is an experience meeting, it rests with the Chairman to confess first. In one company in which we are interested the convertibility problem came up almost simultaneously with the creation of the work. In planning the work it was remembered that this war might last but a few months. Our friends in Wall Street had told us that it would last but 8 months; the bankers said that it could not possibly last longer because there was not enough money to keep it going. Nevertheless, we felt it would be desirable so to plan the work that it could be run for some time, on the one hand, and that it could be as rapidly and easily shifted to a non-war basis as possible. Convertibility, therefore, presented less difficulty for us, and perhaps less difficulty than for many, because our work was not carried far beyond the raw material stage.

The industries other than those making new raw materials are faced with much more serious difficulty, but there are a great many of those industries, most of them small, that are very essential to our own national life if we are to be independent. We of a democracy are so apt to say that we are free people. As a matter of fact we are more absolutely enslaved, or were becoming more hopelessly enslaved to Germany, France and England than we would have been had any one of them possessed and administered our government. That may seem surprising, but men who have been professionally into the detail of the metal business far more than I have been able in the last two and a half years to tell me that in less than ten years Germany would have controlled absolutely the metal industry of the United States; that they were deliberately reaching out to obtain the control directly or indirectly of the metal industries, and we have since that time seen many evidences of it —not in any hostile spirit was this control sought, but purely as a matter of commercial existence—just as a country selects one or two products to be developed as a part of its policy.

The United States is planning to go so far as to give to certain firms different orders for different quantities of material, any material that enters directly or indirectly into the necessary war munitions and it is covering almost everything that is used in life, and giving these orders without bidding and without what would ordinarily be recognized as competition in order to preserve the ability and possibly the very identity of forms of business or methods of process that would be wiped out, perhaps, under normal competitive methods from abroad whether or not the tariff is in existence. There is, therefore, at Washington a rather clear recognition of the fact that we must hold together the nucleus of some of these industries that have been developed here or we will have to pay a very terrible price for our oversight when the time comes.

The country could not possibly consume in time of peace the explosives nor the automobiles we are making here to-day, although we are getting to be pretty strong on the consumption of automobiles. I was noticing some statistics in the automobile business the other day, because it touched our business a little and there is a surprisingly small amount going abroad to-day in spite of the railroad tracks that are lined with them on the western side of the city. The metallurgical industry has taught us chemists a little. They got together and not only told their problems but told their solutions and the metallurgical industry has advanced rapidly. We are altogether too secretive for the best interests of the business.

MR. H. A. LEVY: Can you propose a more reasonable way of coöperation to move away from the secret methods which have been prevalent among chemical workers?

THE CHAIRMAN: That has been proposed, but it will be necessarily a matter of growth. This organization, the Chemical Society, is a step in that direction, necessarily a hesitating step. It is something you cannot force. The American Institute of Chemical Engineers is perhaps more aggressive because the men who are members of the Institute have a certain greater degree of freedom as a consequence of the means of selection. They are men who are either running the industries in one capacity or another, owning them or managing them.

Also the Army and Navy Bureau has collected all this line of information. We have about 16,000 plants that are manufacturing material actually required or supposed to be required for military purposes. The Government is now able, without any red tape whatever, for the United States Government to step into any plant of the United States and take it over without any legal proceedings or anything else and make any of the necessary administrators of that plant officers of the United States Army and put the firm to work. What they are trying to do is to find out what can be done in the plant.

MR. LEVY: The point that I had in mind broadly, is that there are a number of concerns working along the same lines in different research work, laboratory work, and some of them are perhaps duplicating their work in their laboratories. I mean concerns having different research laboratories. The General Electric Company has avoided that by putting up a plant in Cleveland and purchasing a lot of plants in connection with it, and they are doing research work at one point. They are taking up research work where the other men left off.

THE CHAIRMAN: And yet it remains for an entirely independent organization having nothing whatever to do with either the Lamb Laboratory or the General Electric Laboratory or the Westinghouse, or any one of those companies, to turn out the work which has to do with replacing platinum wire in every lamp they make and I don't know how many thousand dollars they paid the people for the patents, but it was quite well up.

One of the large companies is getting into condition for nitrating a great deal of cotton, particularly linters for making nitrate cellulose. There is some talk of an effort to make a high-grade paper mill out of that plant later on.

MR. CLAUSEN: The question of cleanliness is of paramount importance and you couldn't use linters for that reason.

I have never seen linters cleansed from any possible speck at all.

THE CHAIRMAN: My understanding of their plan is that it is not so much to continue the use of linters as to continue the use of the plant on other grades of cotton or other grades of pulp for the manufacture of paper, leaving the plant as a whole earning some sort of interest on the investment, or running it for the purpose of paying taxes and employing the people they have been using and keeping them together as a unit. How far back into the lower grades of cotton they will go, or whether they will use linters at all, I do not think has been so much the discussion as it has been as to whether they can use the plant in some way and keep it alive and prevent it from going to rack and ruin.

MR. MOLOWITZ: Is the government also looking after the supply of the manual labor that will be necessary to manufacture the various products? Have you any idea of the percentage of men employed at present in the manufacture of munitions that might have to go back to peaceable employment again?

THE CHAIRMAN: It would be rash, perhaps, for any one man to make an estimate even though he had studied the question very carefully, but it hardly seems possible that the ratio should be less than 60 or 70 per cent, if by munitions you include all the parts which are now going into shells; but don't forget that the same machine that to-day is turning a screw for the nose of a trap, is perfectly capable of turning a screw for a typewriter or a sewing machine, and many were making screws for typewriters who are now making screws for shrapnel, and will turn back to making screws for typewriters or sewing machines after the war. Of course there are the lathes, the particular processes and the turners, all that type of machinery, what we call machining tools; many of the special machines that are not so special that they cannot be used except for munitions, can also be continued in use after the war.

MR. MASSIE: May I ask along that line, is there any bureau, either private or governmental, which makes any effort to classify the men so that skilled people can know where they are needed?

THE CHAIRMAN: Not yet, but I hope to see the time in the near future when either under the Bureau of Commerce and Labor something of that kind will be done, or else under this Committee.

MR. JORDAN: As President of the Board of Education in my town I conceived the idea a great many years ago that we should supplement our manual training and domestic science and that class of things taught in the school, first with a primary industrial school, which would take the children and educate them naturally into differentiating colors and sizes and shapes of things, taking textiles generally. I devoted more time to the things connected with textiles, dyes, spinning, and things like that, and then I established and got the City Council to agree to support, if we furnished the building and the material, an Industrial High School. This Industrial High School commenced a three years' course, devoting four hours each day to academic work, and four hours each day to manual work and it was for both men and women, coeducational. And at the end of that time if they had worked for some institution for a month, and we have had daily reports of their work, that entitled them to a graduate's certificate. So far our waiting list has been very crowded—through these efforts we have taken boys, some of them who have failed to move up in grades in the academic high school, who upon their graduation have received as much as three dollars a day the first day.

I think something should be done all over the United States to ascertain from everywhere what the people are doing, so that we can say to these graduates that they will have an opportunity. For instance, I get my gardener through the government, through the Labor Distribution Bureau. He is a foreigner, I am sorry to say—either an Englishman or a Frenchman or a German or a Swede—but he comes from the Government—I wrote to the Labor Bureau Department for him. It helps the man, and it helps me. Now, that ought to be carried by the Government to a higher plane than it is on now. I think that supplemental to that there should be an investigation by this Association, or by someone, to find and ascertain all over the country if there are capable natives —capable citizens, whether foreign born or native—and that they should receive the first consideration for employment by all manufacturers in the positions of profit and advancement.

MR. MOLOWITZ: Will the pay of the munition workers be governed by the Government in case of war?

THE CHAIRMAN: That has not in any way been touched upon, except that the statute says that these orders may be placed without bidding and at a fair price, and that it shall be obligatory on the people to make the stuff and it will be fine and imprisonment if they do not.

I don't feel that any question of that kind would ever come up. There are no more patriotic men than our laboring men in this country. The difficulty as I see it is not with the laboring man, but it is his walking delegate who is peculiarly lacking in any idea of patriotism in so many cases. I do not think it is the fault of the laboring man, and I think it is no criticism adverse to the members of the unions that we find the unions in the aggregate so diabolically arrayed against law, order, patriotism, the militia and everything else.

MR. ADAMS: Is not the American League doing something in that line?

THE CHAIRMAN: It was the American League I had in mind, and they are doing a great deal in that line, although lacking Government coöperation and driving support, as yet, but I think it definitely planned to co-ordinate that with the Federal movement.

MR. ADAMS: They have no connection with the Government as yet.

RESOLUTIONS ADOPTED (OFFERED BY MR. JORDAN)

Recognizing the laudable and growing movement throughout the Union to educate the youths of the country industrially and scientifically, and believing that Americans should be encouraged in securing and filling the more important responsible positions in the establishments desiring such employes, and knowing this would in turn be serviceable to the industrial establishments themselves;

Be it Resolved, That this Society urge upon the Government and will co-operate with it in making a thorough investigation along this line to the end—

(1) Ascertaining the extent of the movement named; and

(2) To assist both the employer and the employed in bringing them together on the lines indicated above.

(3) That this Society urge upon the Government to co-operate with it in making investigations to accomplish the purposes of this resolution."

(OFFERED BY MR. MASSIE)

WHEREAS, The permanent and efficient growth of American industries requires a constant and growing supply of specially trained employees, and

WHEREAS, The proper assimilation of the country's personal talent, both native and foreign, equally require the proper placing of individuals in localities and in work where their training and ability will be most productive to themselves and to the general welfare of the country.

Resolved, Therefore, That we earnestly urge the United States Government to provide an adequate special Bureau, the duty of which shall be to investigate the demands and needs for employees of all kinds, to inventory and classify so far as possible all persons, both native and foreign, needing or seeking employment, and to assist in bringing the employers and possible employees in contact with each other.

MR. POTTER: While the resolution offered covers what we wish to convey to the Government, if the Society expects to go forward with it, it seems to me that besides passing this resolution it is very essential that a Committee be appointed who are competent to handle the matter, confer with the proper officials and follow it up—otherwise it is apt to be "gratefully received" and filed among the archives and nothing heard of it again. But if there is a Committee to present the matter and ready to co-operate and advance definite suggestions as to what is to be done, perhaps there is a chance of getting somewhere with it, and I suggest that such a Committee be appointed after deliberation, and that men be chosen who are best in a position to give their time and some weight of authority to the proposition.

THE CHAIRMAN: You have heard the suggestion. It may be considered as placed in the form of a resolution for action, that such a committee be appointed. I think a simple motion that such a Committee be appointed would cover it. Do you so move?

MR. POTTER: I so move.

This motion being duly seconded, was unanimously carried.

THE CHAIRMAN: I take it that you would prefer in this case, from the form of your statement, that the usual practice be not adhered to of appointing the maker of the motion the Chairman of that Committee, or of appointing the Committee at this time.

MR. POTTER: That is correct. I personally would not be in a position to undertake it, and I think the Committee should be appointed after careful consideration and should be a Committee appointed to really do something in behalf of the Society.

THE CHAIRMAN: And preferably, that the Committee be appointed by the Council of the Society so that it would have official recognition.

OILS AND MOTOR FUELS

R. F. BACON, *Presiding*, Chemists' Club, September 30, 1916

R. F. BACON, *Chairman:* Some of the problems that we want to talk about are: relation to motor fuels; lubricating oils; petrol industry. The great problem is flexibility in refining. The ideal situation would be one where the refiner could take any crude and make from that crude just exactly the products demanded. Our biggest need is for gasoline. There has been a tendency lately to increase the production of casing head gasoline, but there is a feeling that such blended gasolines are not as good as straight cut.

DR. MABERY: Crude oils must be thoroughly understood. Laboratory methods have proceeded about as far as they can go. Refining is necessary. We need funds to carry out the affair. We shall find things in petroleum that we do not know about. We need to know what the refiner is doing, his methods, etc. The general public does not care how the crude oil is refined so far as it answers the purpose. The consumer does not know how to select the product that is used in the machine. What is necessary to bring out that work? There should be a line of individual investigation of motor oils and fuels carried out on a broad scale. All products should be taken up and examined thoroughly, including frictional tests. Machines should be constructed that will show these tests. In that way every product that is placed on the market can be standardized, and there should be a regulation by law just as with fertilizers. After the man is instructed as to the different grades of lubricating oils he should know by the oil he selects that he is getting the most suitable oil, so that he will get the best value out of his product. Institutions ought to take up this investigation. A laboratory is needed that can follow out these investigations on a large scale, to become public property. So far as refining is concerned, it depends to a large extent on the way the refining is carried out. Not altogether on the composition of the oil but what has been learned by actual experience. (Display of three or four lubricants. One sample sold for $100 per gal.) The important point in lubricants is the wearing quality and I am convinced that the theoretical end of it is first. There should be broad investigations concerning the quality of every lubricant that is on the market. And the results should be stated in such a way that the laymen can understand them. The time has come now when research has got to take hold of the petroleum industry from start to finish. Nothing leads to that better than competition. Where there is competition we may be able to introduce products that will determine their value. We need a larger supply of gasoline that will hold the price where it is now for there are indications of the price going higher unless we have something on hand to cut it down.

THE CHAIRMAN: I would suggest that students in the universities be put on some one phase of the petroleum field. In crude oils we have thousands of compounds that have never been found out about. Refining companies would be willing to make the preliminary fractionation and the products could be turned over to laboratories.

DR. MABERY: Regarding lubricating oils—we cannot depend on the specific gravity or viscosity. The best test that can be made of any oil is to distill it in vacuum to avoid decomposition and then determine the specific gravity of the distillates. There has got to be some standard. In the first place, the general public is entitled to know the source of the oil. General tests of the oil should be made; then worked out in a practical way on a starting motor car with a testing machine running along with it, to show its actual value. That should be adopted as a standard from which to value any particular oil referred to. It thus comes down to determining the durability practically and scientifically.

DR. DAY: Shall we get out a government report, describing in detail standard products for comparison? In the past more has been accomplished through means of specific brands guaranteed by private manufacturers.

DR. SALISBURY: Standardization should begin with the raw material and not with the finished product.

THE CHAIRMAN: Only from good crudes can be made good lubricating oils.

DR. SALISBURY: There are better lubricating oils to be made from certain crudes. What are those crudes? What is their character? Can other crudes be brought to the point where these crudes are brought? You will get a different product from every crude. Can anybody tell me how to get a better emulsion? I am using simply finished products. The standardization we get is a commercial one and not a standardization of service.

DR. KELLEY: Dr. Maybery did not say anything about the temperature at which the viscosities are to be taken or change of the viscosity with the temperature in the examination of the different cuts. Oil loses viscosity rapidly with the rise in temperature.

DR. MABERY: The value of an oil depends on its elastic quality. Viscosity determinations of the oil are the only way it can be done, to get the consistency of the lubricant and see what the oil should be considered to do. The matter of color has to do much with the same principle.

DR. DAY: What lubricants hold up best?

DR. MABERY: I do not know positively.

DR. BAKER: Tests on lubricants do not tell you anything, Dr. Bacon has said. I cannot agree with that. Tests do infer something in so far as their application to lubricating goes. Many people make tests and are unable to interpret the tests. Dr. Mabery has suggested standardization. This would be alright if our crude oils were uniform and if the refiner could always get the crude he wants. Frictional tests are good, but if we consider frictional tests they would have to be based on one specific purpose. Cylinder oil and gasoline would not be tested on the same machine. Dr. Day says brands are not uniform. Brands do run practically uniform in our experience.

DR. DAY: How would you identify the oil?

DR. BAKER: There are certain characteristics in the oils, and if this oil is run under one condition it may be possible to get one result, where if it is run under another condition you may get another result. I was called in to see what was causing an emulsion in a certain system. The oil was used for engines and emulsified. I examined the original oil, and they had used about 1000 barrels in the system. But the system had not been cleaned for 6 or 7 months. The emulsion was due to organic substances getting into the oil.

MR. W. F. PARISH: (Brought up points that would tend to show that specifications covering the product for use of lubrication oil are of disadvantage, entirely on account of the fact that mechanical conditions of the machine are a constantly varying factor.) Difficulty is always experienced in getting machine users to use exactly the proper oil or to maintain the use of the proper oil after it has once been demonstrated that a fixed lubricant will give the highest results. The machine or motor user is not primarily interested in the question of lubrication even if he is told that a certain standard would be necessary for his motor. The difficulty would be that the motor would very likely change very rapidly, which would require a different standard.

DR. CONRAD: Dr. Mabery's suggestions are all right. When you come to the refiner's point of view, what are you going to do? Refiners at Franklin try to get the fuels as uniform as possible. Once in a while you get an oil that is supposed to be the same, but sometimes they miss it. Durability and lasting quality is necessary. In turbine service they need an oil that lasts longest, sometimes weeks, months and years. The oil that lasts longest is the cheapest. There is a great field for the universities and schools, also the Bureau of Standards, in this line. Oils from different fields show different characteristics. How will you ascertain which is the best? There has been great improvement in the refining processes since ten years ago. In fact, ten years ago we did not know much about lubricating oils.

THE CHAIRMAN: Are there any processes that make gasoline other than the pressure process in which one obtains a product that is not too unsaturated to refine?

DR. GRAY: Gravity has nothing whatever to do with the properties of a crude oil. Gravity of the gasoline varies with the crude. The distillation test is the same for every one of the gasolines so that distillation tests should be used instead of gravity tests.

MR. ROBBINS: Gasoline of high specific gravity has more power than gasoline of light Baumé gravity. Power back of a light gravity gasoline is greater per pound than the heavy.

MR. RITTMAN: Dr. Bacon asked about gasoline savers. The gas savers used are kerosene vapor or a heavy gas vapor, with added materials such as camphor, naphthalene, nitrobenzene, and some even use the explosives nitroglycerine and trinitrotoluol. The eastern part of the United States are using a very inferior quality compared with other parts of the country. The end-point may be as high as 450 to 500° F. The mid-continent insist on an end-point under 425° F., whereas the Pacific Coast insist on an end-point under 375° F. The tendency throughout the country as a whole is to use heavier gasoline. In other words, the gasoline can is chiefly filled with kerosene.

The design of the engine is extremely important in the use of gasoline. The old type of manifolds had a lot of exposed surface before the fuel reached the engine. This was very inefficient because the heavy parts of the gasoline would condense and not be available for consumption. New types of automobiles all have compact manifolds in which the vapors are not condensed once they have vaporized.

The oils from different countries vary widely. A gasoline made by cracking Kern River crude contained as high as 25 per cent aromatic hydrocarbons and under careful auto test gave a mileage of 30 per cent greater than a straight run gasoline with paraffins. Argentine Republic oil, on the other hand, produced a gas very low in aromatic and high in paraffins. Japanese oils were different from either of these.

Motor fuels are of commercial value. Many experts throughout the country are working on this problem, using every conceivable kind of apparatus and processes. Their efforts are earnest and the result can only be success. I absolutely believe that the motor fuel problem is a thing of the past for several years to come at least, despite the fact of the great increase in the number of automobiles.

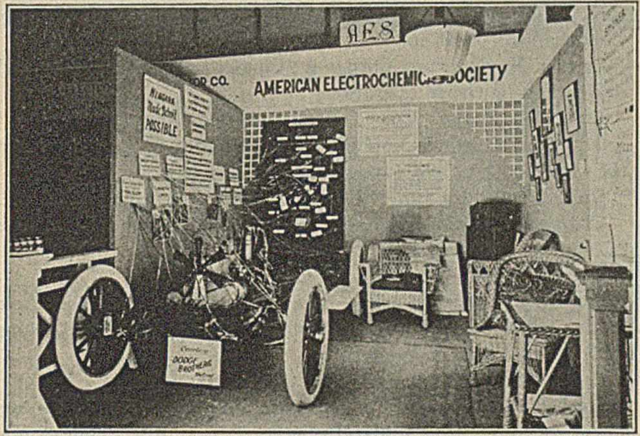
DR. R. E. HUMPHREYS: We are using 300 stills at Whiting, Ind., with a charge of 250 lbs. each. Much time has been spent on the by-product asphalt which is produced in connection with the use of the Burton process. This asphalt approaches very closely the asphalt produced in South American countries. It is not greasy, and, all told, has been found superior to the asphalt formerly produced by blowing air through the residuum from mid-continent oils. This material is largely used in the vicinity of Chicago from oils produced in the mid-continent field. I do not believe that we need fear a shortage in motor fuels.

SECOND EXPOSITION OF CHEMICAL INDUSTRIES

The Second Exposition of National Chemical Industries took place September 25th to 30th, occupying two floors in the Grand Central Palace, New York City.

At the opening meeting Mr. Charles F. Roth, one of the very efficient managers responsible for the organization of the exposition, introduced the speakers.

Dr. Charles H. Herty, President of the American Chemical Society, explained that it had been the fixed determination of the managers and advisors of the exposition to make the chemical show a place for earnest men of the country to bring together their products, not for the purpose of boasting, but to demonstrate their ability to meet the situation and thus to afford inspiration for the future. In other words, the exposition was planned to be not only a showing of what had been accomplished, but also the assembling of resources of the nation concerning which expert representative men of the various industries could consult and give and obtain expert advice. Such displays will undoubtedly bring about coöperation of state governments, railroads and national government by setting forth how the resources of the nation may be best put under chemical direction, for the primary responsibility for the development of these resources rests chiefly upon the chemists of the country; that the necessity of such coöperation is required by other nations is indicated by the recent unification of the dyestuff industries of Germany and the chemical conference of the allies, during which they agreed to interchange technical knowledge in place of continuing individualistic efforts as heretofore.



Dr. Lawrence Addicks, President of the American Electrochemical Society, called attention to the development of the electrochemical industries from the modest beginning of electric batteries to manufacturing processes that require the highest type of chemical engineering. Electrochemistry has the peculiar character of forming the meeting place for electro chemists, physicists, metallurgists and physicians, thus helping to break down the barriers between so-called pure science and engineering. The high prices of the present time are constantly bringing about fields of new uses for materials and especially the lower grade materials which must necessarily replace the shortage of the higher priced ones. In the great awakening that has brought about coördination of industrial resources for national defense, Dr. Addicks considers the accomplishments up to the present as merely an earnest of what is to come.

Mr. Thomas J. Keenan, Secretary of the Technical Association of the Pulp and Paper Industry and Editor of *Paper*, spoke in place of President Daniels of the American Paper and Pulp Association.

"The papermaker stands next to the highest place in the industrial world, for the latest census of manufactures shows that in America the manufacture of paper is second in importance only to the steel industry. The total invested capital is estimated at $500,000,000, in round numbers, while the annual value of the manufactured product—pulp and paper—amounts to $350,000,000."

Dr. Ira Remsen, formerly president of Johns Hopkins University, was enthusiastically received by the audience, and expressed his desire to have it thoroughly understood that he had always been interested in chemical industry in spite of the numerous statements that had been made to the contrary. The truth of the matter was that his contributions to chemistry had been at the other end of the line, since it had always been his belief that industry grows only when science grows.

Mr. Adriaan Nagelvoort, co-manager of the exposition with Mr. Roth, called attention to the fact that the industrial developments of the last year were possible only in such a country as America, a notable instance being the fact that the dyestuff firms of the country are now making 75 per cent of the quantity needed in 1913. The audience was then invited to visit the various exhibits of the "Second Chemical Show."

Unusually attractive features of the exposition were the moving pictures, shown every afternoon and evening, illustrating the processes of manufacturing a wide range of products. Acknowledgment was made to the Bureau of Commercial Economics for their collaboration in this program. These pictures included the following:

Manufacture of Iron and Steel Tubing, Black Powder, Fertilizers, Iron, Silk, Blotting Paper, Varnish, Silver Mining, Asphalt (Barber Asphalt Co.).

American Chemical Society, April, 1916, Meeting. Leaving Danville, Ill., Chamber of Commerce Building.

Industrial Plants on the Clinchfield Route (Carolina, Clinchfield & Ohio Railway).

Bureau of Mines.—Iron Mining Operations, Manufacture of Coke. Mine to Molder. Safe Method of Bituminous Coal Mining. Mining Magnetic Iron Ore. The Shooting of the "Lake View Crusher." The Manufacture of Portland Cement. Zinc Mining, Milling and Smelting. Dredge Gold Mining. Copper Mining, Milling and Smelting. Mining and Extraction of Radium from Carnotite Ore.

Westinghouse Electric & Manufacturing Co.

Mining and Smelting of Copper (United States Smelting Co., Inc.).

Motor Manufacture (General Electric Co.).

Distillation Apparatus (E. B. Badger & Sons Co.).

Filtration of the City Water Supply and Disposal of the City Sewage, City of Baltimore.

Water Powers on the Pacific (Great Western Power Co.).

Petroleum from a Mexican Oil Well, accompanied by discussion by I. C. White, State Geologist, West Virginia.

Manufacture of Paper.
Making of Fine Tools.
Dynamiting the Farm with Profit.
First Aid in the Home.
Sands That Serve.
Time from the Stars.
Manifold Uses of Concrete.
Do it Electrically.
Telling the Forest.
Safety First.
Light from the Rocks.
Striking a Light—Matches.
Irrigation in Southern Alberta.
Queen of Yuma—Water Power.

EXHIBITS

Paul O. Abbé—Grinding machines (ball or pebble mills), heavy, light and sifting mixers, improved rotary cutter.

Abbé Engineering Co.—Working models of the Abbé tube mill showing "Ideal" spiral feeder, double porcelain jar mill, special combination porcelain jar mill; section of pebble mill showing removable manhole frame with detachable flanges.

Alberene Stone Co.—A laboratory installation of bench, gas hood, and sink made of Alberene stone, various samples of cut stone, soapstone linings for pulp furnaces.

American Apparatus Corporation—An exhibit of laboratory furniture, laboratory apparatus and glassware in general, and American-made porcelain ware. Also Riche calorimeters, Lenzman-Kober colorimeter, Stokes water still, cement and oil testing apparatus, electric heating appliances, autoclaves, thermometers, hydrometers, etc. By way of novelty, a 50-gal., oval-shaped glass flask with $^1/_{16}$-inch wall.

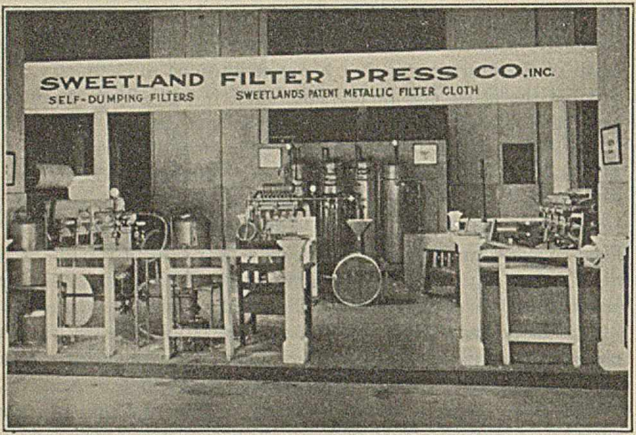
American Chemical Society—Journals published by the Society, charts indicating growth, and a dummy of the 3-vol. decennial index to *Chemical Abstracts* now in course of preparation.

American Coal and By-Product Coke Co.—Model of flueless oven, a wall brick, illustrations of certain by-product apparatus, and colored, diagrammatic sketch of the Roberts method of destructive distillation of coal and method of by-product recovery.

American Electrochemical Society—An automobile, stripped, with descriptive placards attached to various parts, purporting to show the economic effect of electrochemical products on modern industry.

American Institute of Mining Engineers—A booth for visitors.

Arnold, Hoffman & Co.—Products of the Mathieson Alkali Works, Castner Electrolytic Alkali Works and the Nitrogen Products Co., for whom they are sales representatives.



Atlantic Gulf & Pacific Co.—An information booth.

E. B. Badger & Sons Co.—Exhibited photographs and drawings of different installations and chemical plants designed and manufactured by them; also a sample copper apparatus.

J. T. Baker Chemical Co.—"Analyzed Chemicals," C. P.

City of Baltimore—A miniature reproduction of the city showing its harbor and dock facilities.

Barber Asphalt Paving Co.—Showed a complete line of the Barrett refined coal-tar distillation products, synthetic products made therefrom, useful to the dye, pharmaceutical and photographic trades; also numerous specimens of customers' manufactured articles. Different grains, growth of which had been promoted by using their sulfate of ammonia with potash and phosphate.

Bausch & Lomb Optical Co.—Apparatus for micro-photography, lanterns for lectures, and samples of their made-in-America optical glass.

Beach-Russ Co.—Exhibited jointly with the Abbé Engineering Co. De Rycke centrifugal steam separator and grease extractor, acid pump, and a showing of interior of their rotary vacuum pump. A No. 4 rotary pressure blower in operation, pumping up a pressure of 10 lbs.; model of a filter press. A demonstration of their high vacuum pump, exhausting a red liquid and pulling it up a 34½ ft. graduated glass tube to within 0.1 in. of the barometer reading.

W. Becker's Aniline & Chemical Works—An exhibit of all the most important aniline dyes and intermediates as well as textiles, carpets, leather, headwear, paper and other goods dyed exclusively with American dyes made by them from American raw materials.

Bethlehem Foundry & Machine Co.—Nitric acid condensing apparatus, fume pipes, anodes and cathodes all made of tantiron; also gray iron apparatus such as nitric acid retorts, nitrators, reducers, sulfonators and acid eggs.

The Bristol Company—Complete line of indicating and recording instruments and pyrometers, thermometers, etc., featuring their new continuous flow wet and dry bulb recording thermometer or psychrometer and demonstrating their automatic temperature compensator for Bristol's electric pyrometers.

Brown Instrument Co.—Stationary and portable electric pyrometers, recording thermometers and automatic heat-control instruments for furnaces, retorts, etc.

Buffalo Foundry & Machine Co.—A vacuum drum dryer in operation reducing a sulfite waste liquor of 50 per cent moisture to a dry powder, and bottles of various materials made with the dryer. Factory size of nitrator, caustic pot, sulfonator, evaporator, vacuum shelf dryer, fusion kettle, crystallizing pan also built for vacuum, nitric acid retort and condenser; autoclave, 1000 lbs. working pressure; laboratory size autoclave.

Butterworth-Judson Corporation—A line of heavy chemicals, oxide of alumina, iron nitrate, tin crystals, sodium phenylate, benzol sulfonate, etc.

The Carborundum Co.—A line of manufactured products showing the uses of carborundum, including grinding wheels for all purposes, sharpening stones, abrasive paper and cloth, cast silicon chemical ware, carborundum pyrometer protection tubes, dental wheels and goods for dental purposes.

Carolina, Clinchfield & Ohio Railway—Products made and natural resources located along the "Clinchfield Route." In the same booth was the exhibit of the Federal Dyestuff & Chemical Corporation.

Carrier Engineering Corp.—A "Carrier" air conditioning and drying equipment in operation.

Celluloid Zapon Co.—Different applications of "Zapon." Lacquers and enamels applied. Leather cloth was displayed in the same booth by the Zapon Leather Cloth Co.

Central Foundry Co.—"Universal" cast-iron pipe, bolts, etc.

Chemical Catalog Co.—Showed the 1916 edition of the "Chemical Engineering Catalog."

Chemists' Club—A booth for visitors.

Coatesville Boiler Works—Exhibit of materials used in their tanks, boilers and stacks. Photographs of their steel plate work for chemical manufacturers.

E. J. Codd Co.—Chain screen doors demonstrated.

Condensite Company of America—A display of printing plates, auto ignition apparatus, the Edison disc phonograph record, miscellaneous electrical ignition apparatus, moulded Condensite parts as applied to various apparatus.

Contact Process Co.—Exhibited a line of their products including mixed acid HNO_3 (42°), *Aqua fortis* (41½°), oleum (50 per cent), salt and nitre cake, etc.

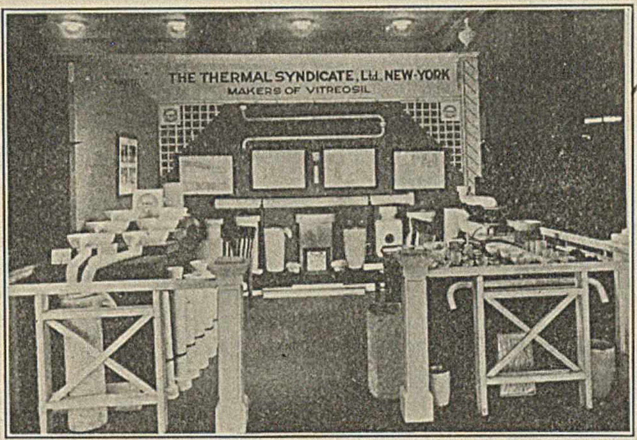
Corning Glass Works—A complete line of glassware including "Pyrex" chemical ware and transparent oven ware, lenses, optical glasses, lamp chimneys, lantern glasses, tubes, etc.

Corn Products Refining Co.—A line of various corn products such as dextrines, starches, corn syrup, Karo, etc.

J. H. Day Co.—Hunter's New Sifter and Mixer; Pony mixer (8 gal.); models of sifters, mixers and pulverizers.

DeLaval Separator Co.—The DeLaval Clarifier and Filter; specimens of unclarified and clarified oils, medicines, grease, etc.

Denver Fire Clay Co.—A complete line of assayers' and chemists' supplies including crucibles, muffles, scorifiers, a pulverizer, crusher, cupel and laboratory flotation machines, assay and melting furnaces, etc.



Detroit Range Boiler Co.—A line of metal bilge barrels.

J. P. Devine Co.—Exhibited the first vacuum double drum dryer made in America, in operation; working models of a dry vacuum pump and a surface condenser; also a high pressure (1000 lbs.) autoclave and a nitrating kettle.

The Dorr Company—Working model of three-deck washing classifier operating on a combination of silica sand and indigo dye; also models of a thickener or continuous settler and an agitator or leaching tank.

The Dow Chemical Co.—Chemicals, including synthetic indigo, dye intermediates, chlorides, bromides, etc.

Downington Manufacturing Co.—A model of the Miller duplex beater for pulp or nitrocellulose, in operation, and a small beater, laboratory size; also some yellow-pine products of the Empire Chemical Co. recovered by the Clope process.

Driver-Harris Wire Co.—"Nichrome" products: castings, carbonizing and heat-treating boxes, pyrometer protection tubes, and baskets of various sizes for metal cleaning, dipping and heat-treating processes.

E. I. du Pont de Nemours & Co.—Chemicals and mixtures for industrial, medicinal and laboratory uses. In the same booth Fabrikoid, a leather substitute, and also the topping fabrics of the Fairfield Rubber Co.

Duriron Castings Co.—Acid, alkali and rust proof castings and apparatus; agitator kettle, nitric acid condenser. Demonstration of a $1^1/_2$-in. centrifugal pump.

Thomas A. Edison—Organic and inorganic chemicals; coal-tar products; motor-truck size of alkaline battery.

Eimer & Amend—A complete exhibit of laboratory supplies including the Barnstead automatic water still electrically heated, Freas electric oven and vacuum oven, Emerson adiabatic calorimeter, Zeiss photomicrographic outfit and a line of multiple replaceable unit electric furnaces of the muffle, crucible, tube and organic combustion types; also Fry and Pyrex laboratory glassware and Coors Colorado porcelain ware.

Electro Bleaching Gas Co.—Chlorinating apparatus, samples of caustic potash, muriate of potash, para-dichlorbenzol, monochlorbenzol, etc., and fabrics bleached with liquid chlorine.

Electro Chemical Co.—An exhibit which dealt with electrolytic bleaching showing finished and unfinished bleached products such as paper, hole-proof hosiery, etc. Models of a laundry unit and a paper mill unit.

Electrolytic Zinc Co.—Samples of electrolytic zinc, magnesium powder (99.5 per cent pure) and aluminum dust.

Electron Chemical Co.—Photographs of installations of the Allen-Moore electrolytic cells.

Elyria Enameled Products Co.—Enamel lined mixing kettle with special oil jacket for high temperature work, enamel lined apparatus for experimental and industrial use. Models of high-speed agitators. Demonstration of resistance of enamel to sudden temperature changes.

The Fabra Co.—Information booth.

Foote Mineral Co.—An exhibit of the "unusual" ores, *i. e.*, ores of the rarer elements such as molybdenum, zirconium, tungsten, tantalum, uranium, thorium, etc. Laboratory ware manufactured from zirconium oxide. Stereomotorgraph views of various mines including new American monazite deposits.

The Foxboro Co.—Recording and indicating instruments.

Franco-Swiss Colours Co.—Dyestuffs, and a demonstration of actual dyeing to prove their qualities.

Freeport Sulfur Co.—Samples of crude sulfur mined by the Freeport Sulfur Co. Sectional views of samples of sulfur-bearing rock showing the sulfur in its native form.

Chas. F. Garrigues Co.—Samples of chemicals used in connection with manufacture of explosives. Steel barrels of Draper Manufacturing Co.

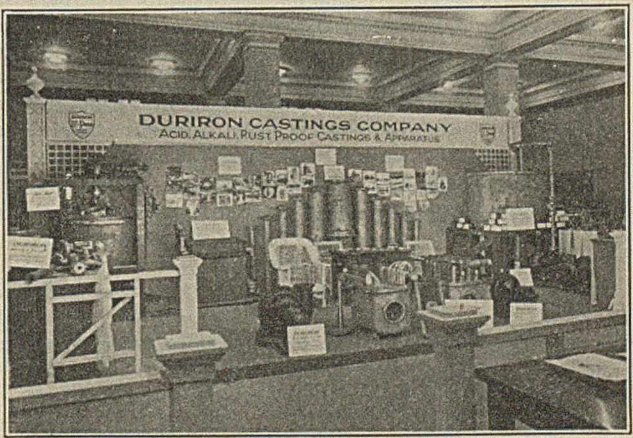
Geissinger Regulator Co.—Demonstration of industrial temperature-control system for heat-control work; conveyor type ovens and large flue dampers in super-heaters.

General Bakelite Co.—Initial ingredients and various raw Bakelite compounds prepared from same. Electrical and mechanical applications of Bakelite.

General Chemical Co.—Complete line of atmospheric nitrogen products, Baker & Adamson C. P. chemicals, and dye intermediates of the Benzol Products Co. The Ryzon Baking Powder Co. exhibited their baking powder and its three ingredients.

General Electric Co.—A booth for inquiries.

German-American Stoneware Works—A full line of chemical stoneware including stirring and mixing apparatus, Meyer condensing tourill, 520 gal. storage vessel, and cellarius tourill. Also exhibited automatic acid elevator, suction filter for vacuum, chlorine generator, centrifugal pump, condensing coil, armored exhauster (stoneware lined), revolving damper, gas cocks, pipe, and some magnesia ware.



Glens Falls Machine Works—A Tromblee & Paull rotary sulfur burner.

Golden Chest Mine—Tungsten ore from Murray, Idaho.

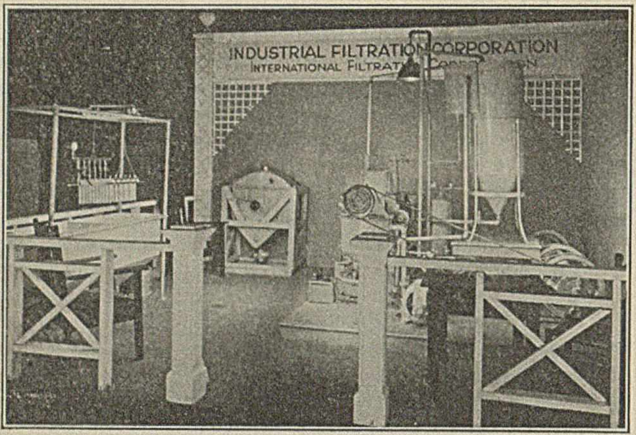
Great Western Power Co.—Photographs and information relating to the hydroelectric developments and possibilities of the electrochemical industries on the Pacific coast.

The Emil Greiner Co.—Scientific instruments, chemical glassware, thermometers, hydrometers, volumetric apparatus.

Hardinge Conical Mill Co.—A working model of their continuous ball and pebble mill; a stereomotorgraph showed pictures of various installations.

Harrison Bros. & Co.—A display of chemicals used in the manufacture of pigments, dyes and paints for fire works, linoleums and textiles.

S. F. Hayward & Co.—Exhibited a line of fire extinguishers, chemical engines, "Hayward" respirator, Maxwell Peerless emergency fire hood, gas helmet, safety goggles, pure air supply apparatus to work in poisonous gases any length of time, and an oxygen reviving outfit.



Frank Hemingway, Inc.—Industrial chemicals, coal-tar products.

Herold China & Pottery Co.—Coors U. S. A. chemical porcelain for laboratory testing.

Herman A. Holz—Beighlee pyrometer equipment (180° deflection angle—12 in. scale) and portable Brinell meter. Samples of rhotanium as a substitute for platinum.

Hooker Electrochemical Co.—Samples of caustic soda, bleaching powder, monochlorbenzol and muriatic acid.

Huff Electrostatic Separator Co.—Electrostatic ore separator for minerals of all kinds; plumb pneumatic jig for same purpose.

F. C. Huyck & Sons—Advertised Kenwood Felts by pictures and pamphlets. Showed samples of woven woolen filter cloths.

Industrial Filtration Corporation—Rotary continuous vacuum filter in operation; model of the movable cell type applied to open tank filtration; working model of rotary thickener and clarifier.

International Equipment Co.—Laboratory centrifuges.

International Glass Co.—A full line of their American-made "Insol" beakers and flasks; also glass tubing, burettes, pipettes, weighing bottles, condensers, condenser tubes, stopcocks, separatory funnels, and special blown ware.

Kieselguhr Company of America—"Sil-O-Cel" in brick and powdered form with a practical demonstration by means of the torch test. There were stereomotorgraph views of the mining and preparation of "Celite."

F. Kleinschmidt & Co.—A model rotary evaporator.

A. Klipstein & Co.—Coal-tar dyes (indigo, sulfur shades, rhodamine, etc.), potash, varnish gums, oils, tanning materials including their "Oxi-tan," samples of leather, etc.

H. Koppers Co.—A model coke oven, and the primary byproducts of coke made from various coals.

L. O. Koven & Bro.—A 450 sq. ft. Kelley filter press.

The Laboratory Supply Co.—A complete line of laboratory porcelain and glassware; Ohio Pottery Co.'s "Circle S" porcelain and also "Solno" chemical glassware.

Lead Lined Iron Pipe Co.—An exhibition of lead-lined iron pipe, valves and fittings for use with acids. A 16-in. lead-lined iron pipe used for hot sulfuric acid was of particular interest.

Leeds & Northrup Co.—A display of the following: Vreeland Sine wave oscillator; electrolytic conductivity apparatus; electrometric titration apparatus for determination of chromium and vanadium in steel and other alloys, in operation; indicating and recording pyrometers; complete bridge equipment for measuring electrolytic conductivities; apparatus for determination of hydrogen-ion concentration; portable wheatstone bridge, galvanometer; sensitive galvanometer with lamp and scale; constant speed high frequency generator.

Lehigh Car, Wheel and Axle Works—Samples of car wheel steel after different treatments. A model of the Fuller-Lehigh pulverizer. Fuller Engineering Co., and Lehigh Stoker Co., design and construction of grinding plants; Lehigh Foundry Co., acid-resisting casting.

Life-Saving Devices Co.—Demonstration of "Lungmotor."

Arthur D. Little, Inc.—Picture and blue-print floor plans of the new Arthur D. Little Laboratory at Cambridge, Mass.

Luzerne Rubber Co.—Various articles in hard rubber to resist chemicals, piping, acid buckets, acid tanks, fittings, tonic combs, dictaphone boxes, insulators and specialties.

Madero Bros., Inc.—Exporters of chemicals.

Manufacturers' Record—Citations from the magazine. Chart showing the U. S. in 1880 and the South of to-day.

Marden, Orth & Hastings Co., Inc.—A line of chemicals and dyes; a 380-lb. sample of Mexican logwood; a large sample of Hematoxylon Campechianum; wall cabinets containing a large collection of dyed wool, silk and cotton yarns.

Merck & Co.—"Blue Label" reagents and jars of hydroquinone, synthetic carbolic phenol acid, aniline oil, etc.

Metallurgical and Chemical Engineering—A booth for visitors and exhibitors. Programs of the Exposition.

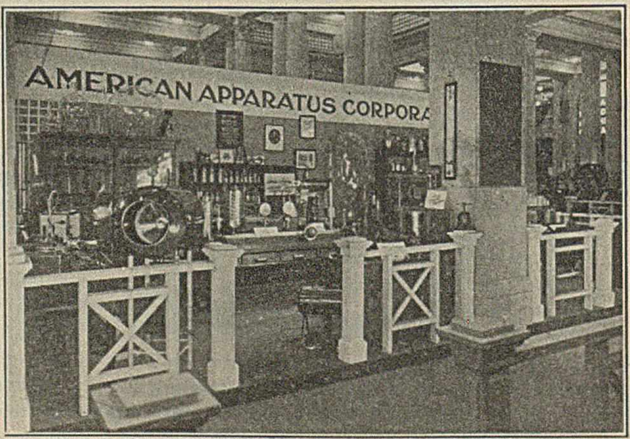
Metals Disintegrating Co.—Samples of powdered metals.

B. Mifflin Hood Brick Co.—Samples of Hood's pottery tile, and acid tower packing. Blue-prints and photos.

Mine & Smelter Supply Co.—Heusser analytical and assay balances, Lindsay oil furnace, Samson laboratory crusher, McCool pulverizer and Colorado clay products.

Mississippi River Power Co.—Photos of power stations, coal gas plants and maps.

Monsanto Chemical Works—Saccharin (U. S. P. and soluble), chloral hydrate, caffeine, coumarin, calcium, manganese, phthalic anhydride, and vanillin, etc.



Multi-Metal Separating Screen Co.—Models of screens used in industries; screens for sifting, straining and filtering; safety device and testing sieves.

Nash Engineering Co.—Hydro-turbine wet vacuum pump in operation. Xyloform chemical products: paint, varnish and grease-proofing compound.

National Aniline and Chemical Co.—A splendid line of goods colored or dyed exclusively with American aniline colors manufactured by Schoellkopf Aniline & Chemical Works, Inc.: hosiery, yarn, cloths, inks, rugs, leather, plush, linings, threads, shoes, shoe laces and shoe polishes, dressings and creams, artificial silks, embroidery, pencils, etc. Some aniline colors.

National Gum and Mica Co.—Mikal tallow, cold water paste, glues and gums, paper boxes made with Mikal cold glues, string finished with Mikal sizing. In the same booth was a display of logwood, chips and extracts by the Obex Laboratories Co. The Taylor Chemical Co. also exhibited their carbonbisulfide and "Fuma" carbonbisulfide. An ultramicroscope was displayed for the benefit of the American Red Cross.

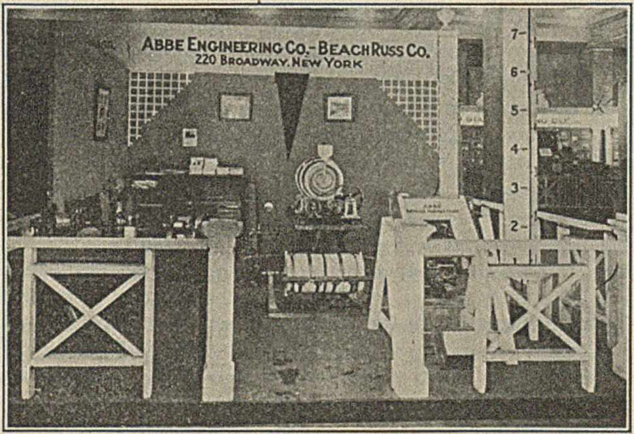
City of Newark, N. J.—Maps and photos of Terminal.

Newport Chemical Works, Inc.—"Newport" rosin with transparency was demonstrated. Benzol (first runnings and finished), toluol, solvent naphtha, ammonia liquor, etc.

Niagara Alkali Co.—Model of automatically and manually controlled apparatus. Liquid chlorine. Elaborate display of cotton, raw to bleached.

The J. L. North Iron Works—A practical demonstration of the North kettle; cast iron, steam jacketed and porcelain lined mixers and kettles.

Norton Co.—An exhibit of the Norton Alundum and Crystolon refractories and laboratory ware showing the applications of the more ordinarily used apparatus in laboratory construction, the display of refractory products including alundum cement, pyrometer tubes, extraction thimbles, filtering crucibles, combustion boats and R R Alundum.



The Palo Co.—Line of chemical and metallurgical apparatus: fluorescope, microscope, microscopical lamps, Brinell meter, Lovibond tintometer, Sochocky-Willis radioscope, radium watches, etc. Assortment of Palo glass and porcelain ware.

Paper—The Technical Organ of the Paper and Pulp Co. Headquarters for meeting of the Technical Association of the Pulp and Paper Industry.

The Paper Trade Journal—Copies of their three regular publications, annual trade directory, and books published.

Patterson-Allen Engineering Co.—Various sizes of the "Everlasting" valve and photographs of it on various machines.

Pennsylvania Salt Mfg. Co.—An exhibit of their products including Greenland kryolith, various alums, caustic soda, bleach, cylinders of liquid chlorine, and samples of heavy acids. Also a display of customers' goods demonstrating the uses of the products; a working model of a salt well.

The Pfaudler Co.—Exhibited a 350-gal. jacketed mixing tank with enameled steel propeller type agitator; a one-piece inner tank with bottom of jacket bolted on to admit steam coils; a one-piece glass-enameled steel closed tank (850 gals.); a one-piece glass-enameled steel evaporator or crystallizing tank (open); one sectional lead lined steel tank; and a one-piece steel tank lined with vulcanized rubber, with lead lining secured by Pfaudler process.

Pittsburgh Testing Laboratory—A few chemical products, and data showing nature of the work being carried on.

Precision Instrument Co.—Gas analysis apparatus. Boiler control gauges for forced draft and natural draft; differential gauge; various types of recorders and recording gauges.

Prest-o-Lite Co., Inc.—Bunsen burners, various size storage batteries, lead-burning equipment and soldering, brazing, welding and cutting torches.

Process Engineers, Ltd.—Rosin sizing process for paper mills.

Product Sales Co.—Exhibited samples of crushed quartz, dry ground silica and crude kaolin.

Pyrolectic Instrument Co.—A "Pyrovolter" pyrometer for actual measurement of temperature.

Raritan Copper Works—Their new "Anaconda" electrolytic zinc, the first on the market; N. E. C. electrolytic copper. The refining of copper was shown in all its stages—from the blister, anode, cathode to the commercial shapes—and by-products of the same, including white arsenic, blue vitriol, nickel sulfate; selenium in three allotropic modifications, tellurium and gold and silver bars. Uses of selenium were shown in ruby glass and selenium electric cells.

The Raymond Bros. Impact Pulverizer Co.—Samples of product, ground and air separated, from stone to radium. Views of different types of pulverizers and air-separating machines.

Research Corporation—A working outfit of the Cottrell electrical precipitation processes for removing dust from gases.

Richmond Waterproof Products Co.—"Monarch cement" for cementing linoleums to concrete.

Roessler & Hasslacher Chemical Co.—All grades of cyanide, "Trisalyt" for electroplating, and chemicals.

Ruggles-Coles Engineering Co.—Exhibited a working model of their Class A, double shell, direct heat dryer.

Schaeffer & Budenberg Manufacturing Co.—Instruments for indicating and recording temperature, pressure, speed and power, consisting of gauges, indicating and recording thermometers, tachometers and tachoscopes; dial thermometer demonstration.

Schaum & Uhlinger, Inc.—Photographs of their centrifugals.

Schutte & Koerting Co.—Apparatus for lifting acids, water spray used in acid condensing plant, spray nozzles, strainers, K-line of valves, exhausters, steam jet chimney ventilator, noiseless heater, oil and tar burners, lead fittings, etc.

Scientific Materials Co.—A line of Fry resistance glass and Nonsol and Pyrex glassware. A Scimatco-Brinell hardness testing machine; Scimatco recorders; a Scimatco fine grinder in operation; and other apparatus of the "Scimatco" brand. Also a Fieldner molybdenum wound furnace (max.-temp. 1700°).

Ernest Scott & Co.—Samples of C. P. glycerine, oil extracted from cotton waste, and other recovered trade wastes. Blueprint of the Scott evaporator and photos.

Seydel Manufacturing Co.—Synthetics, textile chemicals and coal-tar derivatives; sizings; aeroplane cloth sized with "Sizol."

Sharples Specialty Co.—A small laboratory super-centrifuge operating at a maximum speed of 40,000 r. p. m. and a commercial size of super-centrifuge. Samples of fish oil, crude sugar medicine, extract, phenol, varnish, etc., showing both original and clarified material.

T. Shriver & Co.—Practical demonstration of the "Atkins-Shriver" filter press; electrolyzer and regular filter press.

Sidio Company of America—A complete line of "Sidio" pure fused silica products, "made in America."

Solvay Process Co.—Exhibited all grades of soda ash and caustic soda, also bicarbonate of soda and modified sodas used for all washing purposes. A display of products made from or by the help of alkalies. In a joint exhibit the Semet-Solvay showed some by-product coke oven ammonia products and derivatives, also designs of by-product coke ovens.

Sowers Manufacturing Co.—A "Dopp" seamless, steam jacketed kettle; section of a kettle showing construction; a vacuum pan; photos.

E. R. Squibb & Sons—Analyzed reagents brought out since the war. Also a line of medicinal chemicals.

Stamford Manufacturing Co.—Specimens of dry woods and the extracts therefrom. A collection of dyed textiles, furs, etc.

Standard Aniline Products, Inc.—Exhibited their dyes, resinates and other chemicals.

Stevens-Aylsworth Co.—Models showing proper and improper tank agitator; sections of their tin, copper, lead, etc., coated tanks; pipe coils.

Stone & Webster Engineering Corporation—A photographic exhibit of their plant construction work.

The Stuart & Peterson Co.—Models of steam jacketed kettles, evaporating dish, still, autoclave, retorts, storage cans.

Sturtevant Mill Co.—Exhibited their ring roll mill, Newaygo separator, automatic coal crusher and sampler, sample grinder, laboratory roll-jaw crusher, and laboratory roll.

Sweetland Filter Press Co.—Small Sweetland clam shelf filter equipped with their metallic filter cloth, in operation on a sludge; a standard clam press with cotton leaves; a new rotable leaf type filter press; samples of the metallic filter cloth.

Swenson Evaporator Co.—A demonstration of the standard double-effect Swenson evaporator and a display of materials handled in Swenson evaporators.

Swiss Colours Co.—Exhibited textiles, leathers, felts, etc., dyed with products of the American Aniline Products Co.

Takamine Laboratory, Inc.—Exhibited a diastatic extract, "Polyzine," and Newmalt, a substitute for malt extract; samples of imported Japanese chemicals.

Taylor Instrument Co.—Complete line of "Tycos" recording thermometers, recording and controlling instruments, thermoelectric and meteorological instruments.

Technical Association of Paper and Pulp Industries—A place for registration of members.

Tennessee Coal, Iron & R. R. Co.—Display of iron ore and by-products; coal and source of its by-products: washed coal, domestic coke, crude tar, benzole and toluol, crude light and heavy naphtha, etc.

Tennessee Power Co.—Views of their hydroelectric power house and equipment. Now supplying 56,000 H. P. to chemical and metallurgical industries.

Textile Colorist—A set of bound volumes of the publication.

Thermal Syndicate Co., Ltd.—Exhibited pure fused silica apparatus for laboratory and large scale industrial work. Also parts of "Vitreosil" H_2SO_4 concentrators, nitric acid condensers, spent acid denitrators and HCl cooling equipment, together with drawings showing construction of the complete installations. To demonstrate its resistance to extraordinary temperature changes a "Vitreosil" crucible was taken from an electric furnace at 1000° C. and plunged into cold water, without breaking.

Thwing Instrument Co.—Electrical pyrometers, high resistance and multiple recording machines; radiation thermometers.

Toch Brothers—A line of barium products mined and made in America. Dryers, enamels, water- and acid-proofing paints, cement colors, waterproofing cement compound, and leather and moleskin finished with their Japanner's Prussian blue. Pictures of many prominent buildings painted with their products.

Tolhurst Machine Works—Centrifugals of the following types were shown: suspended, self-balancing (in operation), acid wringer, laboratory, and solid curb, open-top type.

Uehling Instrument Co.—Fuel saving equipment: power plant economy apparatus, draft, vacuum and CO_2 recorders, and recording barometers.

The Union Sulfur Co.—Arsenic-free sulfur, guaranteed 99%.

United Cast Iron Pipe & Foundry Co.—A splendid showing of all shapes and sizes of gray iron castings.

United Dyestuff and Photochemical Co., Inc.—Exhibit of sulfur black paste and powder, benzoic acid, monochlorbenzol, dinitrochlorbenzol, dinitrophenol and photographic developer "Hydrono."

United Gas Improvement Co.—Residual products, such as refined water-gas tar, waterproofing pitch and brick filler. Distillates: carbolic acid, crude dead oil (light) and C. P. benzol.

United Lead Co.—Pieces of iron, steel, brass or copper pipe either lead, tin, brass or copper lined or covered; lined and covered fittings; lead and tin covered sheets and acid valves. Kemetaline. A small piece of lead pipe about 2,000 years old, from Rome.

U. S. Bureau of Census—Bulletins, maps, and charts giving data on chemical plants and related subjects.

U. S. Bureau of Foreign and Domestic Commerce—Publications, maps and charts.

U. S. Bureau of Mines—Five dummies equipped with different kinds of the latest devices for rescue work. A display dealing with the government work on radium. Scientific instruments, automatic mine door, etc.

U. S. Bureau of Standards—A table of Bureau Bulletins, a large display of scientific apparatus employed by the Bureau in its investigations; charts.

U. S. Smelting Co., Inc.—Electrolytic copper-refining tank in operation. Refined copper slabs. Products from its subsidiary companies: copper, spelter, zinc ores and concentrates, blast furnace slag, copper matte, cadmium (99.70), ores, silver and gold, etc.

The Universal Fibre Co.—Exhibit of seamless pulp packages and containers.

Valley Iron Works Co.—Exhibited two 250-lb. Vesuvius oxidizing sulfur burners, one of which was dismantled.

Virginia Smelting Co.—Specialists in glycerin, acids, quicksilver, wood pulp, nitrating cotton, etc.

Weiller Mfg. Co.—A working model of a diazotizing and precipitating machine. Also displayed samples of a finished product called "Sudan."

Werner & Pfleiderer Co.—Vacuum and laboratory types of the Universal kneading and mixing machine; outfit used for making fulminates for cartridges; laboratory size rubber masticator used for making rubber compounds; copper bowl, rapid dissolver was in operation.

Westinghouse Electric & Mfg. Co.—Models of automatic control panel, and type "C S" motor for chemical plants. Voltmeter; D. C. ammeters; fans; Thury automatic regulating system for electric furnace control; models of especially insulated coils for chemical plant installation.

Whitall-Tatum Co.—"Nonsol" glass beakers and flasks; also filter papers.

Williamsburg Chemical Co., Inc., Brooklyn, N. Y., showed samples of its monochlorbenzol, dinitrochlorbenzol, dinitrophenol and sulfur black paste and powder. Also exhibited Hydronol of the United Dyestuff & Photochemical Co., Inc., of Brooklyn, which is similar to the German Amidol.

Zaremba Co.—Showed a portion of a 40-in. single-effect evaporator with horizontal tubes. Parts and accessories for evaporator. Photographs of large installation, and detailed design of a crystallizing evaporator.

NOTES AND CORRESPONDENCE

PAPER AND PULP TECHNOLOGY COURSES AT THE UNIVERSITY OF MAINE

Editor of the Journal of Industrial and Engineering Chemistry:

I enclose a clipping from *The Chemical Engineer* for August, purporting to be an extract of a letter by A. D. Little in the Philadelphia *Ledger*. The date of its appearance in the *Ledger* is not given.

"There is no school of papermaking in the country, and one of our most urgent industrial needs is the establishment of special schools in this and other industries for the adequate training of foremen who shall possess a sufficient knowledge of fundamental scientific principles and methods to appreciate the helpfulness of technical research. The Pratt Institute at Brooklyn is fully alive to this demand and has shaped its courses admirably to meet it."

Mr. Little is the author of this statement, as it appeared in his annual report in February, 1913, as official chemist of the American Pulp and Paper Association. This statement is no longer true. It has not represented the facts since it was made, for in that same month of February, 1913, the University of Maine offered its first course in Pulp Mill Chemistry. Since that time this university has introduced ten courses, both classroom and laboratory, in Paper and Pulp Technology. Last year more than forty students in Chemical Engineering elected these courses.

The effort of the University of Maine to provide instruction in the principles and practice of paper and pulp manufacture has met with such success that this field has since been entered by several other institutions. Some graduate work has already been done at the University of Michigan and work in this field is contemplated by Syracuse University, Massachusetts Institute of Technology and McGill University.

It should be understood that the work at the University of Maine is not merely the following out in the laboratory of a few set formulas and their explanation in the classroom, as a trade school might do. The curriculum at Maine embraces instruction in the fundamentals of chemistry, physics, engineering, mathematics and languages.

Among the students in the Pulp and Paper curriculum have been men from New York, West Virginia, Michigan, Wisconsin, Minnesota, and even from China and India. Graduates are already widely scattered in the United States and Canada.

It, is, therefore, quite incorrect to say that there is no school of paper making in this country, even though we lack some expensive equipment and have not the extensive support and encouragement (compared with the schools of Germany and France) that ought to come from the Paper and Pulp Industry.

University of Maine
Orono, September 1, 1916
J. Newell Stephenson

A. C. S. PROFESSIONAL INDEX

Editor of the Journal of Industrial and Engineering Chemistry:

In your editorial "Something to Think About" in This Journal, **9** (1916), 768, you suggest that the A. C. S. maintain a card catalog showing the professional status of its members. The application of some such idea as this to the entire membership list of the society would undoubtedly be of much value to a large number of the members. As you point out, it is very easy to become a member of the society. Also there are institutions in the country which consider membership in the A. C. S. sufficient ground on which to extend their courtesies, and accept this qualification as an indication of personal responsibility.

As you probably know, the U. S. Department of Agriculture does maintain such a card catalog of all those employed in agricultural work under its jurisdiction.

This suggestion of yours is one worthy of serious consideration, not only by the industrial chemists but by every member of the American Chemical Society, whether he be industrial, educational, or research chemist. Personally, I trust the idea will be followed out, and that we shall have such a directory available to all members just as our present directory is.

Griffin, Georgia
September 11,1916
Fred H. Smith

CHEMISTS' PROTECTIVE ASSOCIATION

Editor of the Journal of Industrial and Engineering Chemistry:

While I feel that nothing is to be gained by a prolonged polemic discussion of the merits of Mr. Rollin G. Myers' proposal to form a "Chemists' Protective Association,"[1] I would like to close my discussion by pointing out that the keynote of my criticism of his proposal is that the efficiency of the individual worker and his attitude toward his work should be the basis of advancement. As a corollary to this proposition, I would add that I conceive it to be the duty of every chemist in charge of a laboratory to act as an inspiration to his men; to point out to those of promise who lack college training, by what means this lack can be made up (such means being for instance, work in Company schools where these are provided; the taking up of correspondence courses; evening study such as is afforded in many cities by the various evening schools, the extension work of Columbia University in New York City being a notable example; or where possible, actual attendance at some university or college, if for no longer a period than a summer session per year for several years) and, finally to encourage all their men, college-trained or otherwise continually to study and thus keep abreast of progress in chemical science. Here is where the effect of the American Chemical Society on the efficiency of the worker is felt. By becoming a member he gets the opportunity to meet men who are doing things well in chemical lines and through reading the journals he receives, he has an opportunity of keeping in touch with chemical progress all over the world. The use he makes of these opportunities depends solely on the man and if he makes the right use of them, I cannot see how he can fail to advance—measure his worth in any way you will.

On the other hand, Mr. Myers in his first article distinctly states in the second paragraph of the first column, p. 798, that the ends for which he advocates a "Chemists' Protective Association" are: "The first, to increase the financial return of chemists; the second, to raise chemistry to its rightful and just place among the professions." He then goes on to say: "The first end is the more important and cogent. For this reason the writer will make it play a predominant part in the discussion to follow." In view of the emphasis he thus places on the financial return to chemists, and the relation between personnel and wages, I hardly see how he can attribute to me the sentiment that "worth is expressed in earning capacity." Moreover, nothing of the sort was expressed in my former note, the nearest approach to such an idea being the statement that men capable of doing nothing but low-grade routine work should justly receive low salaries. This, of course, does not imply that all routine work is low-grade, for such is manifestly not the case. All routine work should be under the supervision of a competent and, preferably, a well trained man.

I have no objection to a broad definition of "Chemist" but I do object to one such as Mr. Myers proposes: one which by its very nature disheartens the ambitious young fellow, who, while lacking college training, is at work in a laboratory and meanwhile is making use of every chance to improve himself.

April 10, 1916
William C. Moore

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[1] This Journal, 7 (1915), 798; 7 (1915), 100, and 8 (1916), 383.

PERSONAL NOTES

The Fairmont Chemical Company, Fairmont, W. Va., will erect on Tygart Valley River a sulfuric acid plant, costing approximately $80,000, with a capacity of 10,000 tons per annum, to be operated by The Multiple-Tangent-System. An auxiliary plant for the manufacture of nitric acid will also be erected. The plans were by Ludwig A. Thiele, Columbus, Ohio, who will be the engineer in charge of construction.

Dr. H. S. Adams, of the department of physiological chemistry in the University of Chicago, has accepted a position as research chemist and pharmacologist at the biological laboratories of E. R. Squibb & Sons, New Brunswick, N. J. Dr. Anderson, recently chief pharmacologist of the government, is director of the laboratory.

Prof. Clarence W. Balke has resigned his professorship of inorganic chemistry at the University of Illinois and is now in full charge of the research work of the Pfanstiehl Company at North Chicago.

Arthur Marion Brumback, professor of chemistry in Denison University since 1905, and a member of the American Chemical Society, died on August 12th, aged forty-seven years.

The Sixty-eighth Assemblage of the Eastern New York Section of the A. C. S. took place on September 23rd, and was in the nature of a fall outing. Various points of geochemical and geological interest were visited and expositions and explanations given by Prof. J. H. Stoller.

Dr. L. H. Baekeland will represent the American Chemical Society on the Natural Research Council being organized by a committee of the National Academy of Sciences.

The 129th Regular Meeting of the Pittsburgh Section of the A. C. S. was held at the Mellon Institute on September 21st, with the following program: "Revision of Our Chemical Import Statistics" and "Ten-Year Index to Chemical Abstracts," by Secretary W. C. Cope; "The Properties of Some European Bonding Clays," by A. V. Bleininger, U. S. Bureau of Standards.

W. C. Phalen has resigned his position as geologist in the U. S. Geological Survey and entered on his new duties as a mineral technologist in the Bureau of Mines, with headquarters in Washington.

Sir Charles Bedford has been appointed secretary of the Association of British Chemical Manufacturers. Address: Broadway Chambers, Westminster, S. W.

Dr. Arthur Lederer has resigned his position as chief chemist of the Sanitary District of Chicago, and will take up the course for health officers at Harvard Technology, Boston.

The following appointments, of interest to chemists, have been made at the Massachusetts Institute of Technology: Frederick G. Keyes, associate professor of physico-chemical research; C. K. Reiman, instructor in inorganic chemistry; E. W. Westcott, research associate in applied chemistry; R. E. Wilson, research associate in applied chemistry; C. L. Burdick, research associate in physical chemistry.

At the Throop College of Technology the following appointments have been made in the chemistry department for the next year: W. N. Lacey, University of California, instructor in inorganic and industrial chemistry; J. H. Ellis, University of Chicago and Massachusetts Institute of Technology, research associate in physical chemistry; and Ludwig Rosenstein, University of California, professor in inorganic chemistry.

The regular September meeting of the Chicago Section of the A. C. S. took place on September 15th, with the following program: "The Manufacture of Synthetic Phenol," by Prof. Harry McCormack, Armour Institute, Chicago; "Synthetic Phenol Resins for Printing Plates—A Special Application of Anhydrous Resins," by L. V. Redman, A. J. Weith and F. P. Brock.

Mr. A. B. Carter, formerly curator at the University of Chicago, is now associated with the Central Scientific Company.

The honorary degree of Doctor of Science was conferred upon Dr. Otto K. Folin, the Hamilton Kuhn professor of biological chemistry at Harvard, by the University of Chicago at the Summer Convocation.

Dr. Jean Felix Piccard, of the University of Lausanne, Switzerland, has accepted the assistant professorship of organic chemistry at the University of Chicago for the coming year.

Dr. Charles L. Parsons sails soon for Europe, where he will spend two months visiting plants in connection with the U. S. work preparatory to constructing a nitrate plant

Fire has wrecked the plant of the Hydrocarbon Products Company at Lorillard, two miles from Keansburg, N. J. There were between 15,000 and 20,000 gallons of gasolene in the plant in tanks, and two of these blew up. The loss is in excess of $50,000.

The body of Prof. Charles S. Prosser, head of the geology department of Ohio State University, and a well-known scientific writer, was found floating in the Olentangy River, near the University campus, on September 12th. Prof. Prosser, born in Columbus, N. Y., March 24, 1860, was a graduate of Cornell University and before coming to Ohio State had been instructor at Cornell, Washburn College and Union College. He was an assistant geologist of the U. S. Geological Survey and of the State Geological Surveys of Kansas, New York, Ohio and Maryland; also a fellow in the Geological Society of America and a member of many other scientific societies.

Dr. Leroy Clark Cooley, professor of physics in Vassar College from 1874 to 1907, died at his home in Poughkeepsie, N. Y., on September 20th, aged 82 years. He was born in Point Peninsula, N. Y., and was graduated in 1855 from the New York State Normal College, and in 1858 from Union College. He was the author of a textbook on physics, which was long used in colleges, and of many other scientific and literary works. Dr. Cooley leaves a widow, five daughters and a son.

Dr. Frank Maltauer, formerly of the Cincinnati Board of Health, has accepted an appointment as associate professor of bacteriology and public health at the College of Medicine, University of Tennessee.

The Council of the American Leather Chemists' Association has outlined the following work which will be subjects for Committee investigation during the winter 1916–17: Analysis of Tannery Effluent; Dye Testing of Leather with Artificial and Natural Dyestuffs; Solubility of Hide Substance in Salt (NaCl) Solutions and Effect of Alkali on the Soaking of Dry Hides; Determination of the Ash of Tanning Materials and Leather; Disinfection of Hides; Analysis of Sulfonated Oils; Comparative Analysis of Tanning Materials by the A. L. C. A.; Official Methods; Effect of Hard Waters on Tannin; Determination of Free Sulfuric Acid in Leather.

GOVERNMENT PUBLICATIONS

By R. S. McBride, Bureau of Standards, Washington

NOTICE—Publications for which price is indicated can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Other publications can usually be supplied from the Bureau or Department from which they originate. Commerce Reports are received by all large libraries and may be consulted there, or single numbers can be secured by application to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington. The regular subscription rate for these Commerce Reports mailed daily is $2.50 per year, payable in advance, to the Superintendent of Documents.

GEOLOGICAL SURVEY

Structure of the Vicksburg-Jackson Area, Mississippi (With Special Reference to Oil and Gas). Oliver B. Hopkins. Bulletin 641–D, from Contributions to Economic Geology, 1916, Part II, pp. 93–120. Published July 18, 1916. "The object of this report is to show which of the areas in west-central Mississippi that were examined by the Survey are considered favorable and which unfavorable for the accumulation of oil, to discourage drilling in the unfavorable localities and thus to aid those interested in making conclusive tests to determine the presence or absence of oil and gas in the region."

An Anticlinical Fold near Billings, Noble County, Oklahoma. A. E. Fath. Bulletin 641–E, from Contributions to Economic Geology, 1916, Part II, pp. 121–138. A description of the anticlinical fold and a discussion of the possibilities of developing an oil and gas field here are given in this report.

Pottery in 1915. Jefferson Middleton. Separate from Mineral Resources of the United States, 1915, Part II. Published July 26, 1916. A study of the tables shows that the pottery industry has made much progress, that the value of the domestic output has nearly doubled in the last 15 years, that from an industry of minor importance, both as to quality and value, the pottery industry has risen to great importance, both as to quality and value, supplying large quantities of wares of ever-increasing excellence, and that this country has reached a state where it is practically independent of the old world in manufacture of pottery, more than four-fifths of the wares now sold being domestic. The imports of pottery, which have always been a large factor in consumption, reached their maximum value in 1907 and have declined since that date, the acceleration of the decline in the last two years being doubtless due to the European war. In 1915 they were valued at less than half as much as in 1907.

The exports of pottery have never been very great, especially of wares of the highest grade, but the latter have been increasing and in 1915 showed their maximum value.

"The value of all domestic pottery marketed in 1915 was $37,325,388, an increase of $1,927,227, or more than 5 per cent, over 1914. This value was the largest on record except that for 1913, which exceeded it by about 2 per cent. The pottery imports decreased $1,770,507, or 21 per cent, and the ratio of production to consumption was the highest recorded. Every product, as classified in this report, except one—China—increased in value in 1915, compared with 1914. White ware, the product of largest value and the one of most general interest, reached its maximum value in 1915, as did also the commonest of pottery products, red earthenware.

"The value of white ware, including china, but excluding sanitary ware and porcelain electrical supplies, was $17,654,398 in 1915, an increase of $301,633 over 1914. If the value of sanitary ware and porcelain electrical supplies be added, the total for 1915 would be $30,318,816, or more than 81 per cent of the value of all pottery products and an increase of $961,512."

Feldspar in 1915. Frank J. Katz. Mineral Resources of the United States, 1915, Part II, pp. 43 to 53. Published June 26, 1916. "The marketed production of feldspar in 1915 was nearly 16 per cent less in quantity than in 1914. On the other hand, the decrease in value was very slight because of the small increase in the price per ton of crude spar and a material increase in the price per ton of ground spar; also, because of a larger proportion of spar first marketed in ground form. The quantity and value for 1915 were also less than for 1913, but much greater than for former years.

"The average price for spar sold crude in 1915 was $3.46 per long ton as compared with $3.43 in 1914 and $3.41 in 1913. The average price in 1915 of ground spar was $8.33 per short ton as compared with $7.40 in 1914 and $8.31 in 1913. The average price per short ton for the entire production in 1915, that is, combined sales of both crude and ground spar was $5.54."

This report also includes a discussion of the composition and properties of feldspar, geology and mineralogy, commercial availability, methods of mining, and milling, and the uses of feldspar.

Silica in 1915. Frank J. Katz. Mineral Resources of the United States, 1915, Part II, pp. 55–60. Published June 13, 1916. "Quartz from quartz veins, pegmatite, and quartzite, amounting to 112,575 short tons, valued at $273,553, was sold in 1915. This was a decrease of 27 per cent in quantity and of 24 per cent in value, as compared with 1914. The decrease was in both crude and ground materials, but greater for the latter.

"The average price of crude quartz in 1915 (exclusive of large quantities for metallurgical purposes, which were valued at 50 to 85 cents per ton) was $3.30, as compared with $2.44 in 1914. Prices of ground quartz ranged from $6 to $20 per ton and averaged $10.56, as compared with $9.09 in 1914.

"So far as can be learned no flint (proper) or chert was produced for consumption as crushed or ground silica or for use as pebbles in grinding mills in the United States in 1915."

The statistics of tripoli and diatomaceous earth are given in more detail in the chapter on abrasive materials.

Talc and Soapstone in 1915. J. S. Diller. Mineral Resources of the United States, 1915, Part II, pp. 61–4. Published June 27, 1916. "The United States leads the world in the production and use of talc and soapstone, and in 1915 the production in this country was greater than ever before.

"The domestic output of talc and soapstone for the last 15 years has ranged from a minimum of 86,901 short tons, valued at $840,060, in 1903, to 186,891 short tons, valued at $1,891,582 in 1915, and the development has been approximately uniform.

"In 1915 there were 166,336 short tons of talc produced and marketed in the United States, at a value of $1,401,197. This exceeded the output in 1914 by 15,248 short tons and $60,323 in value.

"In the production of soapstone the United States has first rank among all countries. The output in 1915 was 20,555 short tons, valued at $490,385, a decrease of 653 short tons, or 3 per cent, in quantity and of 6 per cent in value as compared with the production of 1914."

Abrasive Materials in 1915. Frank J. Katz. Mineral Resources of the United States, 1915, Part II, pp. 65–80. Published June 27, 1916. "The total value of the abrasive materials which are considered in this chapter and which entered trade increased about 22 per cent in 1915, as compared with 1914. There was an increase in domestic production of natural and artificial abrasives, but a decrease in imports. The value of natural abrasives produced increased about 33 per cent; of artificial abrasives, about 32 per cent; and imports decreased about 26 per cent.

"The value of abrasive materials imported for consumption in the United States in 1915 was:

Millstones and burrstones	$ 17,027
Grindstones	68,892
Hones, oilstones, and whetstones	14,247
Emery and corundum	271,649
Diatomaceous earth, tripoli, and rottenstone	27,333
Pumice	65,691
Diamond dust and bort	75,944
Total	540,783

"The value of natural abrasives produced and marketed in the United States in 1915 was:

Millstones	$ 53,480
Grindstones and pulpstones	648,479
Oilstones and scythestones	115,175
Emery	31,131
Garnet	139,584
Abrasive quartz and feldspar	(a)
Diatomaceous (infusorial) earth and tripoli	611,021
Pumice	63,185
Total	$1,662,055

(a) See chapter on quartz.

"The artificial abrasives here considered include carborundum and crystolon, which are carbides of silicon; alundum and aloxite, which are crystalline aluminum oxides; and crushed steel and steel shot. So far as known to the Survey, these are the only artificial abrasives manufactured in the United States. Artificial abrasives with other names are either special forms of the above-named products marketed under trade names or are imported products. Artificial abrasives sold in the United States in 1915 amounted to 37,684,000 pounds valued at $2,248,778."

Graphite in 1915. Edson S. Bastin. Mineral Resources of the United States, 1915, Part II, pp. 81–93. Published June 26, 1916. "The production of natural graphite in the United States in 1915 was approximately 19 per cent, by value, of the graphite imported. In addition to natural graphite, this country produced a considerable quantity of manufactured graphite in the electric furnaces at Niagara Falls. The imports came mainly from the Island of Ceylon."

Potash Salts, 1915. W. C. Phalen. **With Simple Tests for Potash.** W. B. Hicks. Mineral Resources of the United States, 1915, Part II, pp. 95–133. Published June 30, 1916. "The year 1915 was an epoch-making one in the domestic potash industry. There was produced in this country that year soluble potash salts valued at $342,000. Quantities are not given for the reason that the product sold came from diverse sources and contained varying proportions of potash. Though this figure for value is of interest as a small beginning in the domestic potash-salts industry, it is practically of no importance in comparison with the total needs of the country, as the quantity it represents is consumed in less than a week in normal time.

"The price of potash salts has increased greatly since the domestic scarcity began to be felt. From a normal price of $35 to $40 a ton for high-grade agricultural salts, prices have advanced until in the spring of 1916 chloride and sulfate were quoted at ten times those figures or more. In April, 1916, chloride was nominally quoted at $425 a ton and sulfate from $350 to $400 a ton.

"Experimental work on the production of potash salts from different sources was most active during 1915, and in some places experiment has passed into active construction of works for the production of soluble potash salts."

There are included in this paper brief descriptions of the various methods of potash recoveries as investigated by the Geological Survey and the Bureau of Soils, including recovery from bittern, Nebraska lakes, alunite, silicates, kelp, cement industry by-product, and numerous miscellaneous sources.

There is also included a section describing simple tests for potash both for qualitative and quantitative determinations.

Gypsum in 1915. Ralph W. Stone. Mineral Resources of the United States, 1915, Part II, pp. 151–9. Published July 19, 1916. "Although the output of gypsum mined decreased in 1915, the decrease was only a little more than 1 per cent, and the decrease in value of products marketed was only about 4 per cent. As a matter of fact, the quantity mined exceeded that of all previous years except three, 1912, 1913, and 1914."

This pamphlet includes a summary of the trade and manufacturing conditions, imports, exports, production statistics, methods for preparing gypsum for markets and the uses of uncalcined and calcined products.

Secondary Metals in 1915. J. P. Dunlop. Mineral Resources of the United States, 1915, Part I, pp. 21–8. Published July 15, 1916. "'Secondary' metals are those recovered from scrap metal, sweepings, skimmings, and drosses, and so called to distinguish them from the metals derived from ore, which are termed 'primary metals.'"

Secondary metals recovered in the United States in 1915 amounted to the following figures:

	Quantity (short tons)	Value
Secondary copper, including that in alloys other than brass	99,937	$33,498,882
Remelted brass	137,500	40,788,000
Secondary lead	36,400	7,416,600
Recovered lead in alloys	42,500	
Secondary spelter	52,900	14,433,600
Recovered zinc in alloys other than brass	5,300	
Secondary tin	5,250	10,554,180
Recovered tin in alloys	8,400	
Secondary antimony	2	1,811,568
Recovered antimony in alloys	3,100	
Secondary aluminum	5,700	5,802,100
Recovered aluminum in alloys	2,800	
Total		$114,304,930

Manganese and Manganiferous Ores in 1915. D. F. Hewett. Mineral Resources of the United States, 1915, Part I, pp. 29–43. Published July 25, 1916. "The year 1915 was eventful in the manganese industry of the United States. There has been great increase in the production of each variety of ores, although the total quantity is still far below the country's need. New deposits that may become important sources of production have been explored in several states and old mines have been reopened. In the manganese alloy industry several new producers of ferromanganese have entered the field and several companies that have not attempted to make alloys for some years have again become producers.

"The domestic production of manganese ore during 1915 was 9,709 long tons, about four times the production for 1914 and the greatest output since 1901.

"The production of manganiferous iron ores was 801,290 tons, most of which came from established sources. Of this quantity, 69,416 tons contained more than 15 per cent manganese and most of this was used in the manufacture of low-grade ferromanganese, whereas those ores which contained less than 15 per cent manganese were used largely in making high manganese pig iron."

There is also included a discussion of general sources of manganese, data as to the production, imports, and world trade conditions in this industry, and interesting metallurgical sections regarding manganese ores, manganiferous zinc residuals, ferromanganese and spiegeleisen both in this country and abroad.

Silver, Copper, Lead and Zinc in the Central States in 1915. J. P. Dunlop and B. S. Butler. Mines Report, Mineral Resources of the United States, 1915, Part I, pp. 45–137. Published July 28, 1916. "The production of silver in the Central

States in 1915 was 647,553 fine ounces, which, at the average price of 5.07 per fine ounce (4.6 cents lower than in 1914), was valued at $328,309, as compared with 482,983 fine ounces valued at $267,089, in 1914. Nearly all the silver that is produced in the Central States is recovered identically in the production of other metals.

"The mine production of copper in the Central States in 1915 was from Michigan and Missouri, the first-named State, as in other years, contributing nearly the entire output, which amounted to 265,685,538 lbs.

"The mine production of lead in the Central States in 1915 was 222,548 short tons, which, rated at the average New York price for the metal for the year of 4.5 cents a lb. ($94 a ton), was valued at $15,899,910 in 1914.

"The production of zinc in the Central States in 1917, based on mine returns with a deduction for separating and smelting losses, was 215,889 short tons, valued at $53,540,472. The value is computed at 12.4 cents per lb. of spelter ($248 per ton), the average sales reported by the smelters for the metal."

SANITARY LEGISLATION

The following items from the Public Health Reports (on the pages of Volume 31, indicated in parenthesis) relate to recently enacted sanitary legislation of chemical interest:

Production, Care, and Sale of Milk. Ordinances covering various phases of the subject and including standards for milk quality or purity are to be found as follows:

San Antonio, Texas, Ordinance adopted June 24, 1915. (1567.)

Regulation of the Toledo, Ohio, Board of Health, adopted June 10, 1915. (1580.)

Tulsa, Oklahoma, Ordinance No. 1403, adopted July 17, 1915. (1661.)

New York State Legislative Act, Chapter 144, adopted April 6, 1916. (1814.)

West Virginia Public Health Council Regulations No. 43–68, adopted January 25, 1916. (1884–7.)

Bakersfield, California, Ordinance adopted April 3, 1916. (1899–1901.)

Laboratory Services in Animal Industry. Chapter 155 of the Massachusetts Legislative Act adopted April 26, 1916, authorizes the State Department of Health to perform necessary services in its laboratory for the Department of Animal Industry under conditions mutually agreed upon by the two departments. (1806.)

CONGRESSIONAL COMMITTEES

The following reports rendered by Congressional Committees bear upon subjects of chemical interest.

Virus, Serum, and Toxin Act. House Report 814, presented June 9. 7 pp. Paper, 5 cents. Report by the Committee on Agriculture to accompany House Bill 15914, which authorizes the Secretary of Agriculture to license establishments for and to regulate the preparation of virus, serums, toxins, and analogous products for use in the treatment of domestic animals.

Importation of Virus, Serums, Toxins. House Report 845, from the Interstate and Foreign Commerce Committee, was presented June 24 to accompany House Bill 199. 2 pp.

Natural Resources Useful for Chemical Products. Report of House Committee on Industrial Arts and Expositions on House Bill 10650 to develop and promote the industries utilizing natural resources for chemical products by an exhibit of certain Government bureaus at the Second National Exposition of Chemical Industries. This is the report on the hearings held May 11. The bill has not yet been reported.

Grain Grades. Committee on Agriculture and Forestry of the Senate hearings on House Bill 12717 (Agriculture Appropriation Bill) which includes regulations for the grading of grains. The hearings reported in this pamphlet of 86 pages are those held May 19 and 20.

Coal and Asphalt Deposits. Two reports, one on hearings and one to accompany House Bill 12544, have been prepared: The first in two parts, one of which was reported in an earlier number. Part 2 of the report on hearings covers 15 pages regarding the sale of coal and asphalt deposits and segregated mineral lands in the Choctaw and Chickasaw nations. The report on this bill was presented June 29 as House Report 888.

Leases of Oil and Gas Lands. Report by the Indian Affairs Committee on House Bill 16396, submitted July 14. 3 pp. The Senate Report on the same general subject by the Senate Committee on Indian Affairs in Senate Report 712 submitted July 22 to accompany Senate Bill 638.

Standard Lime Barrels. Hearing minutes and report to accompany Senate Bill 5425 have been presented by the Coinage, Weights and Measures Committee of the House. Dated respectively June 1 and June 8.

NAVAL CONSULTING BOARD

Industrial Research Stations. Senate Document 446, dated May 24. 25 pp. Paper, 5 cents. This is a letter of W. R. Whitney, Chairman of the Committee on Chemistry and Physics of the Naval Consulting Board, transmitting a circular letter to various scientists and including extracts from replies received. The subject discussed is the proposal to establish industrial research stations in connection with land grant colleges in the several states.

SMITHSONIAN INSTITUTION

Annual Report. 544 pages. Cloth, 85 cents. Publication No. 2410. This report includes among other articles the following three of some chemical interest:

(1)—**Constitution of Matter and Evolution of Elements.** SIR ERNEST RUTHERFORD.

(2)—**Place of Forestry among Natural Sciences.** HENRY S. GRAVES.

(3)—**Vaccine.** L. ROGER.

Sources of Nitrogen Compounds in the United States. CHESTER G. GILBERT. Publication No. 2421, issued June 30. 12 pp. Price on application. The same publication which includes as a sub-title "Natural Occurrence of Nitrogen and its Adaptability to Use" is available as Senate Document 471. Dated June 22.

NATIONAL MUSEUM

Handbook and Descriptive Catalogue of Meteorite Collections in National Museum. GEORGE P. MERRILL. 207 pp. and 40 plates. Bulletin 94. Paper, 55 cents.

BUREAU OF FISHERIES

Fairport Fisheries Biological Station: Its Equipment, Organization, and Functions. ROBERT E. COKER. Bureau of Fisheries Document 829, issued July 7. 25 pp. and 7 plates. Paper, 20 cents.

OFFICE OF PUBLIC ROADS

The Result of Physical Tests of Road-Building Rock. PRÉVOST HUBBARD AND FRANK H. JACKSON. Agricultural Department Bulletin 370, issued July 20. 100 pp. Paper, 15 cents.

DEPARTMENT OF AGRICULTURE

The following articles in the Journal of Agricultural Research are of chemical interest:

Rape as Material for Silage. A. R. LAMB AND JOHN M. EVVARD. Journal of Agricultural Research, 6 (July 3), 527–533.

Effect of Autolysis upon Muscle Creatin. RALPH HOAGLAND AND C. N. MCBRYDE. Journal of Agricultural Research, 6 (July 3), 535–546.

Digestibility of Very Young Veal. C. F. LANGWORTHY AND A. D. HOLMES. Journal of Agricultural Research, 6 (July 17), 577–587.

Influence of Calcium and Magnesium Compounds on Plant Growth. F. A. WYATT. Journal of Agricultural Research, 6 (July 17), 589–616.

Digestibility of Hard Palates of Cattle. C. F. LANGWORTHY

AND A. D. HOLMES. Journal of Agricultural Research, 6 (July 24), 641–648.

Some Properties of the Virus of the Mosaic Disease of Tobacco. H. A. ALLARD. Journal of Agricultural Research, 6 (July 24), 649–672.

BUREAU OF MINES

Report of the Selby Smelter Commission. J. A. HOLMES, EDWARD C. FRANKLIN AND RALPH A. GOULD. Bulletin 98. 538 pp. and 41 plates. Paper, $1.25. See THIS JOURNAL 7 (1915), 41.

A Bibliography of the Chemistry of Gas Manufacture. W. F. RITTMAN AND M. C. WHITAKER. Compiled and arranged by M. S. HOWARD. Technical Paper 120. 29 pp. This is a bibliography of 274 entries (including some duplicates) of articles on carbonization or distillation of coal and various other phases of the gas generating processes in use, together with articles on some of the physical-chemical phases of the subject.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Potash Production in California and Potash from Kelp. THOMAS H. NORTON. Reprint from Commerce Reports. 13 pp. This account gives the summary of the efforts which have been made to relieve the potash shortage in this country.

Japanese Cotton Goods Industry and Trade. GEORGE N. WEST. Supplementing the Special Agents Series 86. 12 pp. Paper, 5 cents. This is a collection of recent consular reports on the cotton goods business in Japan.

COMMERCE REPORTS—AUGUST 1 TO 29 1916

Exportation of **caustic soda** from Japan, formerly prohibited, is again permitted owing to a great increase in domestic production. (P. 439.)

Ammonium sulfate, made from synthetic ammonia prepared by the Haber process, is now being used extensively in fertilizers in Germany. The estimated output for 1916 is 300,000 tons of ammonium sulfate, against 30,000 tons in 1913. By 1917 it is estimated that the German production of nitrogenous fertilizers, *viz.*, ammonia from coke, synthetic ammonia, and calcium nitrate, will be more than equivalent to the normal German import of Chilean nitrate. (Pp. 440–2.)

In spite of increased exports of **matches,** the supply of potassium chlorate in Japan now exceeds the demand. There are 33 match factories in operation. (P. 538.)

The following **dye-producing plants** are found in the Philippines, usually however not in large quantities. Indigo, sappan (which contains the same dye as does brazil wood), mangrove, bancudo, mango, berberine, and turmeric. (P. 566.)

The Japanese production of **gold, silver, copper, antimony,** and **zinc** shows marked increases. (P. 575.)

The chief **fertilizers** used in India consist of **oil cake, fish manure,** and **plant ashes.** (P. 596.)

Pepsin is being used in Canada as a substitute for **rennet** in cheese making. (P. 599.)

Arrangements are being made for the development of **bauxite** deposits in British Guiana. (P. 602.)

The Spanish cultivation of **peanuts,** chiefly for oil, is increasing. (P. 613.)

The production of **uranium ore,** and uranium and radium compounds in Bohemia in 1915, shows an increase over 1914. The **radium** compounds in 1915 contained 1.75 g. radium. (P. 627.)

The Argentine government will erect a plant for the production of **aluminum sulfate,** used extensively for clarifying water. (P. 631.)

Sansevieria **fiber,** from Porto Rico and Haiti, is now available for rope, etc., but requires special machinery to handle it. (P. 637.)

Efforts are being made to establish a plant for the extraction of **quebracho wood** in Paraguay, to produce 15,000 tons of extract per year. (P. 643.)

The New Zealand government is to engage in the **kauri gum** industry. Most of this gum is exported to the United States. (P. 645.)

Efforts are being made to increase the use of **fish offal** as fertilizer in Canada. (P. 647.)

A study of **kelp** harvesting has failed to show any evidence of damage to fish or shell fish. (P. 655.)

The production of **bleaching materials** in the United States in 1914 including chlorine, chloride of lime, sodium hypochlorite, hydrogen peroxide, sodium peroxide, sulfur dioxide, etc., shows a marked increase (54 per cent) over 1909. (P. 677.)

Copper mines in New Brunswick, Canada, that have been idle 16 years, are to be reopened. (P. 683.)

The figures for the United States **production of acids** in 1909 and 1914 are given, showing in most cases an increase in both amount and value in 1914. (P. 694.)

A conference was held in Yorkshire, England, to arrange for **textile research** in the University of Leeds and technical schools. (P. 700.)

Export of **tungsten** and **molybdenum** ores from Japan has been subjected to restrictions. (P. 741.)

Extensive deposits of **kaolin** believed to be suitable for china, etc., have been found in Paraguay. (P. 746.)

Various processes for using the residue from the **sulfate paper** pulp industry are discussed. In Germany the waste liquor is neutralized with lime, filtered through coke, and evaporated to a nearly dry pitch-like resin known as "zellpech" (or "celpech"). This material is used as a binder in coal briquets, ore **briquets,** artificial stone and molding sand; and for **filling cotton** goods; and impregnating sail cloth, cords, nets, etc. In Sweden **alcohol** is being made successfully from the waste sulfate liquor. (P. 782.)

Production and export of **nitrate** from Chili is increasing though still below former maximum output. (P. 788.)

The use of **copra** (coconut oil in margarin) in Netherlands has increased, owing to shortage of vegetable and animal oils. (Supplement 9*b*.)

SPECIAL SUPPLEMENTS ISSUED IN AUGUST, 1916

GREECE—7*a*
NETHERLANDS—9*b* and *c*
SPAIN—15*d*
UNITED KINGDOM, GLASGOW—19*i*
MEXICO—32*a*
ADEN—49*a*
CHINA—52*c*
PORTUGUESE EAST AFRICA—76*a*

EXPORTS TO THE UNITED STATES. (PP.)

SWANSEA, WALES—(482)
Oxalic acid
Nickel salts
Copper matte
Hides
Tin plate
MALAY STATES—(516)
Rubber
Tin
Gold
Tungsten ore
ROTTERDAM—Sup. 9*c*
Beeswax
Carbolic acid
Formic acid
Tartaric acid
Cream of tartar
Dextrin
Fusel oil
Glycerin
Gum copal
Gum damar
Madder
Magnesite
Artificial musk
Potassium cyanide
Sodium cyanide
Quinine sulfate
Fibers
Glue
Hides
Rubber
Manganese ore
Oleostearin
Paints
Paper
Paper stock
Paraffin
Saccharin
Starch
Tin

BOLIVIA—(485)
Tungsten ore
Antimony ore
HONDURAS—(651)
Sugar
Hides
Rubber

SPAIN—Sup. 13*d*
Copper
Copper ore
Hides
Iron ore
Pyrites
Lead

GLASGOW—Sup. 19*i*
Aluminum
Aluminum sulfate
Bone char
Corundum
Creosote oil
Tanning extracts
Magnesite
Fire brick
Fertilizers
Hides
Manganese ore
Paper stock
Sperm oil
Sumac extract

NORTHERN CHINA—Sup. 52*c*
Soya bean oil
Talcum
Hides

HONGKONG—(760)
Tin
Cassia
Antimony

MEXICO—Sup. 32*a*
Hides
Oil cake
Rubber
Sesame
Copper
Lead
Zinc ore
Arsenious oxide
Cottonseed oil
Glycerin
Graphite
Sugar
Alcohol
Antimony ore
Beeswax
Bones
Guayule rubber
Tin
Vegetable wax
Mercury
Chicle
Petroleum
Onyx
Copra
GREECE—Sup. 7*a*
Licorice
Gum mastic
Marble
Olive oil
Opium
Chromite
Emery
Magnesite
Paints
Hides
Amyl alcohol
Soap
Saffron
MOZAMBIQUE—Sup. 76*a*
Mangrove bark

NEW PUBLICATIONS

By Irene DeMatty, Librarian, Mellon Institute of Industrial Research, Pittsburgh

Analysis: Elementary Qualitative Analysis; A Laboratory Guide. A. B. Dales and O. L. Barnebey. 16mo. 205 pp. Price, $1.25. John Wiley & Sons, New York.

Centrifugal Pumps and Suction Dredges. E. W. Sargeant. 8vo. 196 pp. Price, 10 s. 6 d. Charles Griffin & Co., London.

Cereals: Die Chemie der Ceralien. F. Roehmann. 8vo. 28 pp. Price, M 1.50. F. Enke, Stuttgart.

Chemical Plants: A Manual of Chemical Plant. Part V. S. S. Dyson. 8vo. Price, 2 s. 6 d. The Dover Printing & Publishing Co., Dover.

Earth Pressure, Retaining Walls and Bins. William Cain. 8vo. Price, 10 s. 6 d. Chapman & Hall, London.

Economic Geology. Heinrich Ries. 4th Ed. 8vo. 860 pp. Price, $4.00. John Wiley & Sons, New York.

Engineering: Bibliography on "English for Engineers" with Selected Lists of Technical Books for Graduates in Civil, Electrical, Mechanical and Chemical Engineering. W. O. Sypherd. 12mo. 63 pp. Price, $0.25. Scott, Foresman & Co., Chicago.

Engines: Practical Handbook of Gas, Oil and Steam Engines, Stationary, Marine, Traction; Gas Burners, Oil Burners, etc. J. B. Rathbun. 12mo. 370 pp. Price, $1.00. C. C. Thompson Co., Chicago.

Foods: Preservatives and Other Chemicals in Foods. Otto Folin. 18mo. Price, 2 s. 6 d. Clarendon Press, London.

Hydraulics: A Textbook of Practical Hydraulics. James Park. 8vo. 300 pp. Price, 12 s. 6 d. Charles Griffin & Co., London.

Illumination: Modern Illumination, Theory and Practice. 16mo. 273 pp. Price, $1.00. Frederick J. Drake & Co., Chicago.

Indicators: Der Indikator und die Indikatordiagramm. W. Wilke. 8vo. Price, M 7.50. Otto Spamer, Leipzig.

Inorganic Chemistry: Laboratory Manual of Inorganic Chemistry. L. C. Newell. 12mo. 240 pp. Price, $0 60. D. C. Heath & Co., New York.

Light and Power Mains: The Localization of Faults in Electric Light and Power Mains. F. C. Raphael. 3rd Ed. 8vo. 217 pp. Price, 8 s. 6 d. "The Electrician."

Machine Shop Library. 9 vol. 8vo. McGraw-Hill Book Co., New York.

Motor Wheels: Das moderne Motorrad, seine Konstruktion, etc. G. O. Caesar. 8vo. 139 pp. Price, M 2.80. R. C. Schmidt & Co., Berlin.

Organic Compounds: Analyse und Konstitutionsermittlung organischer Verbindungen. Hans Meyer. 8vo. 323 pp. Price, M 44.80. Julius Springer, Berlin.

Petroleum: The American Petroleum Industry. R. F. Bacon and W. A. Hamor. 2 vol. 8vo. 975 pp. Price, $10.00. McGraw-Hill Book Co., New York.

Plant Physiology: Some Recent Researches. W. R. G. Atkins. 12mo. 323 pp. Price, $2.40. The Macmillan Co., New York.

Steam Power. C. F. Hirshfeld and T. C. Ulbricht. 8vo. 428 pp. Price, $2.00. John Wiley & Sons, New York.

Steel: The Heat Treatment of Steel. Harry Brearley. 2nd Ed. 8vo. 223 pp. Price, $3.50. Longmans, Green & Co., New York.

Tables: Electrical Tables and Engineering Data. H. C. Horstmann and V. H. Tousley. 16mo. 331 pp. Price, $1.50. Frederick J. Drake & Co., Chicago.

Thermodynamics: Einfuehrung in der technischen Waermelehre. Richard Vater. 8vo. 112 pp. Price, M 1.25. B. G. Teubner, Leipzig.

Transformers: Fortschritte im Transformatorenbau. R. Eder. 8vo. 88 pp. Price, M 2.50. Hachmeister & Thal, Leipzig.

Yeast: Die wirtschaftliche Bedeutung der Hefe als Nahrungs-, Futter-, und Heilmittel. Max Winckel. 8vo. Price, M 0.70. Carl Gerber, Munich.

RECENT JOURNAL ARTICLES

Aluminium: How Aluminum Sheets are Rolled. *Iron Trade Review*, Vol. **59** (1916), No. 9, pp. 423–424.

Asbestos: Studien ueber Asbest. Fritz Bayer. *Kunststoffe*, Vol. **6** (1916), No. 12, pp. 146–149.

Blast Furnace: Commercial Considerations Concerning the Blast Furnace. J. E. Johnson, Jr. *Metallurgical and Chemical Engineering*, Vol. **15** (1916). No. 5, pp. 235–244.

Boiler Content: Bestimmung des Teilinhaltes liegender Kessel. Wilhelm Kiby. *Chemiker-Zeitung*, Vol. **40** (1916), No. 75, pp. 540–541.

Castor Oil: Zur Kenntnis des Rizinusoels. W. Fahrion. *Chemische Umschau*, Vol. **23** (1916), No. 6, pp. 71–72.

Condensers: Factors that Influence the Selection of a Condenser. H. J. MacIntire. *Power*, Vol. **44** (1916), No. 10, pp. 343–345.

Copper Mines: Two Great Copper Mines Compared. P. B. McDonald. *Mining and Scientific Press*, Vol **113** (1916), No. 11, pp. 391–393.

Cottonseed Oil: Kottonoel-Soapstock und seine Verarbeitung. H Keutgen. *Chemische Rundschau*, Vol. **23** (1916), No. 6, pp. 73–75.

Counter-Piston Machines: Neuerungen fuer Gegenkolbenmaschinen. Wimplinger. *Dingler's polytechnisches Journal*, Vol. **331** (1916), No. 13, pp. 197–199.

Cyanide Plant: Construction and Operation of the Nevada Packard Mill. H. G. Thompson. *Mining and Scientific Press*, Vol. **113** (1916), No. 11, pp. 377–384.

Driving a 1,200 Foot Raise. S. F. Eaton. *Engineering and Mining Journal*, Vol. **102** (1916), No. 11, pp. 461–464.

Engineering Service Plus Machine Building. O. J. Abell. *The Iron Age*, Vol. **98** (1916), No. 10, pp. 499–504.

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MARKET REPORT—SEPTEMBER, 1916

WHOLESALE PRICES PREVAILING IN THE NEW YORK MARKET ON SEPTEMBER 21.

INORGANIC CHEMICALS

Acetate of Lime,	100 Lbs.	5.00		
Alum, lump ammonia	100 Lbs.	4½	@	4½
Aluminum Sulfate, high-grade	Ton	65.00	@	100.00
Ammonium Carbonate, domestic	Lb.	9½	@	10
Ammonium Chloride, gray	Lb.	10	@	12
Ammonium Phosphate, commercial, 98–100%	Lb.	14	@	15
Aqua Ammonium, 26°, drums	Lb	5½	@	6
Arsenic, white	Lb.	5⅞	@	6
Barium Chloride	Ton	100.00	@	105.00
Barium Nitrate	Lb.	15		
Barytes, prime white, foreign	Ton	26.00	@	28.00
Bleaching Powder, 35 per cent	100 Lbs.	4	@	4¼
Blue Vitriol	Lb.	8½	@	9½
Borax, crystals, in bags	Lb.	7½	@	7¾
Boric Acid, powdered crystals	Lb.	11¾	@	12½
Brimstone, crude, domestic	Long Ton	35.00		
Bromine, technical, bulk	Lb.	1.20	@	1.30
Calcium Chloride, lump, 70 to 75% fused	Ton	28.00	@	32.00
Calcium Chloride, granulated	Ton	—	@	—
Caustic Soda, 74 per cent	Lb.	3¾	@	4
Chalk, light precipitated	Lb.	4½	@	—
China Clay, imported	Ton	18.00	@	30.00
Feldspar	Ton	8.00	@	12.00
Fuller's Earth, foreign, powdered	Ton	$35.00		
Glauber's Salt, in bbls	100 Lbs.	60	@	65
Green Vitriol, bulk	100 Lbs.	95	@	1.00
Hydrochloric Acid, commercial, 18°	Lb.	1⅞	@	2
Hydrochloric Acid, C. P., conc., 22°	100 Lbs.	2	@	2¼
Iodine, resublimed	Lb.	4.25	@	4.30
Lead Acetate, white crystals	Lb.	15⅝	@	15⅞
Lead Nitrate	Lb.	15½	@	16
Litharge, American	Lb.	9¼	@	9¾
Lithium Carbonate	Lb.	1.02	@	1.05
Magnesium Carbonate	Lb.	19	@	22
Magnesite, "Calcined"	Ton	—	@	—
Nitric Acid, 36°	Lb.	4½	@	¾
Nitric Acid 42°	Lb.	6¼	@	6¾
Phosphoric Acid, sp. gr. 1.750	Lb	30	@	—
Phosphorus yellow	Lb.	1.20	@	—
Plaster of Paris	Bbl.	1.50	@	1.70
Potassium Bichromate, casks	Lb.	37	@	39
Potassium Bromide (granular)	100 Lbs.	$1.35		
Potassium Carbonate, calcined, 80 @ 85%	Lb.	50	@	55
Potassium Chlorate, crystals, spot	Lb.	48	@	49
Potassium Cyanide, bulk, 98–99 per cent	Mixture	44	@	46
Potassium Hydroxide	Lb.	55	@	—
Potassium Iodide, bulk	Lb.	3.95		
Potassium Nitrate	Lb.	—	@	—
Potassium Permanganate, bulk	Lb.	1.55	@	1.65
Quicksilver, flask, 75 lbs.		75.00		
Red Lead, American, dry	Lb.	9¾	@	—
Salt Cake, glass makers'	Ton	10.50	@	12.00
Silver Nitrate	Oz	41½	@	42½
Soapstone in bags	Ton	8.00	@	12.00
Soda Ash, 48 per cent	100 Lbs.	3⅛	@	3¼
Sodium Acetate	Lb.	12	@	14
Sodium Bicarbonate, domestic	100 Lbs.	1.65		
Sodium Bicarbonate, English	Lb.	3½	@	$3^5/$
Sodium Bichromate	Lb.	27	@	29
Sodium Chlorate	Lb.	27	@	28
Sodium Fluoride, commercial	Lb.	—	@	—
Sodium Hyposulfite	100 Lbs.	1.25	@	1.30
Sodium Nitrate, 95 per cent, spot	100 Lbs.	2.95	@	3.00
Sodium Silicate, liquid	100 Lbs.	1.00	@	3.00
Sodium Sulfide, 30%, crystals, in bbls	Lb.	1⅞	@	2
Sodium Bisulfite, powdered	Lb.	5¼	@	5½
Strontium Nitrate	Lb.	48	@	50
Sulfur, flowers, sublimed	100 Lbs.	2.30	@	2.70
Sulfur, roll	100 Lbs.	1.95	@	2.25
Sulfuric Acid, chamber, 66° Be	Ton	20.00	@	21.00
Sulfuric Acid, oleum (fuming)	Ton	45.00	@	50.00
Talc, American white	Ton	9.00	@	12.00
Terra Alba, American, No. 1	100 Lbs.	75	@	80
Tin Bichloride, 50°	Lb.	13½	@	14
Tin Oxide	Lb.	43	@	44
White Lead, American, dry	Lb.	8¾	@	—
Zinc Carbonate	Lb.	26	@	28
Zinc Chloride, commercial	Lb	13	@	15
Zinc Oxide, American process XX	Lb.	9¾	@	10
Zinc Sulfate	Lb	6½	@	7¼

ORGANIC CHEMICALS

Acetanilid, C. P., in bbls	Lb.	55	@	60
Acetic Acid, 56 per cent, in bbls	Lb.	8½		
Acetic Acid, glacial, 99½%, in carboys	Lb.	20	@	22
Acetone, drums	Lb.	30	@	—
Alcohol, denatured, 180 proof	Gal.	46	@	48
Alcohol, grain, 188 proof	Gal.	2.64	@	2.66
Alcohol, wood, 95 per cent, refined	Gal.	63	@	65
Amyl Acetate	Gal.	4.75	@	4.85
Aniline Oil	Lb.	25	@	28
Benzoic Acid, ex-toluol	Lb.	9.00	@	10.00
Benzol, 90 per cent	Gal.	60	@	62
Camphor, refined in bulk, bbls.	Lb.	69½		
Carbolic Acid, U. S. P., crystals, drums	Lb.	55	@	60
Carbon Bisulfide	Lb.	7	@	8
Carbon Tetrachloride, drums, 100 gals.	Lb.	16½	@	17
Chloroform	Lb.	48	@	50
Citric Acid, domestic, crystals	Lb.	62	@	67
Cresol, U. S. P.	Gal.	65	@	70
Dextrine, corn (carloads, bags)	100 Lbs.	3.95	@	4.00
Dextrine, imported potato	Lb.	14	@	16
Ether, U. S. P., 1900	Lb.	15	@	20
Formaldehyde, 40 per cent	Lb.	10	@	11
Glycerine, dynamite, drums included	Lb.	43	@	43½
Oxalic Acid, in casks	Lb	60	@	61
Pyrogallic Acid, resublimed bulk	Lb.	2.85	@	2.90
Salicylic Acid	Lb.	1.50	@	1.75
Starch, cassava	Lb.	3¾	@	4½
Starch, corn (carloads, bags) pearl	100 Lbs.	2.65	@	2.70
Starch, potato	Lb.	7	@	7⅛
Starch, rice	Lb.	8	@	9
Starch, sago	Lb.	3½	@	4
Starch, wheat	Lb.	6½	@	8
Tannic Acid, commercial	Lb.	65		
Tartaric Acid, crystals	Lb.	66	@	68

OILS, WAXES, ETC.

Beeswax, pure, white	Lb.	40	@	45
Black Mineral Oil, 29 gravity	Gal.	13½	@	—
Castor Oil, No. 3	Lb.	13½		
Ceresin, yellow	Lb.	10	@	11
Corn Oil, crude	100 Lbs.	$9.00		
Cottonseed Oil, crude, f. o. b. mill	Gal.	normal		
Cottonseed Oil, p. s. y	Lb.	10	@	—
Creosote, beechwood	Lb.	2.75	@	3.00
Cylinder Oil, light, filtered	Gal.	21	@	—
Fusel Oil, crude	Lb.	4.25	@	4.50
Japan Wax	Lb.	14¼	@	15
Lard Oil, prime winter	Gal.	1.08	@	1.10
Linseed Oil, raw (car lots)	Gal.	69	@	—
Menhaden Oil, crude (southern)	Gal.	47	@	48
Naphtha, 68 @ 72°	Gal	33¾	@	34
Neat's-foot Oil, 20°	Gal.	1.05		
Paraffine, crude, 120 m. ρ	Lb.	5	@	—
Paraffine Oil, high viscosity	Gal.	29½	@	30
Rosin, "F" Grade, 280 lbs.	Bbl.	6.65		
Rosin Oil, first run	Gal	33		
Shellac, T. N.	Lb.	33	@	34
Spermaceti, cake	Lb.	24	@	25
Sperm Oil, bleached winter, 38°	Gal.	80	@	82
Spindle Oil, No. 200	Gal.	24	@	25
Stearic Acid, double-pressed	Lb.	13	@	13½
Tallow, acidless	Gal.	88	@	90
Tar Oil, distilled	Gal.	35	@	40
Turpentine, spirits of	Gal.	46	@	46½

METALS

Aluminum, No. 1, ingots	Lb.	61	@	63
Antimony, ordinary	Lb.	14	@	16
Bismuth, N. Y.	Lb.	3.05	@	3.10
Copper, electrolytic	Lb.	28	@	28¼
Copper, lake	Lb.	28	@	28¼
Lead, N. Y.	100 Lbs.	$7.10		
Nickel, electrolytic	Lb.	45	@	—
Nickel, shot and ingots	Lb.	50	@	—
Platinum, refined	Oz.	85.00		
Silver	Oz.	68⅝		
Tin	Lb.	38½		
Zinc, N. Y.	100 Lbs.	9.70		

FERTILIZER MATERIALS

Ammonium Sulfate	100 Lbs.	3.00	@	3.10
Blood, dried F O B Chicago	Unit	3.20		
Bone, 4½ and 50, ground, raw	Ton	28.50		
Calcium Cyanamid	Unit of Ammonia	2.55		
Calcium Nitrate, Norwegian	100 Lbs.	—		
Castor Meal	Unit	—		
Fish Scrap, domestic, dried, f. o. b. works	Unit	3.60	&	10
Phosphate, acid	Ton	10.00	@	12.00
Phosphate rock; f. o. b. mine:				
Florida land pebble, 68 per cent	Ton	2.75	@	3.00
Tennessee, 78–80 per cent	Ton	5.00	@	5.50
Potassium "muriate," basis 80 per cent	Ton	300.00		
Pyrites, furnace size, imported	Unit	15½	@	—
Tankage, high-grade; f. o. b. Chicago	Unit	2.90	&	10