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In this Issue

MATERIALS OF CONSTRUCTION

Chem. & Met.'s 11th Report on Materials for Process Equipment

Regular Monthly Features

An index to advertisers will be found on page 470

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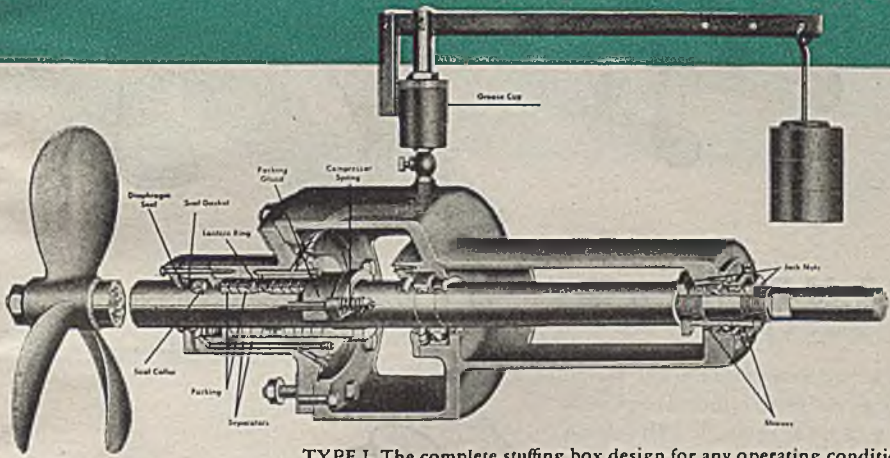

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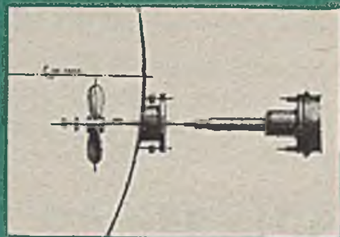
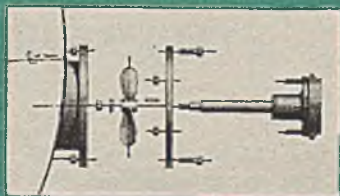


Companion Nozzle (to fit mixer bolt circle). Located in proper Off Center position. User will furnish and install nozzle. This method useful for installing mixer adajacent to manway which must be kept clear. Photo shows unique method of fabricated support, by user.



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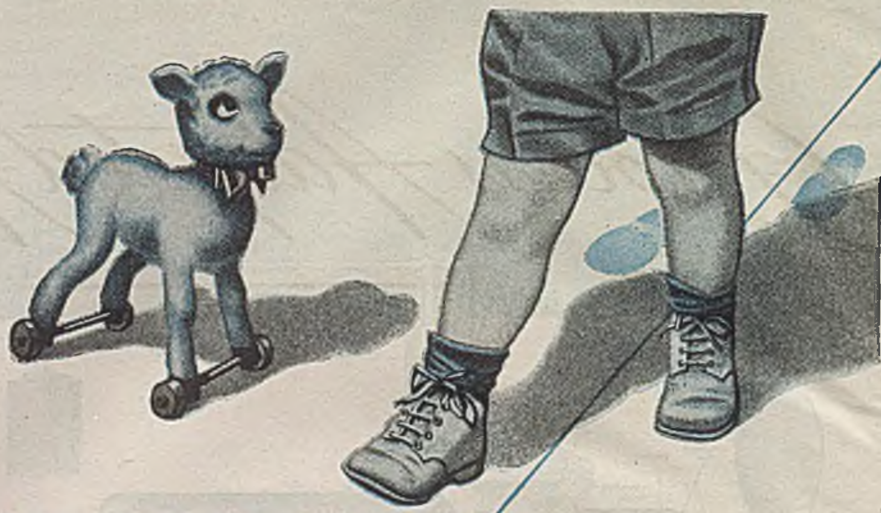
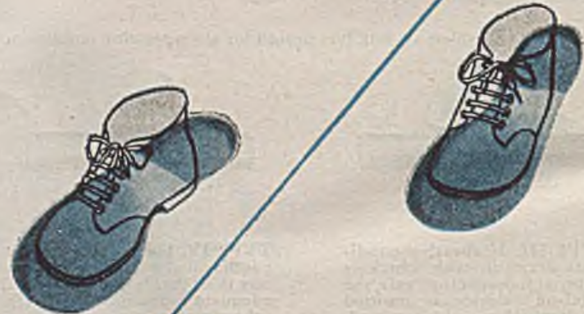


IMPORTANT FIRST STEPS



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WATCHING WASHINGTON

R. S. McBRIDE, Editorial Consultant • PAUL WOOTON, Chief of McGraw-Hill Washington Bureau • MALCOLM BURTON, Washington Correspondent

Uncle Sam begins the sale of industrial facilities . . . Plans for disposing of the properties are beginning to be announced . . . More than 30 items are now offered . . . Nitric acid supplies to chemical users are cut . . . Civilian gasoline is to get only fraction of ethyl fluid which it had in 1941 . . . Estimates place U. S. rubber requirements for each of the next five years at a million tons . . . Disposal of chlorine plants will not come up for some months, it now seems certain . . . Six companies are turning out satisfactory rock phosphate which is safe for feed usage . . . Office of the Rubber Director has revised basic regulations

SURPLUS PROPERTY SALES

Sale of industrial facilities by the government is now actually beginning. The Industrial Facilities Section of the Surplus War Property Administration is in charge of the disposal of plant sites, factories, and industrial facilities of all kinds, including items of equipment sold separately either for scrap or for reuse. Only a few of the policies regarding such sales have been announced. But the trend of the plans indicates a probable procedure..

An item of industrial property comes to the attention of this office of DPC in either of two ways. It may be an item which has actually been released by the government agency which owns or controls it. Such an item is available immediately for sale. Other items not finally determined as surplus come to this office because the controlling agency has ordered the property put in stand-by condition. Properties so declared no longer needed for active use are not "surplus" and cannot immediately be offered for sale. However, there are means for getting acquainted with the existence of such items and preliminary discussions can sometimes start even though actual negotiations of a formal nature have not been authorized.

GETTING SURPLUS NOTICES

Defense Plant Corp. has adopted for the time a restriction on the publicity policy. It will be necessary for the present for those interested in surplus establishments to follow this policy or they will not be able to get information promptly. The procedure is about as follows:

As soon as an item of property is declared surplus, there is a sheet prepared giving a brief description of it. The sheet identifies the location and the character of the establishment. It indicates the amount of land, the number and types of buildings, and something regarding the machinery and equipment which is included in the surplus property so offered. That sheet is mimeographed and copies of it are sent to each of the 31 district offices of RFC. Each office is given the entire responsibility for bringing such information to the attention of anyone in the district who is interested in surplus property.

The Washington office has set up an almost absolute rule against giving out information except regarding single items on which a specific inquiry may be made without difficulty. All mailing lists for sending out the information are to be maintained in the regional offices. Washington absolutely refuses to take any responsibility of that sort.

LOCAL CONTACT NEEDED

Under the circumstances, it is desirable for each individual or company interested in surplus property to make the acquaintance of some proper person in the nearest regional office. Any inquirer can put himself on record in that office requesting notice of new surplus items announced. He will not be given all the items. But he will be given on request any variety of items which he may describe as of interest to him. It will not suffice to say merely any chemical plant, because the definition of chemical plants used by DPC is very much narrower than would probably be intended by the average chemical engineer or industrial executive. Only by continuing and persistent contact with district offices can it be expected that any enterprise will learn promptly of all items of property that are offered for disposal and of importance to them.

PROPERTY NOW "SURPLUS"

As of August 15, there were on the surplus property list approximately 30 items. About a dozen of these represented completed factories, including a substantial amount of machinery or equipment. About a dozen were establishments with more or less complete buildings and building facilities, but without any great amount of process equipment. About a half-dozen represented only plant sites, land ranging from a few acres up to much larger plots, one of more than 13,000 acres.

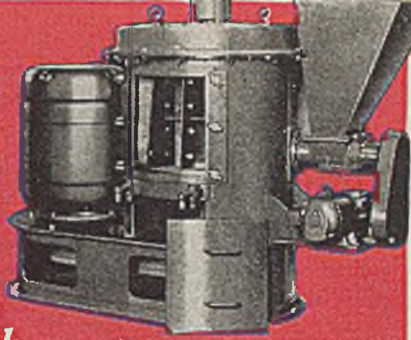
HOW TO DO IT

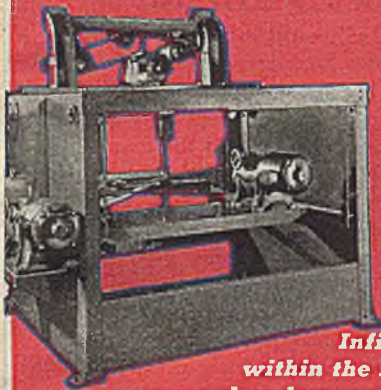
If an inquirer discovers a surplus property item on which he desires more information, this can be obtained in any one of three ways. Each regional office has descriptive sheets which give a fair idea of the size and general character of each property. Such sheets are available on request. In fact, it is these sheets which will be mailed to inquirers who get their names on the mailing list of the regional office. If such information indicates that further inquiry is desirable, it would be best to consult either the director of the regional office in which the surplus property is located, or the Washington office of DPC. The announcement sheets give in each case the name of the man in charge in the regional district where the surplus property is located. That man can initiate discussions regarding the property, can furnish detailed descriptions, and can show the property to inquirers who are seriously interested. In fact, this regional officer is expected to conduct all of the preliminary negotiations for sales.

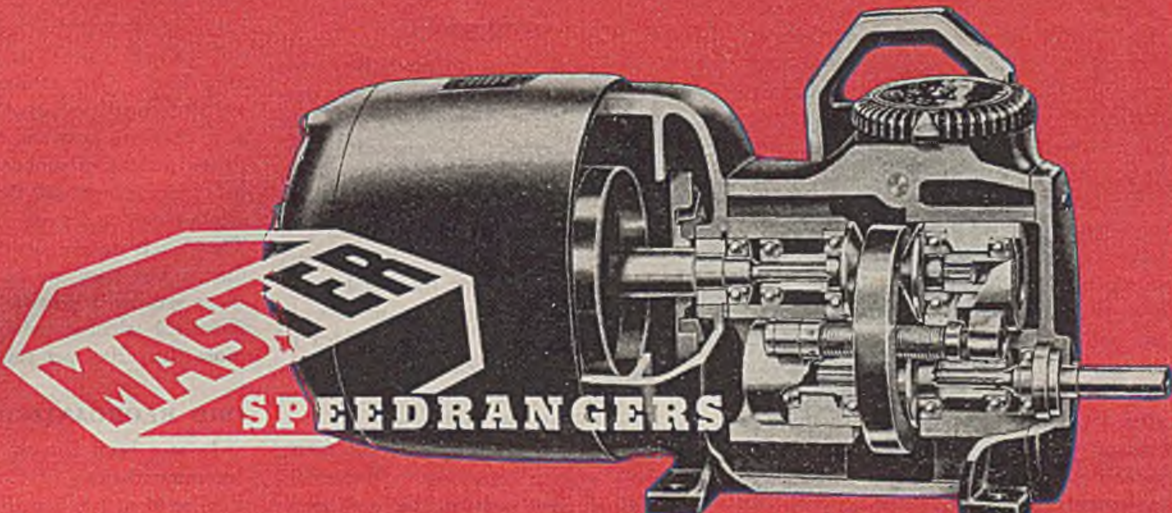
NITROGEN CONDITIONS CHANGE

The increased ordnance requirements for explosives are having the immediate effect of cutting off nitric acid from numerous chemical users. As early as August 15, the government stopped shipping ammonium nitrate from arsenal plants. Delivery from TVA and Canadian plants for fertilizer usage has, however, continued.

The War Department has announced that effective September 1, it was going to cut off shipments of anhydrous ammonia from arsenals, not only from fertilizer users, but also from other chemical establishments. Shipment of nitric acid from these plants was scheduled to stop on October 1. This nitric acid has previously been used for making commercial



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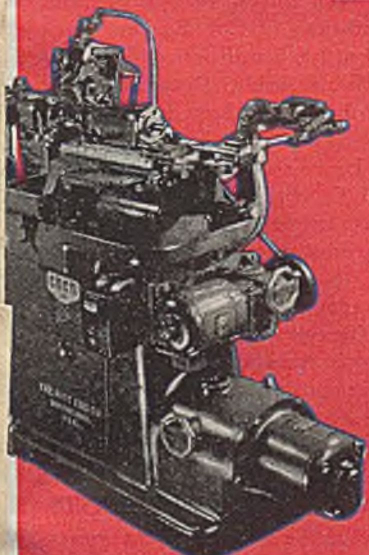

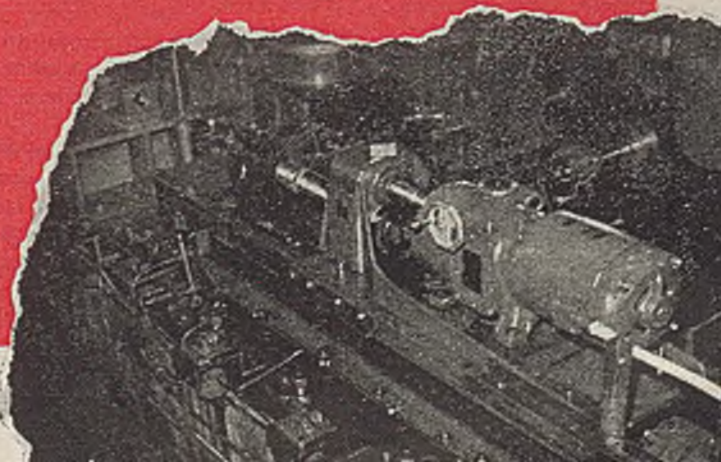

explosives, plastics, dyestuffs, and numerous other products of chemical process industry.

WITH GERMANY'S FALL

Completion of the European conflict will bring with it a big cutback on all military activities. This will undoubtedly occur soon enough to permit adequate supplies of ammonia and ammonia chemicals for spring fertilizer distribution. Presumably it will also relieve other chemical shortages not only for ammonia, nitric acid, and other products, but also sulphuric acid and the other fertilizer components. In fact, 1945 manufacture of chemicals from surplus ordnance raw materials will undoubtedly be encouraged at an early date. Some of this will probably go on even before these government establishments are declared surplus property.

RECONVERSION ORDERS

Firms which do not make an aggressive effort to get maximum reconversion authorization from the military and manpower authorities may be handicapping themselves. If they show anxious desire to return to civilian manufacture, such firms will not actually be unpatriotic. It is up to military officials and manpower representatives, working through WPB, to make these decisions. There will be disappointments and turn-downs, but firms that do not ask for civilian privileges are not likely to be sought and forced to take them. Washington is still too busy with manufacture of fighting supplies to give a great deal of thought to civilian requirements, and only a few spokesmen from the Office of Civilian Requirements are aggressively working on that part of the job.

RECONVERSION CRITICS

Those who criticize efforts of reconversion are justifiably being told two things. Nelson rightly wrote the rules for reconversion before the game started. He did not choose to umpire a proceeding in which the rules were written only after events made rules necessary. And secondly, reconversion refusals can properly still be made by the military. But it is now up to the military to get out of the way where actual war necessity does not require their restrictions. Civilian needs are secondary; but they are still extremely important.

PRICING UNCLE SAM'S SALES

Methods which may be used for price control in sales of surplus commodities released by the government have been ruled on by OPA. Regulations regarding resale and stock piling for almost everything except food have been made available. Food pricing had been regulated by earlier rulings. Those people who acquire for resale any government property will be expected to conform just as rigidly to ceiling prices as do other merchants. This policy, which OPA will try to enforce strictly, is intended to have plenty of teeth for the embarrassment of speculators.

HIGH OCTANE DATA

The reduction of civilian gasoline from 72 to 70 octane rating releases tetraethyl lead enough to make 120 million gallons of aviation gasoline. An equivalent of 90 million gallons of aviation enrichment materials is saved by the curtailment of distribution of premium grades of automobile fuel. As a result of the changes ordered during August, civilian gasoline will get 46 percent of the ethyl fuel which it had in 1941. In that year, less than a quarter of the ethyl fuel went for military uses. Now well over three-fourths of the total is employed for military aviation.

IDLE WAR WORKERS?

With the German collapse there will be a 40 percent cutback in military production. This cut, according to Donald Nelson, will permit new civilian manufacture sufficient to give civilian supplies equal to 1939. Thus adequate manufacture for ordinary civilian operations can go on with 60 percent of the war workers still making supplies for the Pacific area and for the eleven million persons in uniform. These facts give some idea of the magnitude of the re-employment problem to take care of these millions when the Pacific fight has also been won.

Many will retire from employment, especially women returning to homemaking. Much new construction and many new consumer's capital goods will then be made. Even so, the figures of the WPB chairman indicate some millions whom it will be hard to place in jobs. Thus the first over-all quantitative statement by a high official is anything but optimistic.

POSTWAR SYNTHETIC RUBBER

Quasi-official estimates of rubber requirements have been prepared by present and former members of the staff of the Office of Rubber Director. These indicate that approximately a million tons of rubber will be required in the U. S. for each of the five years from 1944 to 1948. Military requirements will be tapering off from the present half of the total to almost nothing in 1947, according to these figures.

Washington seems generally to accept the idea that a very large part of this total rubber supply will come from synthetic sources for several years after the Japanese collapse. Rubber from the Far East will be welcome for blending, but a very substantial part of the total from that area will either go to Europe direct or create European demands for our rubber products which are not included in the estimated rubber consumptnion of the United States. These facts lead to much speculation regarding the future chemical requirements for the synthetic program.

RUBBER RAW MATERIAL

It is the present intention of Washington to use far more butadiene from petroleum beginning next year, just as soon as raw material can be spared from the high octane program. Even in the fourth quarter of 1944, it is expected that much more butadiene will be made from petroleum than from alcohol. This means that next year some of the alcohol producers can probably go back to their beverage business.

Since little alcohol will be used for antifreeze from now on, it seems likely, the industrial alcohol companies will be able to carry their share of the total butadiene load before another 12 months have passed. The abundance of methanol and other alternate solvents for industrial and chemical use will contribute materially to this same end. One estimator, who appears well informed, says that the alcohol business after this year will be largely devoted to the making of rubber raw material, and its survival there will depend on whether alcohol can again be made very cheap. These facts do not worry the beverage industry; but they are of deep concern to those seeking a postwar program for that industrial alcohol which must sell for more than 20c. per gal.

ORD REORGANIZED

It has been announced that following recommendations of Col. Bradley Dewey the President had issued a directive abolishing the Office of Rubber Director and that a Rubber Bureau had been set up within WPB with James F. Clark as director. Mr. Clark has been assistant deputy director of ORD since October, 1943.

The new Rubber Bureau will function under the direction of the Operations Vice Chairman to oversee industry problems and the administration of the Rubber Order. The operation of the synthetic rubber plants and the carrying out of research, development and testing will be in the hands of Rubber Reserve Co. under direction of Jesse Jones.

GOVERNMENT CHLORINE PLANTS

Review of the facilities of the government for the manufacture of chlorine and electrolytic caustic soda shows that there are seven such establishments which have been built with government money. Four of these are connected with the arsenals of Chemical Warfare Service. One is the part of a phenol plant and one a part of a magnesium plant, which have been built by DPC. Only one of the chlorine establishments was built by DPC to make

chlorine for general industrial distribution under WPB allocation.

DISPOSAL OF FACILITIES

Not even preliminary plans have yet been formulated by the government as to the postwar disposition, use, or retention as stand-by of any of these seven chlorine establishments. Ultimate decisions will depend principally on what facilities are deemed necessary for CWS after the war, and what plans are made for the handling of magnesium, phenol, and other general facilities. The problem of disposal of chlorine plants as such will, therefore, not come up actively in Washington for some months, it now appears certain.

PROFIT YARDSTICK USED

Wet corn millers can now ask for ceiling-price changes if over-all profits before income taxes are now less than the base period profits of 1936-1939. Thus OPA has given a much broader basis for judging the fairness of prices in that particular industry. This broad principle is not yet being generally applied in other chemical industries. But there is no harm in asking for it if any management thinks that the new policy would be fairly applicable in its business.

PHOSPHATE ROCK FEED MADE

Shortage of phosphate feeds from normal prewar sources has occasioned development by industry of new methods using phosphate rock as a starting material. The Department of Agriculture reports that six different establishments are now turning out satisfactory rock phosphate which is safe for feed usage.

Previously rock was not considered satisfactory as a raw material because of the high content of fluorine; but methods have been developed in industry and by the Department so that calcium phosphate practically free from fluorine can now be made economically. Approximately 100,000 tons per year of such feed phosphates are now being manufactured annually.

NEW FERTILIZER BOTTLE-NECKS

Resumption of explosives manufacture on a large scale to support European battlefronts temporarily cut off wanted supplies of chemicals for the fertilizer industry. Major shortages are temporarily being experienced in ammonia, ammonium nitrate, sulphuric acid, superphosphate and other finished fertilizers.

The industry is much less concerned than government officials. The latter are worried lest supplies to be given away for soil improvement programs be cut off by these developments. Shortages for commercial distribution are not very likely except briefly and locally.

Official requests for superphosphate have been as high as 10 million tons for the fertilizer year which began July 1, 1944. It now appears that 8 million tons of superphosphate will be available which appears adequate to meet commercial demands that are likely to exceed somewhat the last year's consumption of approximately 6.8 million tons. The curtailment in superphosphate will give some comfort to phosphate rock producers who were threatened with difficult conditions when it appeared that they would have to mine more than 6 million tons of rock next year.

"BIG INCH" HAS A GOOD YEAR

During its first 12 months of operation, "Big Inch" delivered more than 96 million barrels of crude oil. The line was designed to handle 300,000 bbl. daily. During July it averaged 314,000 bbl. Its daily average for the first year was only 263,000 because many of the pumping stations were not operated for the entire period. Its peak delivery rate was on June 12 of this year, when 326,000 bbl. were handled. Postwar users of petroleum have in this huge pipeline, a delivery system equivalent to 23,000 tank cars working continuously on an 18-day turnabout schedule.

MINERAL STOCKPILING

The domestic mining industry, led by American Mining Congress, is seeking to organize a bloc in Congress which will protect American miners from postwar sale of government-owned mineral surpluses. They are working vigorously with the legislators to secure Congressional action requiring the government to put aside for stockpiling all of the metals and minerals which are owned by Uncle Sam and his corporations. Even in the case of strategic minerals for which domestic production is small, or nil, the industry wishes to prevent the marketing by the government of any of these supplies.

POLITICAL SIGNIFICANCE

Opponents of the mineral stockpiling program argue that it will needlessly burden consumers with high prices both of the minerals and the commodities made from them. They are especially critical of the proposal that even scrap metal and scrapped industrial equipment must be put into the reserves irrespective of the quantity of material which this would put into stockpiles. There has not been clear evidence of a well organized opposition to the program. Washington observers are, therefore, forecasting some success for these proposals of the mining industry, since they may have important political significance in many of the western mining states during an election year.

GLASS CONTAINERS

Although the production of glass containers is at the highest rate in history, the chemical industry has not benefited in the resulting easing of restrictions on the use of glass. The food industry is the beneficiary while the chemical industry merely holds its own by retaining previous packing quotas under the latest revision of the glass container and closure order L-103-b.

When standardization of glass containers took place gains were made not only because production of jars and bottles was increased but also because larger sizes were produced. Reports from the glass industry indicate that present rate of production is approximately 127 percent of prewar capacity. Figures for last June show it to be 15 percent ahead of June, 1943, and for the first six months of this year production was 13 percent ahead of the corresponding period of last year. June, 1944, was the best month in the history of the industry up to that time.

WHOSE ESTIMATE WAS RIGHT?

The Senate committee investigating war activities (formerly the Truman Committee) apparently unanimously supported the figures of WPB when these were presented by Donald Nelson and criticized by the Army. The military shortages have apparently been traceable to bad estimates by the Army itself. The cutback on big guns and heavy ammunition made months ago was too deep and the resulting shortages were not caused by inability to get workers.

Several arsenals were closed down but have had to be reopened hastily. This has included several of the establishments making ammonia and various types of explosives. Only a handfull of items, such as big guns, big trucks, and heavy ammunition, have been seriously short. This fact has put the military planners definitely on the defensive with Congress. No one wants to discipline them. But they are not going to be believed so quickly in the future, even when they do present more carefully studied estimates. Incidentally they are not being blamed for the shortage of tires. That shortage has been caused by conditions in Akron.

NEW RUBBER REGULATIONS

The Office of the Rubber Director, WPB, has announced a revision of the basic rubber regulations that provides a compilation of all rubber directives and amendments issued previously. The revised regulations include a number of provisions reflecting progress in the nation's conversion from crude to synthetic rubber. They include: 1, all medium-sized highway truck tires to contain 90 percent synthetic; 2, use of neoprene and buna N is now permitted without restriction in all wire and cable construction; 3, elastic thread manufacturers are now permitted to use neoprene without restriction. The officials consider neoprene satisfactory for girdles and similar items.

SILICONES

new lubricant increases valve life— reduces maintenance costs

Dow Corning Plug Cock Grease is rapidly proving to be an ideal grease for the lubrication of valves and plug cocks. This basically new product—one of a series of recent Dow Corning silicone developments—is highly resistant to attack by alkalies, acids and oxidizing agents. Because it protects the metal plug cock from corrosive liquids and vapors, it reduces corrosion hazards to a minimum, and so affords continuously efficient, *free* valve operation. Too, Dow Corning Plug Cock Grease maintains its vaseline-like consistency throughout an exceptionally broad range of operating temperatures: from −40°F. to 400°F.

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INTERPRETATIONS

This installment covers orders rules and regulations issued by the War Production Board and the Office of Price Administration during August, 1944. Copies of each item interpreted here may be obtained from the appropriate federal agency.

CARBON BLACK

ALL members of the rubber industry have been requested to replace their easy processing channel black requirements with medium processing channel black to the fullest possible extent. Where direct substitution is not possible Chemicals Bureau officials have suggested a blend with semi-reinforcing furnace or high modulus furnace or high modulus alone. This action was taken because increased demand for easy processing black has reduced production of channel black by about 15 percent. The supply situation will improve later since new production of both channel and furnace carbon blacks is scheduled to be brought in each month over the rest of the year.

Since the first of this year, production of furnace black has been increased from less than 100,000,000 lb. a year to more than 430.000,000 lb. and when the present program is completed early next year, production will be at the rate of 625,000,000 lb. a year. Channel black capacities also are being enlarged and by next March should be at a rate of more than 600.000.000 lb. a year.

TANNING MATERIALS

THE industry advisory committee has asked for a continuation of controls over distribution of chestnut extract. In the first half of this year, production was about 127,000,000 lb. of 25 percent chestnut extract. Results for the second half of the year are expected to be about the same, thus giving a total production of 254,000,000 lb. In 1942 consumption was 391,000,000 lb. Tanners have been drawing from inventories which have been reduced 40 percent in the last six months. Permissible prices for the extract were raised in July and last month announcement was made that users of hemlock and chestnut oak bark will not be permitted to pay more for these commodities than the highest price each user paid for the same product during the period from May 15 to July 15, 1944.

ALLOCATION CONTROLS

BECAUSE of increasing war requirements, ultramarine blue has been subject to allocation since Aug. 1. Those seeking authorization to use or to deliver this pigment must file application on Form WPB-2947 by the twentieth of the month before the proposed delivery month. Small order exemption is 25 lb. per month.

Distribution of diphenylamine and naphthalene was transferred to Order M-300 with no substantial change in the controls.

Effective Oct. 1, monomethyl amine and dimethyl amine will be placed under quarterly allocation with Order M-300 as directive control. Military demands for them now exceed productive capacity and it is probable that civilian uses will be denied for the next six months.

Sales of uranium or uranium compounds, alloys, or mixtures for certain uses continue to be forbidden and WPB will allocate all other sales and purchases in lots of 10 lb. or more. Persons desiring to purchase must make application on Form 3909 and send it to WPB, P. O. Box 175, Madison Sq. Station, New York 10, N. Y.

Formerly controlled by directive, sodium ferrocyanide, potassium ferrocyanide, potassium ferricyanide and potassium-sodium ferricyanide are now under general allocation. All are in short supply.

Control over ascorbic acid has been transferred to M-300. Three companies are now producing this acid and the output is increasing. Present corn supply is not sufficient to permit maximum production of the acid but if the corn situation should improve it would be possible to remove the allocation controls.

ALLOCATIONS REMOVED

DIRECT allocation controls were removed from polyfiber produced from polystyrene and polydichlorostyrene, and from propylene and diethylene glycols. Production of polyfiber has increased and the other two products which were in active demand as glycerine substitutes, are in better supply because glycerine is now available in a larger way.

Present demands for beryllium have leveled off and users no longer are asked to apply for permission to make purchases other than beryllium copper.

Wider use of DDT in the armed forces has eased the position of methyl bromide and as the supply is regarded as ample for all purposes, allocation controls are no longer in force.

As a result of the drop in amount of alcohol allotted for anti-freeze use, denaturants for anti-freeze alcohol have been freed from controls. These include Acetaldol, ST-115, Dehydrol-0, G.-C.-78, and Pyronate.

Aniline salt was removed from direct allocation according to terms of Order M-300. Its use will now be controlled on the producers level by applications for the allocation of aniline for the manufacture of the salt. Aniline also has been transferred to the regulations of M-300.

LACTIC ACID

MILITARY uses for lactic acid have been growing so fast that it is now expected that 40 percent of all production will go to the armed forces. In order to safeguard this supply, it has been found necessary to control distribution effective Sept. 1. Officials say the larger amounts reserved for military use will not leave sufficient for all civilian needs. Producers have been attempting to increase production by improving present facilities and production techniques. WFA is cooperating through efforts to supply additional raw materials such as corn starch, corn syrup, whey, and high grade molasses.

NAPHTHENIC ACID

DESPITE efforts of manufacturers to speed up outputs, demand for naphthenic acid for military purposes has increased to an extent where virtually all civilian requests will be denied in the allocations for September. While many civilian requests for naphthenic acid for use in protective coatings have been denied, a still smaller quantity of the acid will be allocated for a few highly essential requirements. The acid will continue to be granted for use in ore flotations where special problems exist and for demulsification in petroleum operations.

PRICE CEILINGS

ALL types of boiled-down soap stock have come under price control effective Aug. 16. The specific prices are determined by adding to the Maximum Price Regulation No. 53 ceiling prices for the raw soap stock used, the usual trade differential, which includes processing and delivery costs. Maximum delivered prices for imported boiled-down soap stock will be determined by the port of entry. Imports through Atlantic Coast or Gulf ports will be priced the same as stock produced in Texas, while imports in a Pacific Coast port will be priced the same as stock produced in California.

An increase of 5c. a bu. over previous ceiling prices for flaxseed went into effect on Aug. 14. It affects only Minneapolis, Duluth, Red Wing, Milwaukee, Chicago, and Portland, Ore. This makes the ceiling at those basing points $3.10 a bu.

Producers of pyrophyllite who are unable to make and sell the product at present maximum prices may apply for adjustment. Increases will not be above the amount necessary to cover total costs of making and selling a particular grade or grades or to cover total costs for a producer's entire production of the commodity.

West Coast producers or distributors of barrels and kegs will have a selling price established on an individual basis.

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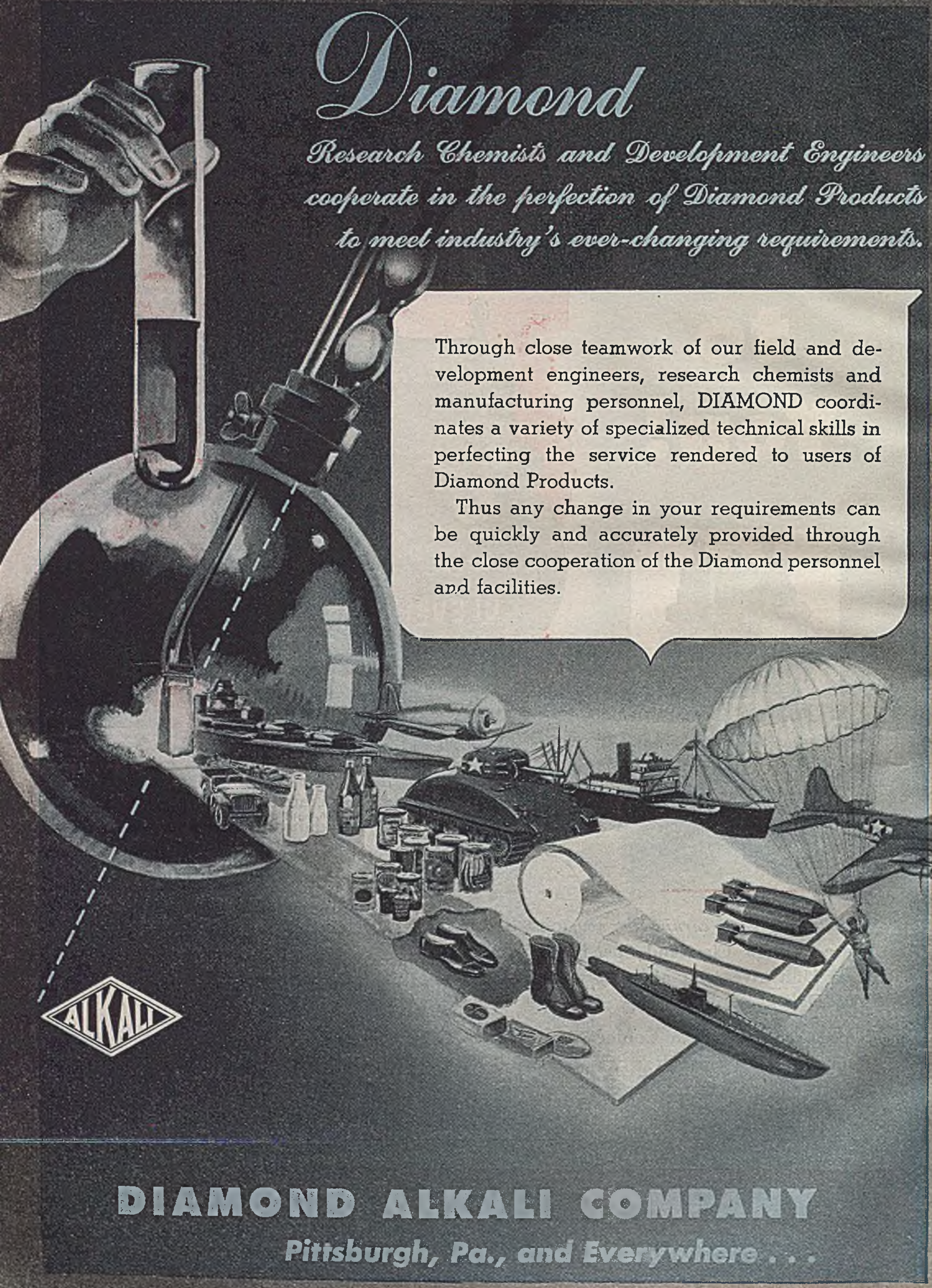
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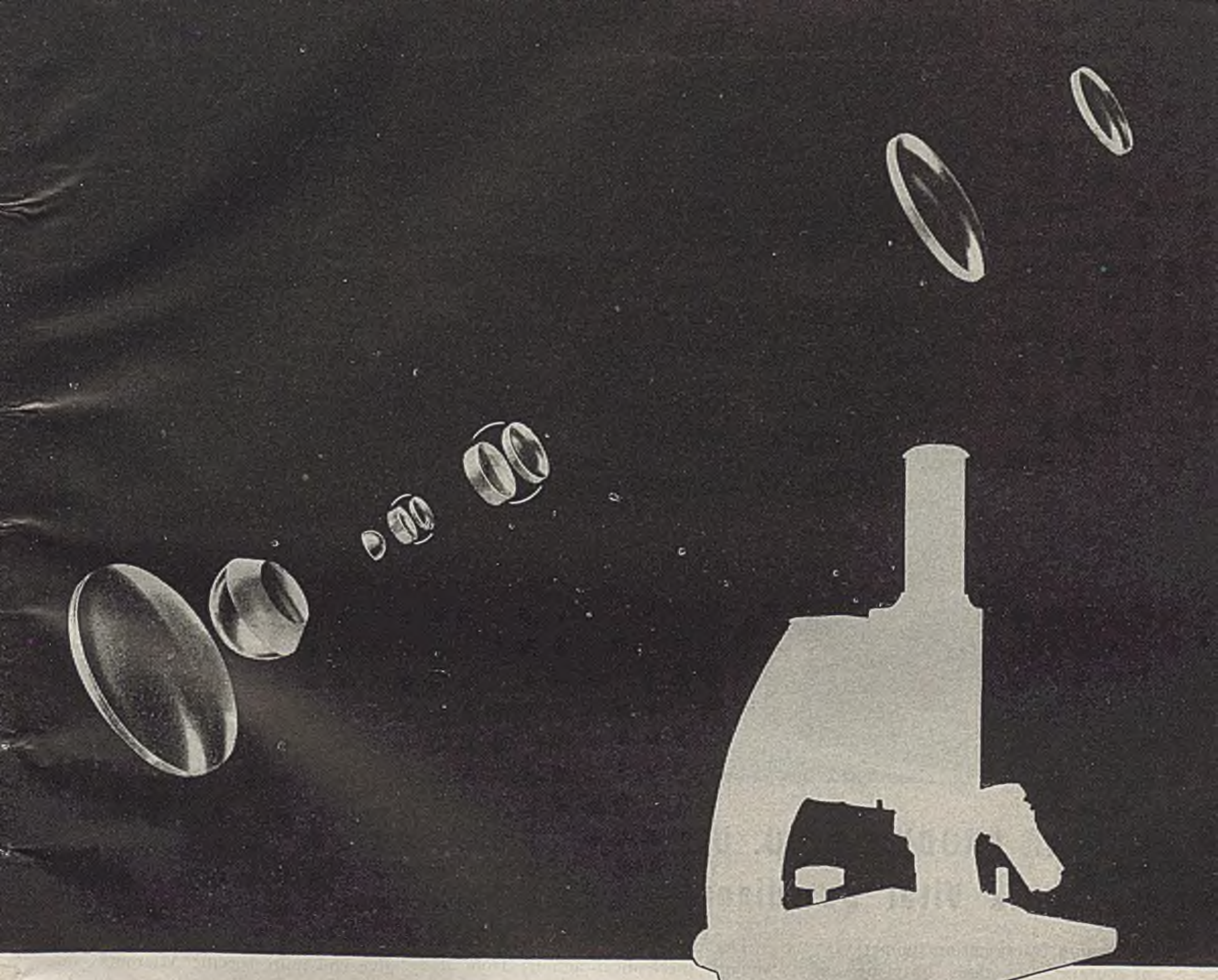
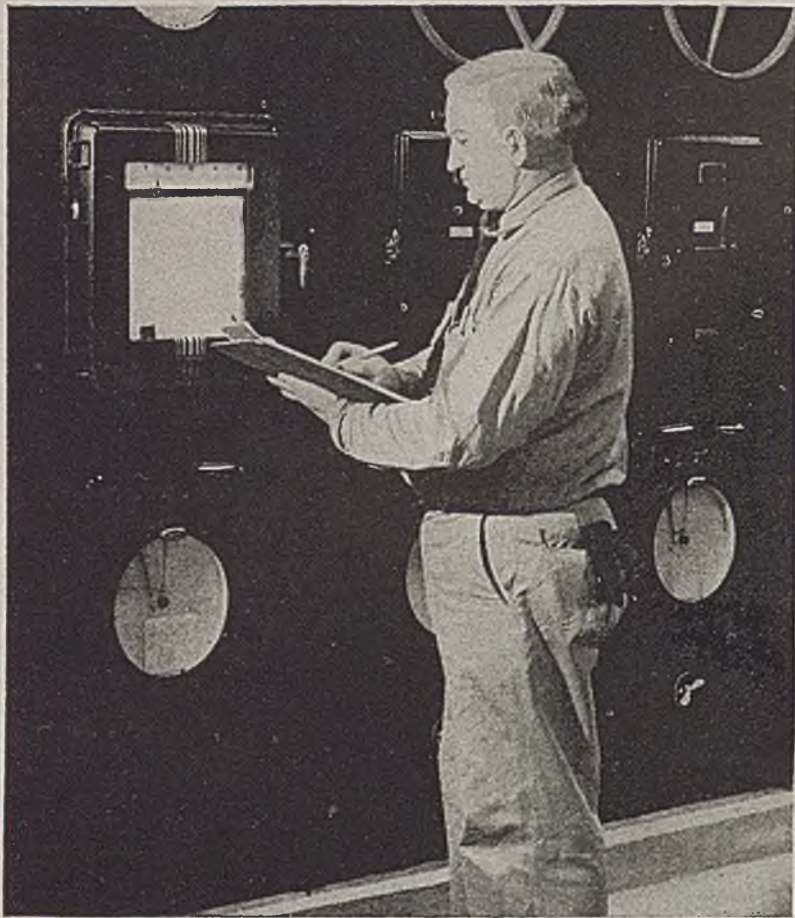
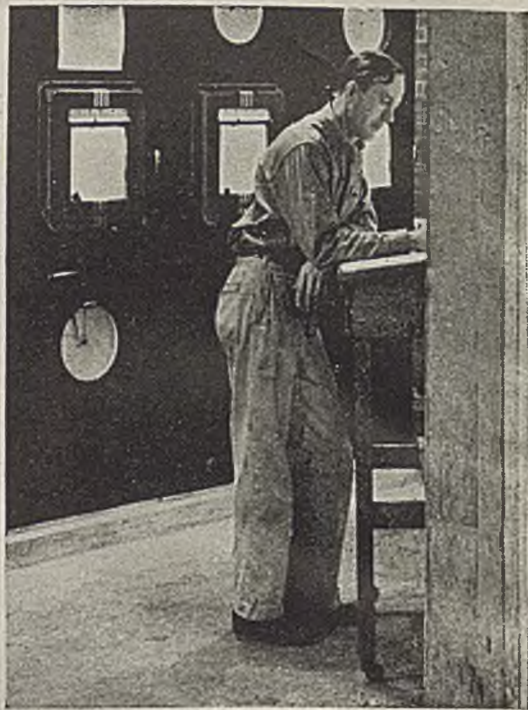






Left: Incoming operators at Butane Products Co., Port Neches, Texas, get a complete temperature history from the wide, easily-read strip-charts of Micromax Pyrometer Recorders. Above: Three of the 60 Micromax Recorders which provide accurate and reliable records of the important fractionating and dehydrogenating temperatures at this butadiene plant.

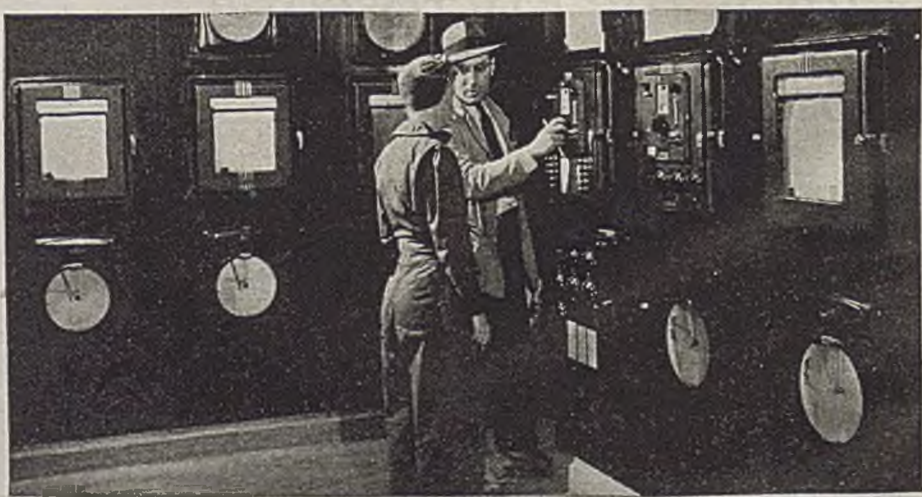
BUTANE PRODUCTS CO. USES MICROMAX
To Check Vital Butadiene Temperatures

Because fractionation temperatures of butane, isobutane, butylene and isobutylene are all within the same ten-degree range, accuracy becomes one of the vital qualities in the temperature instruments used for fractionation of butadiene for synthetic rubber manufacture. At Port Neches, Texas, the Butane Products Co. has turned over the job of automatic temperature watchmen to Micromax Recorders, using in all, 60 Recorders and 20 Indicators on their highly critical fractionating units.

Typical of the hundreds of Micromax instruments in refinery service, these pyrometers have shown on a 24-hr., day-in, day-out basis the Micromax ability to hang onto temperature. No matter how small or how great the fluctuation, Micromax detects it, measures it and, by recording it promptly on its wide strip-chart, leaves a permanent temperature guide.

Details of Micromax design assure smooth mechanical action; from its sturdy, cast frame to its vapor-proof door all its parts are rugged. Machine-type; gears, bearings and shafts are extra-heavy. And maintenance demands are few: Micromax automatically standardize itself; signals when ink, chart or dry cell need replacing.

An L & N engineer will be glad to give you more specific Micromax information, or will send you a catalog if you prefer.



Temperatures of near or distant couples are read with equal reliability on the many L&N Manual Indicators in the Neches plant.

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CHEM. & MET.'S 11th REPORT ON

MATERIALS OF CONSTRUCTION FOR CHEMICAL ENGINEERING EQUIPMENT

TWENTY-ONE years ago we published our first "Corrosion" issue, focussing attention on the comparatively few materials then available for the construction of chemical engineering equipment. Cast iron, lead, wood and stoneware were the standbys. Chrome-nickel and other ferrous and non-ferrous alloys were just beginning to claim attention while plastics and other synthetics were largely confined to the laboratory. Then, as the process industries began their great growth and development, the chemical engineer set out in earnest to solve the ever-present problem of corrosion.

His progress to date is fairly reflected in these biennial "Materials of Construction" issues. Each, since 1929, has been planned and produced under the direction of our managing editor, James A. Lee. Each has pointed the trends and presented in convenient form the most reliable information available on the properties and applications of the many metallic and non-metallic materials used by the chemical engineer in his continuing battle against the destructive forces of corrosion.

For corrosion is a relentless as well as an insidious enemy. It has been quick to take advantage of our weaknesses during the past few years when war demands have pushed for capacity production from over-worked equipment, often built of substitute materials, in makeshift designs. Metals have been scarce and that scarcity has been aggravated by corrosion losses—in materials, but more important, in time and, therefore, even in lives.

Shortly, we hope, there will be an opportunity to redesign equipment and to replace ineffective materials with those that have proved their worth in the fiery furnaces of experience. To help *Chem. & Met.* readers in that process of preparing for the resumption of peace-time production, this issue puts special emphasis on corrosion experiences. More data are presented on the resistance of more materials against more corrosives than in any of the preceeding issues. The test of all this is its value and practical usefulness to you who are responsible for chemical engineering progress. We hope it serves you well.

CHEMICAL & METALLURGICAL ENGINEERING

330 W. 42nd St., New York (18) N. Y.

CORROSION

Experiences in Chemical Process Industries

Here is how chemical engineers in 60 typical plants in the process industries size up their corrosion problems. Their views—sometimes amounting only to personal opinions—are largely based on their own experiences with the various metals, alloys and other materials of construction they use. This article tells the story largely in the words of the men we interviewed. We promised not to reveal their names or their plants, but we are all indebted to them for this sharing of their corrosion experiences.—Editors

ELSEWHERE in this Eleventh Materials of Construction issue of *Chem. & Met.* is tabulated the most recent and comprehensive information available on the metals, alloys, plastics, rubber, glass, ceramics and other structural materials most widely used in the chemical process industries. For the most part, this information has been supplied by the manufacturers whose research and service staffs have long studied the application and corrosion resistance of their products. To supplement this excellent and authoritative information with the results of operating experience, we have gone to the users of construction materials. Trained investigators have visited plants and interviewed approximately 60 men in responsible operating positions in as many different localities. In addition, questionnaires were sent to a carefully selected list of almost a hundred chemical engineers who were asked to tabulate their recommended practices in the use of materials for various equipment and processes.[1] All this is briefly summarized, as objectively as possible, in this introductory article.

Wartime experiences with corrosion have been unusually severe. Plants have often been forced to increase production beyond the capacity of existing equipment and, where new facilities have been provided it has sometimes been necessary to use substitute materials for which adequate operating information was not available. Wartime restrictions on secret processes and products have prevented frank discussion among users faced with similar problems or with the suppliers of equipment. Thus, it is not surprising that our investigators often reported conflicting and contradictory experiences, sometimes within the same industry. Take, for example, the views of several men in the alcohol industry, purposely selected from plants in different parts of the country:

Distiller's Dilemma

An engineer in an eastern distillery, converted entirely to industrial alcohol for the war effort reports: "Wheat is now the raw material for our grain alcohol and, in the raw mash stage, it is extremely corrosive. This raw wheat mash has caused considerable trouble with our pumps. We use a bronze, open-impeller centrifugal type, and so far we have had to replace the impellers about every four months, which involves too much maintenance for truly efficient operation. We are not certain whether this excessive wear is caused by corrosion or erosion. We strongly suspect that it is a combination of both."

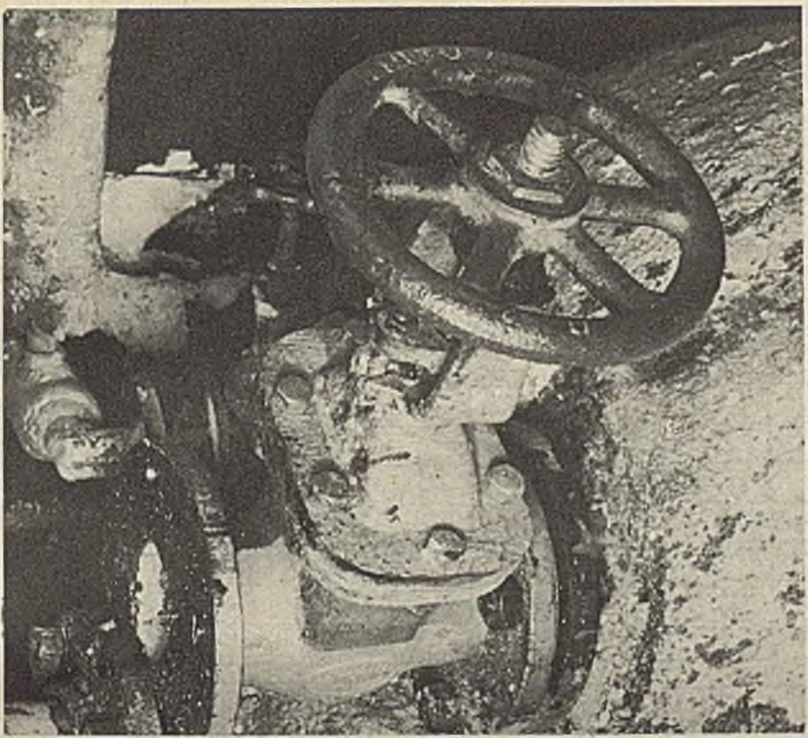
The plant superintendent for a midwestern solvents manufacturer said: "Corrosion has become a much more troublesome problem since the advent of the war. For one thing, we are handling considerably greater quantities of alcohol, but the rate of corrosion, it seems, increases at a faster rate than the volume. If we double our volume, the rate of corrosion is almost tripled. Consequently, we have found that corrosion from raw mash has made most of our present liquid-handling equipment entirely unsuitable.

"For instance, we have a number of lead centrifugal pumps and have always found lead to be a pretty good corrosion-resistant material for most chemical uses. But because a lead impeller is heavy, it cannot be used in a high-speed pump. In peace time this might not be too important a drawback but, due to war demands, we have to have high-speed equipment. Also, our lead pumps have lower efficiency so that from a cost standpoint, it would save us money to have a more efficient pump provided we could get one that would resist corrosion by the raw mash."

A third producer reports more satisfactory use of copper and bronze: "Alcohol, when it gets down to around pH 5 is so corrosive that the only material which satisfactorily resists it is copper. Most of our valves are bronze-seated gate valves which have proved very successful in our operations. We have considered glass or glass-lined pumps, but have not found any large enough for our work."

Acids Are Bad Actors

"We use acetic acid in manufacturing esters in our chemical plant," reports an eastern chemical engineer. "It has given us many sleepless nights in trying to locate the correct material to withstand its corrosion under the various conditions we encounter. Originally we used aluminum in alloy form on our acetic-acid lines and valves, but we had to discard this in favor of bronze. This gave us better service, but even so, bronze valves would show up with completely corroded gates at the end of three months' operation. We are now in



Corrosion often occurs in dangerous and inaccessible places as in this pipeline in a petroleum resin plant which had to be replaced with high Ni-Cr-Mo alloy steel after a costly failure of valve and fittings

the process of changing over to stainless steel. It costs at least twice what bronze costs, but we believe it will outlast bronze by about three times in this application, making the amortized cost of stainless steel actually less than that of bronze. Stainless-steel lines and valves will stand up for about a year.

"But the acetic-acid problem is still further complicated. At one stage in the operation, acetic acid is mixed with sulphuric acid and even stainless steel shudders in the presence of this combination. We are searching for an alloy that will give us at least a year's service in the presence of acetic and sulphuric acids."

Another manufacturer reports severe corrosion experiences with formic acid: "We have used glass pipelines on formic acid but we have replaced these with natural-rubber-lined pipe. Now we have been forced to use synthetic rubber in place of natural, but we have not been in operation long enough to draw any conclusions. Stainless steel seems to be the best material for use in formic-acid storage tanks. This is more expensive than plastic or rubber-lined steel, but we feel the cost to be justified. High-silicon iron cocks have given us good results. Copper condenser coils in formic acid formerly had to be replaced once a year. We installed stainless steel condensers two and a half years ago and they are still in operation. In general, we want material that will stand up with a minimum of maintenance. We know that 75 percent of our maintenance cost is in labor, only 25 percent in materials. To keep our maintenance cost down, we have to use the best materials available."

Lactic acid is not ordinarily considered a bad actor, but in one eastern chemical plant all of the lactic-acid equipment was formerly made of silver "because it will not contaminate anything with which it comes into contact." Interestingly enough, our interviewer was told that this plant had "replaced most of the silver with stainless steel because of the cost differential."

Pros and Cons on Stainless

This very evident trend toward the increased use of chromium-nickel steel was frequently mentioned to our interviews. Occasionally, however, these materials came in for criticism on the basis of cost. A quite typical comment was that of a hard-boiled plant superintendent who said: "We have to watch our costs constantly. We are no 'war baby'. We are manufacturing the same product we did in peace times, the only difference being that our only customer is the government. Our gross sales are up, it is true, but so are taxes, labor costs and materials. We can't go 'hog wild' on expenses if we expect to remain in business after the war. This policy has to be reflected in our equipment. We can't afford extravagance, or bright shiny equipment that will run our costs up. We want equipment of the 'work-horse' kind, that will stand up day in and day out even under the bad care that green help is giving it."

Contrast that view with the following statement from a chemical engineer in a paint manufacturing plant: "As far as we are concerned, one of the most important developments in paint equipment is the increased use of stainless steel. Contamination can not be tolerated in paint manufacture and stainless steel is definitely impervious to contamination. We plan to replace all of our tanks with stainless after the war, as well as a number of iron lines and in any other place the application may seem desirable. The advantages of stainless steel are well known, but there is one reason for liking it that doesn't seem to be generally considered. That is the manner in which it 'dresses up' the plant. The men working around stainless equipment seem to desire to keep it looking bright and clean, and of course, stainless is easier to keep in this condition. It's an intangible advantage. It could be compared to what we recently did in our laboratory when we doubled our window space, installed new lighting, painted the walls and floors white. Definite advantages almost immediately developed in terms of higher employee morale and lessened fatigue. It is our belief that stainless steel equipment would help to make this a brighter, more cheerful atmosphere."

The maintenance engineer in a much larger paint and varnish plant reports: "We have been and are going to continue to install more stainless steel kettles, mixers and the like. Stainless will withstand caustic cleaning solutions and also will stand higher temperatures.

Mineral Acids Make Mischief

The design engineer in a rayon plant has had interesting experience with sulphuric acid of various strengths. He reports: "We handle considerable quantities of sulphuric acid in all stages of concentration. By far the most pressing problem with our liquid-handling equipment is corrosion, particularly as related to pumps. From the standpoint of corrosion resistance, one of the best pumps in our plant is the centrifugal made from high silicon iron. It requires little maintenance and is highly efficient. Hard lead is best for corrosion resistance alone, but because the impeller is so heavy the end result with this pump is that you have to use a lot of power and obtain a lower rate of efficiency. We have a few rubber-lined pumps in operation and have had pretty good luck with them. But as with both rubber and lead pumps we do find that repairs are necessary quite frequently because the moving parts will not retain their tolerances.

[1]On the following pages (96, 97 and 98) are tabulated the results of this inquiry. Recognized chemical engineering authorities in plants manufacturing these chemical products were asked to report their best practice in the selection of materials of construction for the various pieces of processing equipment listed in this tabulation. Comments and criticisms will be welcomed.

MATERIALS OF CONSTRUCTION FOR CHEMICAL ENGINEERING EQUIPMENT AS REPORTED BY TYPICAL USERS

	Acetic Acid	Acetic Anhydride	Alcohol	Aluminum Chloride, Anhydrous	Ammonia Soda Alkalis	Ammonium Nitrate	Ammonium Sulphate	Bromine	Cane Sugar Refining	Cellulose Acetate	Chlorine, Dry	Chlorine, Wet	Chromic Acid
Absorbers	21,5,78, 28,41	21	10		10						84,33L, 69L,48,9	84,33L, 69L,48	
Acetylators	21,5,78, 28,41	3,7,28, 41,78	21							7,21,77, 57,58			
Agitators	21,5,78, 28,41	3,7,28, 41,78	9		10,9	76			10,6,9		70,33L,39	70,33L,39	13
Autoclaves	21,5,78, 28,41	3,7,28, 41,78											
Bins and Hoppers			9	54,9	20,93,10, 9	16,68,9		74	32,74	3			9
Centrifugals	21,5,78, 28,41	3,7,28, 41,78	7;74		10,74		7,54		7,74	77,7			
Classifiers				54	10,9				9				
Columns, Fractionating	21,5,78, 28,41	21,3,7, 28,41,78	21,74		10,9			33,84	21		9		
Condensers	21,5,78, 28,41,72	21,3,7, 28,41,78	21,7,2	9	10,57,54, 3			86,33,84	9,21	74	9		
Condenser Tubes	21,5,78, 28,41,72	21,3,7, 28,41,78	21	50L,74,9	10,57,54, 3			33,86	21,2		9		
Conveyors				54	69				9,7				9
Cookers	21,5,78, 28,41	21,3,7, 28,41,78	9						9				
Crushers and Grinders			10	10,54	10,9				9				13
Crystallizers	21,5,78, 28,41		9		10,9	10,11		74	9				
Dryers	21,5,78, 28,41	21,3,7, 28,41,78	10,9		10,9		42,7	74	9	3	69L,84,33	69L,84,33	
Drying Towers	21,5,78, 28,41				10,9						69L,84, 33,7	69L,84, 33,64,71	
Evaporators	21,5,78, 28,41	21,3,7, 28,41,78	21,7		10,57,58	80,76,10			9,10,21		57,9		
Fans and Blowers	21,5,78, 28,41		9	54	10,9				9,74		10.9	84	
Fermenters	23		93,9,23, 67						46				
Filter Presses	21,5,78, 28,41,23	21,3,7, 28,41,78	10,7,54		10	10		74	10,7,50L, 54	93			
Heat Exchangers	21,5,78, 28,41	21,3,7, 28,41,78	21,9,7	9	10,3,9	81,80		57	9,21,2, 28		9,57,7	69L,84, 33	
Kettles	21,5,78, 28,41	21,3,7, 28,41,78	21		10	10				77			9
Piping	3,21,5, 78,28,41, 7,74,33, 33L	21,3,7, 28,41,78, 9	21,74,48, 9	9	10,9	81,76,9	6	33,84,50, 71	9,6,21, 74	74,21,3	9,21	69L,33, 84	9
Pumps	21,5,78, 28,41,43	21,3,7, 28,41,78, 43,10	10,7,54		10,74,54	10,76	42,94,54	33,84	10,7,74	74,7,42	10	43,33	
Reaction Vessels	21,5,78, 28,41	21,3,7, 28,41,78			10,9			74	9	7,74	33L,57	33L,57	
Retorts	21,5,78, 28,41	21,3,7, 28,41,78	10	29					74				
Screens	21,5,78, 28,41		54,7	54,9	74	76,9			9,7,21, 54,74				
Scrubbers	21,5,78, 28,41		10,9		10			84	9		84,48	84,48	
Shipping Containers	93,3,33, 9,93	3,9	93,61,33, 9	9	47,61,93, 9,57	66,16,68, 93,9,61		33,50L, 84	61,22,47, 9		9	9	9
Stills	21,5,78, 28,41,72L	21,3,7,9 28,41,78,	21	9	10,9			33,86	21				
Tanks, Settling	21,5,78, 28,41,23	21,3,7,9 28,41,78,	9		10,9				9				
Tanks, Storage	3,21,5,78, 28,41,23, 84,69L,1	21,3,7, 28,41,78, 9	93,9		10,9	16,68,9, 10,93		50L	9,21	74,3,93	9	9	9
Tanks, Wash	21,5,78, 28,41,23		9		10,20,9								
Thickeners	21,5,78, 28,41,23				9				9				
Tower Packing	64,84	64,84	84,8		84,8			64,33,84	64,84		48,84,33	48,84,33	
Valves and Fittings	3,7,21,5, 78,28,41, 23,15,74	21,3,7, 28,41,84, 78,9,72L	10,7,54	9	10,74,54, 83	10,76		33,39,84, 74	10,7,74	74	9,34,6, 57,39,10, 84,48,64	69	9

	Dyes	Ethyl Acetate	Formaldehyde	Formic Acid	Glycerine	Hydrochloric Acid	Hydrofluoric Acid	Lactic Acid	Magnesium Chloride	Magnesium Sulphate	Methylene Chloride	Naphthalene	Nitric Acid, Strong	Nitric Acid, Weak	Paint & Varnish	Phenol
Absorbers	9,10,84, 40	30				85,1,48, 86,40,31, 15L,84,65L							81,80,76 1,84	81,80,76, 1,84		
Acetylators	33L,3	21,74,33L, 7,50L														
Agitators	70,51,93, 39,9,10, 33L,74,50	21,74		74				96	45	9,54		9	76	76		77,10,9
Autoclaves	58,9,10, 13,74											9				
Bins and Hoppers	58,9,74			9				74	9	9		9				
Centrifugals	70,54,7, 9,74				28,74,54				45	9,57		9,74				74
Classifiers									45	9						
Columns, Fractionating	9,10,21, 74	21,74				48,40,85, 1,65L						9				9
Condensers	9	21,74		74	9	86,48		74	9,45	9	74,18	9	43,31,33, 84	82,81,33, 43,84,31,		21,57,1L, 9
Condenser Tubes	9,2,54	21,74		74	21,2,54	86,48		74	9,45	9		9				17,21,57, 9,77
Conveyors	9								9,10	9		9				9
Cookers																
Crushers and Grinders	10,9,74								9,10			9			9	
Crystallizers	10								9,69L 1L	9,54		9				
Dryers	54,9,10, 74								9,45, 29L	9,54						9
Drying Towers						1,85L,65L			9,1L,45							
Evaporators	9,10				10,21,9	48,86,1L 65L		21,74	9,1L,45	9,74		9	86,43	86,43		1L,57,10, 9,77
Fans and Blowers	9,69L					40,91,36L, 64,84,15			9	9		9				9
Fermenters								96								
Filter Presses	93,39,10, 96				10,32,59	8,34,70			10,59	10,9,93		9,74				
Heat Exchangers	33,9,10, 7	21,74				48,86			9,45,59	9		9	81,76,80	81,76,80		9,74,77, 7
Kettles	9,50L,10, 1L,3,74, 69L,33L								1L,74,62L			9,74,54, 3			74,33,3	10,50,9
Piping	74,93,39, 69,85,71, 9,10,3, 69L,50	21,74,53, 7	88	69L,33L, 85,74,9 33	9	91,36,71, 69L,40,33, 48,64,31, 84L	53,71,30, 21,54,57, 69	21,74,24 72	9,45	9	77	9,50,3	43,3,81 33	81,76,80, 43,33	74,33,32 9	64,33,21, 9,69L,57, 10,50
Pumps	74,10,39, 69L,7,57, 36L	94,74,7, 53	74,7	43	10,7,74	68,63,48, 25,33,69L, 69,36	53,26,36 9,54,48	74,7,76	10,59,45	10,54	74	9,10,50L 43	43,33,74, 77,84	77,33,43, 84	10	33,38,74, 50L,9
Reaction Vessels	74,58,23, 9,50L,10, 1L,3,33L	21,74				85,1,48, 86,40,15L, 84,65L						9				9,10,50L
Retorts												9				
Screens	9,6,54, 74							74	9,45	74,54		74				77
Scrubbers	9,10,84, 40					85,1,48, 86,40,15L, 84,65L		33,40	93			9	81,84	81,84		9
Shipping Containers	61,9,93	53,9	3	33	9	69L,33	9	93,33	9	9		93,47,9	81,80,9,3	81,80,9		9
Stills	9,74,21	21,74		10	9	48,86,1, 65L		74				9			74	9,77
Tanks, Settling	93,9,1L, 50L							74	1L	9		9				9,93
Tanks, Storage	74,50L,9, 3,57,69L	53	3,74,33L 69L,20	74,40	3,74,54 69L,50L, 75L,32	69L,91,40 33,84,33L	53	74	9,1L	9	77	9,3	33L,4	81,80,33L		33L,9
Tanks, Wash	93,9,50L 1L,69L								1L	9		9				9
Thickeners									45,1L	9						
Tower Packing	84,8					64,8,15			64			84,64	64,84,33,	1,15,33		64,8,15
Valves and Fittings	39,54,9 10,50,6,74 57	7,53		26,74,43	9,6	56,69,48, 54	53,30,54, 13	74,72,7, 69	10,59	10,74		9	64,43,3, 81	43,81	74,9,84, 43,7	9,10,74, 50L,64

	Phosphoric Acid	Potassium Chloride	Potassium Hydroxide	Soap	Sodium Chloride	Sodium Chromate & Bichromate	Sodium Hydroxide	Sodium Hypochlorite	Sulphate Pulp	Sulphide Pulp	Sulphuric Acid
Absorbers							9,57,54	69L		9	1,84,9
Acetylators											
Agitators	70,77, 50L,1L	9,10	57	74,54,10, 7	77	9	9,54,57	69L,72, 86			
Autoclaves						9					50L,1,10
Bins and Hoppers	9	9		9,58,75	54,93,58	9	9,54,57			93,9	9
Centrifugals		54,57,45, 7	9,57		77,54	9	9,54,57	69L,77, 72			
Classifiers		9				9	9,54,57	69L	9		
Columns, Fractionating											
Condensers	10		57			9	9,57	69L	9		
Condenser Tubes		54	57			9,95	9,2,6	72,33	74,9		
Conveyors	69	9		9,32	69,54,93	9	9,54,57		69	9,69	
Cookers						9			53,9,78	1L	50,53
Crushers and Grinders	69L,50L,9	9				9,10	10	69L			
Crystallizers		9	57,58		10,74,9	9,10	9,57	69L			
Dryers		9		9	54,54L, 95	9	10	10,33L			1
Drying Towers				9			84,1				1L
Evaporators	50L,1L, 78,35,51	10,54,9	57,58	21,12,10	10,74,21, 59,9	9,10	58,10,54, 57	69L,72L	53		
Fans and Blowers	9,70	9				9	9	69L	9,78,95, 54,16	35	50L,9,10
Fermenters											
Filter Presses	69,77,50, 93,70	54,9	10,57	3,21,6, 7,10,9	59,54	10	10,9,57	69L,36, 92,34			
Heat Exchangers		54,9	57			9	57,54,9	72,33			9,74,10
Kettles			10	58,75,9, 54L		9	10	33L,72			
Piping	69L,50L, 50,69, 1L	69,69L, 54,10,84, 93	9,57	66,9,74	53,9,95,	9,10	9,57,15L, 69L	69L,36, 10,33,72	9,10,95, 78,36,52	89,93,95, 10,78,21, 20L,6	9,10,95, 50,43,40, 21,7
Pumps	77,35,70	59,10	59	9,74,10, 54,59,7, 43	59,94,7	10,7	57,10,43	69L,43, 10	78,77,74, 59,54,27, 60,7,10, 12		10,43,74, 50,94,69L, 7,35,84,33 49,44,13
Reaction Vessels	70,77, 50L,1L					9	9,10,57, 69L	69L,33L, 20			
Retorts											10
Screens		76	57		7,74,54	9	9,54	77,70, 72	54,9,74, 57	19	
Scrubbers	90,21,71, 54,69					9	9,10	84,70			50,84
Shipping Containers	9,69L		9	61	47,61,93	93,61	9,69L	33,69L, 32,9,84			9,50L,33
Stills				74,75,54, 57							13
Tanks, Settling	50L,1L	9	9,58	23,9	67	9	9,58,57	69L,20			
Tanks, Storage	50L,9	9	9	9,23,93, 75,58	9	9	9,58,57	69L,20		93	9,33L,84
Tanks, Wash		9	9			9	9,58	69L,20	78,54,9, 10	93	
Thickeners	70,93,50, 77,50L,1L	9,1L	9,57,58			9	9	69L			
Tower Packing						84,64,15	9	84,64			1,15,33
Valves and Fittings	77,50L, 69L	10,9,74	57,59	9,10,74	7,6	9,10	10,54,57, 7	69L,36, 10,72,37	78,83,54, 10,77,59, 14	50,6,7, 78,54,10	10,50,94, 39,35,43, 33L,64,69

L = Lined
1 Acid-proof brick
2 Admiralty
3 Aluminum
4 Aluminum 2S
5 Aluminum Bronze
6 Brass
7 Bronze
8 Carbon
9 Carbon steel
10 Cast Iron
11 Cast Iron (Ni, 2; Cr, 0.4)
12 Cast Iron (Ni, 5)
13 Cast Steel
14 Causul
15 Ceramics
16 Chlorinated Rubber Paint
17 Chrome Alloy
18 Chrome Steel
19 Chrome Plate
20 Concrete
21 Copper
22 Cotton
23 Cypress
24 Dilecto
25 Durichlor
26 Duramet
27 Elcomet K
28 Everdur
29 Fire Brick
30 Forged Steel
31 Fused Quartz or Silica
32 Galvanized Iron
33 Glass
34 Glass Cloth
35 Hard Lead
36 Hard Rubber
37 Hastelloy
38 Hastelloy B
39 Hastelloy C
40 Haveg
41 Herculoy
42 High Cr Steel
43 High Si Iron
44 Illium
45 Inconel
46 Ingot Iron
47 Jute
48 Karbate
49 LaBour-R55
50 Lead
51 Pb Covered Cu
52 Low Cr Ni C. I.
53 Mild Steel
54 Monel
55 Natural Rubber
56 Neoprene
57 Nickel
58 Nickel Clad
59 Ni-Resist
60 Ni Steel (2%)
61 Paper
62 Phenolic Resin
63 Plastic
64 Porcelain
65 Pyroflex
66 Red Brass
67 Red Wood
68 Resin-Base Paint
69 Rubber
70 Rubber Covered
71 Saran
72 Silver
73 Soapstone
74 Stainless
75 Stainless Clad
76 Stainless 304
77 Stainless 316
78 Stainless 317
79 Stainless 344
80 Stainless 347
81 Stainless 430
82 Stainless 443
83 Stellite
84 Stoneware
85 Synthetic Rubber
86 Tantalum
87 Tile
88 Tinned Copper
89 Transite
90 Treated Wood
91 Tygon
92 Vinyon
93 Wood
94 Worthite
95 Wrought Iron
96 Yellow Pine

"We have one hard rubber pump on a solution containing 25 percent of sulphuric acid as well as some oil. Although the rubber would withstand the acid, it would not withstand the oil. We tried synthetic rubber instead of hard rubber and this was even worse. We are experimenting with stoneware at the present time, and we hope that this material will solve our problem. We have just installed carbon heating coils in our acid tanks. These replace lead coils."

Looking toward the millenium, our design engineer sums up his needs as follows: "Our major problem with materials of construction is this. We have tanks constructed out of wood, lead, steel, concrete and brick. What we are after is an all-purpose material that will withstand acid, alkalis and oils, so that we can standardize and avoid the present wide divergence in the types of materials we have in use." Nevertheless, he continues to experiment with both glass and plastic, only to discover that the latter material would not withstand temperatures beyond 200 deg. C. and that it was scarcely safe to use glass-lines on pressure service of 100 lb. per sq. in. "Recently," he added, "we have scrapped a number of lead valves on our sulphuric acid line in favor of porcelain valves. The lead in the former type was going into the acid. In manufacturing rayon we can't tolerate any foreign substance in the acid since it would color the fiber which is the end product."

An assistant production superintendent in an eastern coal-tar products plant reports: "We use a considerable amount of sulphuric acid as a reagent in washing. Other than the corrosion angle, this is an acid which poses some definite safety hazards. It can easily burn and scald the worker, and if the line or valve carrying sulphuric acid should suddenly go, there is no end of damage the spray might do. Consequently, we equip our workers handling the acid with rubber caps, gloves, and in some cases, with full-length coats. These provide adequate protection, but the rubber safety caps we have in use are improperly designed. The caps do not fit tightly over the back of the neck and it is possible, and has been the case, that drops of acid filter down the worker's neck, and this form of 'human corrosion' is highly unpleasant, to say the least.

"We use two different materials in our sulphuric acid line, depending on whether the acid is in concentrated or dilute form. For the concentrated acid, we use carbon steel, for the dilute, we use lead-lined pipe. Both materials are excellent for the purpose; we know of none better."

Another plant reports: "Finding a material that will stand up in our chromic-acid flakers is a problem that we have never really solved. Under the double action of corrosion and abrasion, the rolls corrode and form pits in which the flakes stick. When pressure is put on the knives to scrape out the pits, the knives are ruined. We used a high-carbon steel, but the chromic acid seemed to take the carbon out of the steel and even went to work on the steel in some places. We tried chrome plate, which you would think would be a natural, but the hot chromic acid loosened it. Now we use an extra heavy steel and must resurface the rollers about once every eight months. We are very much interested in spraying metals because there are any number of places where such deposits could be used advantageously in the chemical industry. We ourselves have tried to spray tanks with stainless steel, but the coating did not adhere strongly. Major problems with sprayed metals are eliminating porosity and attaining adherence, but these properties will ultimately come, in our opinion."

Hydrofluoric acid, because of its increasing use as a catalyst in the petroleum industry, is now becoming one of our important mineral acids. It is bringing with it a number of corrosion problems to both manufacturers and users. The chief engineer of one such chemical plant says: "Valves on our anhydrous HF lines were made of cast iron at one time and they were entirely unsuited for this service. At the present time we use valves made of forged steel with a Monel trim and aluminum packing. Can't say too much in favor of these valves. They have been in service three years and have given us almost completely trouble-free performance. Our anhydrous HF lines are also made of forged steel.

"Probably the toughest problem with which we are faced in our entire plant is related to the handling of dilute HF. We have at various times experimented with a number of metals, finally concentrating on copper, Monel and nickel, with emphasis on the first two at the present time. But we can't honestly say that these metals are giving us what might be regarded as optimum service. Dilute HF will force us to replace lines and equipment made with these metals every six months."

Interview with another plant superintendent brought out the fact that dilute HF (under 60 percent concentration) attacked steel but if 1½ percent sulphuric acid is added, for some unknown reason it serves to pacify or protect the steel drums from corrosion.

The chief supervising engineer in an eastern oil refinery reported: "We use hydrofluoric acid as a catalyst and this is a particularly mean acid for us to handle. After experimenting with a variety of materials in pumps for HF, we finally resolved on carbon steel with a Monel metal trim. This pump is giving us excellent service but, of course, it must be continuously lubricated and flushed in order to deliver top performance. The acid is peculiar in that it has different qualities in dilute and concentrated forms. Although carbon steel will withstand the attack of hydrofluoric acid in concentrated form, it quickly corrodes in the presence of the dilute acid. Consequently, we are turning to structural carbon almost completely to handle dilute hydrofluoric acid. We have found it to be of a highly satisfactory material."

A development engineer in another petroleum refinery reports: "We're partial to carbon equipment. In the first place, it's so very easy to repair. Carbon cement, which gave us a lot of trouble before we learned how to use it, now makes any break or crack a comparatively minor matter, since a pump or line can be repaired in very short order. Carbon is also a good heat-transfer medium. If the product is developed to a point where it has greater tensile strength and can stand extremes of temperature and turbulence, it will be the most wonderful material the chemical industry will have at its disposal."

Another plant reports: "We have recently installed a number of the new plastic tubes on HF lines and believe they are going to work out fine. Plastic is more expensive than copper which it is replacing, but it is non-corrosive, and I think the additional cost is justified. These lines are only ¼ in. in diameter, so that the material can be used at pressures that would not be possible on plastic lines of larger diameter."

Despite his interest in plastics, this chemical engineer says: "The major development I would like to see after the war is the development of more durable and less easily corroded metals and alloys. The trend during the war has seemed to be in the direction of such non-metallic materials as glass, plastics and synthetics. I personally would rather have metal equipment or pipelines than any of these new materials. I am just saving myself work in the long run if I get corrosion-resistant metals in the plant in the first place."

Someone said that differences of opinion are what make horse races interesting. Our interviewer remarked that two other men in the same plant were most enthusiastic about the new non-metallics.

Paint Problems

"Fortunately, the problem of corrosion in this plant (a large eastern paint factory) is comparatively minor. Our main problems, particularly, with liquid-handling equipment are first, contamination (that is the color of a pigment being affected by the material with which it comes into contact), and second, the caking of moving valves and pump parts with drying oils.

"With respect to the problem of contamination, we have experimented with and are very much interested in glass. In the paint industry glass as a material has certain definite advantages. It won't contaminate and it is possible to check the pigmentation easily and safely. But, sometimes we feel the price we have had to pay for this is almost too great. We're hoping that post-war developments in this field will bring a greater durability to glass which will enable us to use the material for purposes where we need the intrinsic qualities of glass."

A dyestuff manufacturer and user must also guard against contamination. The manager of one small unit in the Middle West reported: "After the war, we're going to spend from $60,000 to $100,000 on stainless steel equipment. It may not be a lot of money to some companies, but it is certainly a major expenditure for a company of our size. Stainless is the best material available for dyeing work. It has a number of very important advantages. First, it is easy to clean. When we want to change from one color to another, it is important that the kettle be cleaned thoroughly. Second, it resists dilute acids and alkalis as well as peroxides. The equipment we are going to replace with stainless steel includes peroxide bleaching kettles, pumps, dye parts and packaged dye units.'"

Alum Allergies

"In each of our alum boiling tanks," said the superintendent of a medium sized heavy chemical plant, "we maintain a steam coil at the bottom. Originally these coils were constructed entirely of lead, but we found that the lead bulged from the steam pressure wherever there was a weak spot in the material. This usually took about 8 months. To lick this problem, we started covering copper pipe with lead, which eliminated the problem of bulging. After a couple of years, however, the alum liquor penetrates the lead and although we could recoat the pipe, we have found that it costs no more to purchase and install an entire new unit."

The chief engineer in a larger eastern plant reported: "We are replacing brass filtrate pipes on our alum rotary filter with stainless steel. Although the cost of stainless is mich higher, we feel it is justified in terms of better service. We are also in the process of installing stainless steel coils in place of aluminum coils in our kettles. Our reason for this is that aluminum restricts the use of the kettles. Stainless can be used on more types of acids than aluminum, consequently, a kettle equipped with stainless-steel coils can be used for many different plant operations. And, too, stainless will not contaminate the product. We are replacing the steel salt dissolving tanks with the same material. We are using lead coils in our fatty-acid tanks which are giving us poor service due to the fact that the coils corrode. We will install Type 347 stainless steel coils as soon as the present lead coils completely wear out."

Cosmetic Chemistry

The chief chemist in charge of cosmetics in an eastern plant reports: "We are really not chemical manufacturers, but rather packagers and compounders. All of the actual ingredients which go into our cosmetics are purchased from other companies. We manufacture various types of creams, hair-setting lotions, hand lotions and the like for the 10-cent store market. Our compounding kettles are steam-jacketted copper, lined with tin. The copper itself would be no good as a lining inasmuch as it would soon turn green and contaminate the product. Tin is expensive but it stands up well, and it is comparatively easy to reline a kettle when this becomes necessary."

Space does not permit us to include more of these first-hand reports of experiences in meeting the many corrosion problems that are so common to most chemical engineering operations. Perhaps these are sufficient, however, to show something of the severity and importance of these problems as well as their great diversity. The most encouraging comment reported by practically all of our interviewers is the recognition that progress is being made. Chemical engineers generally feel that their corrosion problems can be and are being solved. Even though complaining and often finding fault with new and untried materials, the truth is that a great deal of research and experimentation is under way in all of the plants we visited. The cooperation extended to our investigators is encouraging evidence that the users of chemical engineering equipment are willing to join with the manufacturers[2] of such equipment and the producers of materials to make certain that corrosion problems are brought out into the open, so that all may benfit through frank discussion and a sharing of experiences.

[2]As an example of what leading producers of equipment are doing to help chemical engineers keep corrosion under control, the reader is referred to a comprehensive article and tabulation by L. G. Vande Bogart, research engineer of the Crane Co. of Chicago which appeared originally in "Valve World," for May, 1944 and is now available in reprint form. This tabulation recommends the materials of construction be used in handling corrosive solutions most often met in industry.—Editor.

A 4 in. black-iron pipe in a constant-level tank after 18 months' service in an alcohol plant

Inside of the dried grain bins and ducts steel plate is badly damaged, probably as a result of a combination of corrosion and erosion. Raw-mash proves equally corrosive

Aluminum baffle plates in the dust collectors of a grain drying unit in a whisky distillery now converted to the production of industrial alcohol were seriously corroded

DIRECTORY OF METALS

Materials for Chemical Engineering Equipment

Herewith has been compiled, with the assistance of the manufacturers, a list of most of the metallic materials that are used for the construction of process industry equipment. Ferrous alloys are followed by non-ferrous. The name of each material is accompanied by name and address of the manufacturer, essential nominal chemical composition, and forms in which it is available. In addition, the table gives the primary purpose of the material: corrosion, heat or abrasion resistance. The numbers in the first column refer to a tabulation appearing on pages 107-130 in which resistance of the metals to 80 corrosive chemicals is shown.

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
	FERROUS ALLOYS				
1	301 Stainless Steel, wrought	Note: Physical and chemical properties for those stainless steels in *wrought* form which	Fe; Cr. 16–18; Ni, 6–8; C, 0.08–02; Mn, 2.0 max.; Si, 1 max.	B, CR, D, HR, P, S, W	Corrosion
2	302 Stainless Steel, wrought	have been assigned type numbers by the American Iron & Steel Institute are grouped	Fe; Cr. 17–19; Ni. 8–10; C, $>$ 0.08–0.20; Mn, 2.0 max.; Si, 1 max.	B, CR, D, HR, P, S, W, T, R	Corrosion
3	302B Stainless Steel, wrought	herewith at the suggestion of the Stainless	Fe; Cr, 17.0–19; Ni, 8–10; C, 0.08–0.20; Si, 2–3; Mn, 2.0	B, CR, D, HR, P, S, W	Corrosion
4	303 Stainless Steel, wrought	Steel Technical Committee of the producers. These stainless steels in *wrought* form are	Fe; Cr, 17–19; Ni, 8–10; C, 0.2 max.; P or S or Se, 0.07 min. Zr or Mo, 0.60 max.	B, CR, D, HR, P, S, W	Corrosion
5	304 Stainless Steel, wrought	generally available from the following producers: Allegheny-Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 18–20; Ni, 8–10; C, 0.08 max.; Mn, 2.0 max.; Si, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
6	308 Stainless Steel, wrought	Alloy Metal Wire Co., Prospect Park, Pa. American Rolling Mill Co., Middletown, Ohio	Fe; Cr, 19–21; Ni, 10–12; C, 0.08 max.; Mn, 2 max.; Si, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
7	309 Stainless Steel, wrought	Babcock & Wilcox Tube Co., Beaver Falls, Pa. Bethlehem Steel Co., Bethlehem, Pa.	Fe; Cr, 22–24; Ni, 12–15; C, 0.20 max.; Mn, 2 max.; Si, 1 max.	B, CR, D, HR, P, R, S, W	Corrosion
8	310 Stainless Steel, wrought	A. M. Byers Co., Pittsburgh, Pa. Carpenter Steel Co., Reading, Pa.	Fe; Cr, 24–26; Ni, 19–22; C, 0.25 max.; Mn, 2 max.; Si, 1.5 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
9	316 Stainless Steel, wrought	Cooper Alloy Fdry. Co., Elizabeth, N. J. Crucible Steel Co., New York, N. Y.	Fe; Cr, 16–18; Ni, 10–14; C, 0.10 max.; Mo, 1.75–2.5; Mn, 2 max.; Si, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
10	321 Stainless Steel, wrought	Wilbur B. Driver Co., Newark, N. J. Firth Sterling Steel Co., McKeesport, Pa. Forging and Casting Corp., Ferndale, Mich.	Fe; Cr, 17–19; Ni, 8–11; C, 0.10 max.; Ti, min. 4xC; Mn, 2 max.; Si, 1. max.	B, CR, D, HR, P, R, S, T, W	Corrosion
11	347 Stainless Steel, wrought	Henry Disston & Sons, Philadelphia, Pa. Ingersoll Steel & Disc Div., Borg-Warner	Fe; Cr, 17–19, Ni, 9–12; C, 0.10 max.; Cb8xC; Mn, 2 max.; Si, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
12	403 Stainless Steel, wrought	Corp., New Castle, Ind.	Fe; Cr, 11.5–13; C, 0.15 max.; Mn, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
13	405 Stainless Steel, wrought	Jessop Steel Co., Washington, Pa.	Fe; Cr, 11.5–13.5; C, 0.08; Al, 0.10–0.30	B, CR, D, HR, P, S, W	Corrosion
14	406 Stainless Steel, wrought	Latrobe Electric Steel Co., Latrobe, Pa.	Fe; Cr, 12–14; C, 0.15 max.; Al, 3.5–4.5	B, CR, D, HR, P, S, W	Corrosion
15	410 Stainless Steel, wrought	Michiana Products Corp., Michigan City, Ind. Midvale Co., Philadelphia, Pa.	Fe; Cr, 11.5–13.5; C, 0.15 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
16	414 Stainless Steel, wrought	Spang Chalfant Div., Nat. Supply Co., Pitts-	Fe; Cr, 11.5–13.5; Ni, 2.5 max.; C, 0.15 max.	B, D, HR, P, R, S, W	Corrosion
17	416 Stainless Steel, wrought	burgh, Pa. Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 12–14; C, 0.15 max.; P or S or Se, 0.07 min. Zr or Mo, 0.60 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
18	420 Stainless Steel, wrought	Republic Steel Corp., Cleveland, Ohio	Fe; Cr, 12–14; C, $>$ 0.15; Mn, 1 max.	B, CR, D, HR, P, R, S, W	Corrosion
19	430 Stainless Steel, wrought	Rustless Iron & Steel Corp., Baltimore, Md.	Fe; Cr, 14–18; C, 0.12 max.; Mn, 1 max.	B, CR, HR, P, R, S, T, W	Corrosion
20	430F Stainless Steel, wrought	Superior Steel Corp., Carnegie, Pa. United States Steel Corp., Pittsburgh, Pa. Universal Cyclops Steel Corp., Bridgeville, Pa.	Fe; Cr, 14–18; C, 0.12 max.; P or S or Se, 0.07 min. Zr or Mo, 0.60 max.	B, CR, D, HR, R, W	Corrosion
21	431 Stainless Steel, wrought	Vanadium Alloys Steel Co., Latrobe, Pa.	Fe; Cr, 15–17; Ni, 1.25–2.5; C, 0.20 max.	B, CR, D, HR, P, S, W	Corrosion
22	440A Stainless Steel, wrought		Fe; Cr, 16–18; C, 0.60–0.75; Mn, 1 max.; Si, 1 max.		Corrosion
23	440B Stainless Steel, wrought		Fe; Cr, 16–18; C, 0.75–0.95; Mn, 1 max.; Si, 1 max.		Corrosion
24	440C Stainless Steel, wrought		Fe; Cr, 16–18; C, 0.95–1.20; Mn, 1 max.; Si, 1 max.		Corrosion
25	442 Stainless Steel, wrought		Fe; Cr, 18–23; C, 0.35 max.; Mn, 1 max.; Si, 1 max.	B, CR, D, HR, P, R, S	Corrosion
26	443 Stainless Steel, wrought		Fe; Cr, 18–23; C, 0.20 max.; Mn, 1 max.; Si, 1 max.		Corrosion

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
27	446 Stainless Steel, wrought	See previous page for manufacturer's name	Fe; Cr, 23–27; C, 0.35 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
28	501 Stainless Steel, wrought	and address.	Fe; Cr, 4–6; C, > 0.10; Mn, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
29	502 Stainless Steel, wrought		Fe; Cr, 4–6; C, 0.10 max.; Mn, 1 max.	B, CR, D, HR, P, R, S, T, W	Corrosion
30	CA-14 Stainless Steel, cast		Fe; Cr, 11–14; Ni, 1 max.; C, 0.14 max.	Castings	Corrosion
31	CA-40 Stainless Steel, cast		Fe; Cr, 11–14; Ni, 1 max.; C, 0.20–0.40	Castings	Corrosion
32	CB-30 Stainless Steel, cast		Fe; Cr, 18–22; Ni, 2 max.; C, 0.30 max.	Castings	Corrosion
33	CC-35 Stainless Steel, cast		Fe; Cr, 27–30; Ni, 3 max.; C, 0.35 max.	Castings	Corrosion
34	CD-10M Stainless Steel, cast		Fe; Cr, 27–30; Ni, 3–6; C, 0.10 max.; Mo, 2.00 max.	Castings	Corrosion
35	CE-30 Stainless Steel, cast	Note: These are the standard designations	Fe; Cr, 27–30; Ni, 8–11; C, 0.30 max.	Castings	Corrosion
36	CF-7 Stainless Steel, cast	of cast compositions for nickel-chromium	Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.	Castings	Corrosion
37	CF-10 Stainless Steel, cast	alloys published by the Alloy Casting Institute.	Fe; Cr, 18–20; Ni, 8–10; C, 0.10 max.	Castings	Corrosion
38	CF-16 Stainless Steel, cast	The recommended uses have been	Fe; Cr, 18–20; Ni, 8–10; C, 0.16 max.	Castings	Corrosion
39	CF-20 Stainless Steel, cast	assembled from published data of individual	Fe; Cr, 18–20; Ni, 8–10; C, 0.20 max.	Castings	Corrosion
40	CF-7Se Stainless Steel, cast	producers. These compositions are available	Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Se, 0.20–0.35	Castings	Corrosion
41	CF-7C Stainless Steel, cast	from one or more of the following foundries:	Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Cb, 10XC	Castings	Corrosion
42	CF-7M Stainless Steel, cast	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Mo, 2.5–3.5	Castings	Corrosion
43	CF-10M Stainless Steel, cast	American Manganese Steel Div. of the American	Fe; Cr, 18–20; Ni, 8–10; C, 0.10 max.; Mo, 2.5–3.5	Castings	Corrosion
44	CF-16M Stainless Steel, cast	Brake Shoe & Fdry. Co., Chicago	Fe; Cr, 18–20; Ni, 8–10; C, 0.16 max.; Mo, 2.5–3.5	Castings	Corrosion
45	CF-7MC Stainless Steel, cast	Heights, Ill.	Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Mo, 2.5–3.5; Cb, 10XC	Castings	Corrosion
		American Steel Castings Co., Newark, N. J.			
46	CG-7 Stainless Steel, cast	Atlas Foundry Co., Irvington, N. J.	Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.	Castings	Corrosion
47	CG-10 Stainless Steel, cast	Babcock & Wilcox Co., Barberton, Ohio	Fe; Cr, 20–22; Ni, 10–12; C, 0.10 max.	Castings	Corrosion
48	CG-16 Stainless Steel, cast	Chicago Steel Foundry, Chicago, Ill.	Fe; Cr, 20–22; Ni, 10–12; C, 0.16 max.	Castings	Corrosion
49	CG-16Se Stainless Steel, cast	Cooper Alloy Foundry Co., Elizabeth, N. J.	Fe; Cr, 20–22; Ni, 10–12; C, 0.16 max.; Se, 0.20–0.35	Castings	Corrosion
50	CG-7C Stainless Steel, cast	Crane Co., Chicago, Ill.	Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.; Cb, 10XC	Castings	Corrosion
51	CG-7M Stainless Steel, cast	Driver Harris Co., Harrison, N. J.	Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.; Mo, 2.5–3.5	Castings	Corrosion
52	CG-10M Stainless Steel, cast	Duraloy Co., Scottdale, Pa.	Fe; Cr, 20–22; Ni, 10–12; C, 0.10 max.; Mo, 2.5–3.5	Castings	Corrosion
53	CG-16M Stainless Steel, cast	Duriron Co., Inc., Dayton, Ohio	Fe; Cr, 20–22; Ni, 10–12; C, 0.16 max.; Mo, 2.5–3.5	Castings	Corrosion
54	CG-7MC Stainless Steel, cast	Electric Steel Foundry Co., Portland, Ore.	Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.; Mo, 2.5–3.5; Cb, 10XC	Castings	Corrosion
		Electro-Alloys Co, Elyria, Ohio			
55	CH-10 Stainless Steel, cast	Empire Steel Castings, Inc., Reading, Pa.	Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.	Castings	Corrosion
56	CH-20 Stainless Steel, cast	General Alloys Co., Boston, Mass.	Fe; Cr, 23–26; Ni, 10–12; C, 0.20 max.	B, C	Corrosion
57	CH-10C Stainless Steel, cast	General Metals Corp., Oakland, Calif.	Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.; Cb, 10XC	Castings	Corrosion
58	CH-10M Stainless Steel, cast	Grede Foundries, Milwaukee, Wis.	Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.; Mo, 2.5–3.5	Castings	Corrosion
59	CH-20M Stainless Steel, cast	Hoskins Mfg. Co., Detroit, Mich.	Fe; Cr, 23–26; Ni, 10–12; C, 0.20 max.; Mo, 2.5–3.5	B, C	Corrosion
60	CH-10MC Stainless Steel, cast	Lebanon Steel Foundry, Lebanon, Pa.	Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.; Mo. 2.5–3.5; Cb, 10XC	Castings	Corrosion
		Michiana Products Corp., Michigan City, Ind.			
61	CK-25 Stainless Steel, cast	Michigan Steel Casting Co., Detroit, Mich.	Fe; Cr, 23–26; Ni, 19–21; C, 0.25 max.	Castings	Corrosion
62	CM-25 Stainless Steel, cast	Midvale Co., Philadelphia, Pa.	Fe; Cr, 8–11; Ni, 19–21; C, 0.25 max.	Castings	Corrosion
63	CN-25 Stainless Steel, cast	National Alloy Div. of the Blaw-Knox Co.,	Fe; Cr, 18–22; Ni, 23–26; C, 0.25 max.	Castings	Corrosion
64	CS-25 Stainless Steel, cast	Blawnox, Pa.	Fe; Cr, 8–12; Ni, 29–32; C, 0.25 max.	Castings	Corrosion
65	CT-25 Stainless Steel, cast	Ohio Steel Foundry Co., Lima and Springfield,	Fe; Cr, 13–17; Ni, 34–37; C, 0.25 max.	Castings	Corrosion
66	HB Stainless Steel, cast	Ohio	Fe; Cr, 18–22; Ni, 2 max.	Castings	Heat
67	HC Stainless Steel, cast	Otis Elevator Co., Buffalo, N. Y.	Fe; Cr, 27–30; Ni, 3 max.	Castings	Heat
68	HD Stainless Steel, cast	Shawinigan Chemicals, Ltd., Montreal, Que.	Fe; Cr, 27–30; Ni, 3–6	Castings	Heat
69	HE Stainless Steel, cast	Sivyer Steel Casting Co., Milwaukee, Wis.	Fe; Cr, 27–30; Ni, 8–11	Castings	Heat
70	HF Stainless Steel, cast	Standard Alloy Co., Cleveland, Ohio	Fe; Cr, 18–23; Ni, 8–11	Castings	Heat
71	HH Stainless Steel, cast	Symington-Gould Corp., Rochester, N. Y.	Fe; Cr, 23–27; Ni, 10–13	Castings	Heat
72	HI Stainless Steel, cast	Taylor Wharton Iron & Steel Co., High	Fe; Cr, 26–30; Ni, 13–16	Castings	Heat
73	HK Stainless Steel, cast	Bridge, N. J.	Fe; Cr, 23–26; Ni, 19–21	Castings	Heat
74	HL Stainless Steel, cast	Warman Steel Casting Co., Huntington Park,	Fe; Cr, 28–32; Ni, 19–21	Castings	Heat
75	HN Stainless Steel, cast	Calif.	Fe; Cr, 18–22; Ni, 23–26	Castings	Heat
76	HP Stainless Steel, cast	Utility Electric Steel Foundry, Los Angeles,	Fe; Cr, 28–32; Ni, 29–31	Castings	Heat
77	HS Stainless Steel, cast	Calif.	Fe; Cr, 8–12; Ni, 29–32	Castings	Heat
78	HT Stainless Steel, cast		Fe; Cr, 13–17; Ni, 34–37	Castings	Heat
79	HU Stainless Steel, cast		Fe; Cr, 17–21; Ni, 37–40	Castings	Heat
80	HW Stainless Steel, cast		Fe; Cr, 10–14; Ni, 59–62	Castings	Heat
81	HX Stainless Steel, cast		Fe; Cr, 15–19; Ni, 65–68	Castings	Heat
82	A Metal	Midvale Co., Philadelphia, Pa.	Fe; Cr, 19; Ni, 35; C, 0.35; Si, 1; Mn, 0.5	Castings	Heat
83	A M F	Midvale Co., Philadelphia, Pa.	Fe; Ni, 46–50; C, 0.1–0.2; Mn, 1—2	Castings	Corrosion
84	Abrasion Resisting	Lukens Steel Co., Coatsville, Pa.	Fe; C, 0.4–0.5; Mn, 1.80 max.	HR, P	Abrasion
85	Alchrome 3	Wilbur B. Driver Co., Newark, N. J	Fe; Cr, 20; Al, 3	R, W	Heat
86	Alchrome 6	Wilbur B. Driver Co., Newark, N. J	Fe; Cr, 20; Al, 6	R, W	Heat
87	Allegheny Metal 18-8M	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 24–26; Ni, 19–22; C, 0.25 max.; Mn, 2.00 max.; Mo, 2–3	B, C, CR, HR, D, P, S, R, T, F, W	C & H
88	Allegheny Metal 12W	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 12–14; C, 0.15 max.; W, 2.5–3.5; Mn, 0.50 max.; Ni, 0.5 max.	B, C, R, F	C & H
89	Allegheny Metal 46SM	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 4–6; C, 0.10 max.; Mn, 0.50 max.; Ni, 0.50 max.; Mo, 0.4–0.6[1]	B, CR, P, S, R, T, W, F	C & H
90	Allegheny Pluramelt	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	See footnote 2		Corrosion
91	Alray D	Alloy Metal Wire Co., Prospect Park, Pa.	Fe; Cr, 35; Ni, 15		Heat
92	Amsco Hardface-Self Hardening	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C; Cr; Mo; Mn		Abrasion
93	Amsco Hard Facing Rod 217	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C; Cr; Mn; W, Mo	Welding rod	Abrasion
94	Amsco Manganese Steel	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C, 1.05–1.20; Mn, 12.5–13; Si, 0.4–0.6		Abrasion
95	Antaciron	Worthington Pump & Mach., Corp., Harrison, N. J.	Fe; C, 0.60; Si, 14.5; Mn, 0.50	Castings	Corrosion
96	B & W 5150	Babcock & Wilcox Co., New York, N. Y.	Fe; Cr, 1.4; C, 1.0; Mn, 0.4; Si,, 0.25		
97	Bethlehem 235	Bethlehem Steel Co., Bethlehem, Pa.	Fe; C, 0.35; Mn, 1.20–1.75; Si, 0.15–0.25		Abrasion
98	Buflokast Gray Iron	Buffalo Fdry. & Machine Co., Buffalo, N. Y.	Fe; C, 3.2–3.6; Ni, 2 max.; Si, 1–2; Mn, 0.6–0.9	Castings	
99	Calite A	Calorizing Co., Wilkinsburg, Pa.	Fe; Cr, 15; Ni, 35; C, 0.55 max.	C, T	Heat

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
100	Calite B-28	Calorizing Co., Wilkinsburg, Pa	Fe; Cr, 25-28; Ni, 10-12; C, 0.35; Mo, 0.8-1.1	C, T	Heat
101	Carbon-Molybdenum Steel	Lukens Steel Co., Coatsville, Pa.	Fe; C, 0.18-0.28; Mo, 0.4-0.6; Mn, 0.5-0.9	HR, P, S	Heat
102	Cast Iron	Generally available	Fe; C, 3.55 (graphite, 2.79)	Castings	
103	Cast Iron	Generally available	Fe; C, 2.52; Si, 2.25; P, 0.76; S, 0.13; Mn, 0.58	Castings	
104	Causul Metal	Lunkenheimer Co., Cincinnati, Ohio	Fe; Ni, 19; C, 2.2-2.8; Cu, 4; Cr, 1.5	Castings	Corrosion
105	Chromax	Driver Harris Co., Harrison, N. J.	Fe; Cr, 19; Ni, 35	B, CR, HR, P, R, S, W	Heat
106	Chromel C	Hoskins Mfg. Co., Detroit, Mich.	Fe; Cr, 16; Ni, 61; C, 0.10	B, CR, D, HR, R, W	Heat
107	4-6 Chrome	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; Cr, 4-6; C, 0.10 max.; Mn, 0.5 max.; Ti, 4-6XC	HR, T	C & H
108	4-6 Chrome	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; Cr, 4-6; C, 0.20 max.; Mn, 0.5 max.	HR, T	C & H
109	Chrome Copper Nickel Steel	Lukens Steel Co., Coatsville, Pa.	Fe; Cr, 0.65-0.85; Cu, 0.45-0.65; Ni, 0.75 max.; C, 0.12 max,; Mn, 0.65-0.85	HR, P, S	
110	Chrome Manganese Steel	Lukens Steel Co., Coatsville, Pa.	Fe; Cr, 0.50; Mn, 0.90; C, 0.40	HR, P, S	Abrasion
111	Circle L13	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 13; C, 0.25 max.; Mn, 0.75; Ni, 0.75 max., Mo, 0.40	Castings	C & A
112	Circle L21	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 19; Ni, 9; C, 0.07 max.; Mn, 0.75; Cb, 0.75	Castings	Corrosion
113	Circle L22M	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 19; Ni, 9; C, 0.07 max.; Mn, 0.75; Mo, 1.75; Se, 0.25	Castings	Corrosion
114	Circle L22XM	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 20; Ni, 10; C, 0.07 max.; Mn, 0.75; Mo, 3	Castings	Corrosion
115	Circle L23XM	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 19; Ni, 9; C, 0.20 max.,; Mn, 0.75; Mo, 3	Castings	Corrosion
116	Circle L24	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 10; Ni, 20; C, 0.20 max., Mn, 0.75	Castings	Corrosion
117	Circle L31	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 29; Ni, 9; C, 0.30 max.; Mn, 0.75	Castings	Corrosion
118	Circle L32XMC	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 15; Ni, 35; C, 0.07 max.; Mo, 3.25; Cu, 2.25; Mn, 0.75	Castings	Corrosion
119	Circle L30-H	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 24; Ni, 12; C, 0.50 max.; Mn, 0.75	Castings	Heat
120	Circle L31-H	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 29; Ni, 9; C, 0.50 max., Mn, 0.75	Castings	Heat
121	Circle L32	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 15; Ni, 35; C, 0.50 max.; Mn, 0.75	Castings	Heat
122	Circle L34	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 21; Ni, 29; C, 0.07 max.; Mo, 3.25; Mn, 0.75	Castings	Corrosion
123	Circle L41	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 15; Ni, 65; C, 0.50 max.; Mn, 0.5	Castings	Heat
124	Circle L46	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 25; Ni, 20; C, 0.18 max.; Mn, 0.75	Castings	Heat
125	Colonial 610	Vanadium-Alloys Steel Co., Latrobe, Pa.	Fe; Cr, 16-18; Ni, 1; C, 0.12 max.; S, optional	B, D, HR, P, R, S, W	Corrosion
126	Cooper 16M	Cooper Alloy Fdry. Co., Hillside, N. J	Fe; Cr, 15-17; C, 0.15; Ni, 0.50 max.; Mo, 0.3-0.4	Castings	Corrosion
127	Cooper 21 A-B-C	Cooper Alloy Fdry. Co., Hillside, N. J.	Fe; Cr, 15-20; Ni, 20-25; C, 0.07-0.10; Mo, 3; Si, 1.5	Castings	Corrosion
128	Cooper 22 P-M	Cooper Alloy Fdry, Co., Hillside, N. J.	Fe; Cr, 24-28; Ni, 9-12; C, 0.2-0.5; Mo, 3	Castings	Corrosion
129	Corrosiron	Pacific Fdry. Co., San Francisco, Calif.	Fe; C, 0.8-1.0; Si, 14.50; Mn, 0.50	Castings	Corrosion
130	Crane 5-Cr-Mo Steel	Crane Co., Chicago, Ill.	Fe; Cr, 4-6; C, 0.30 max.; Mo, 0.55	Castings	C & H
131	Croloy 2	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 2; C, 0.15 max.; Mo, 0.50	B, C, HR, P, S, T, W	
132	Croloy 2¼	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 2.25; C, 0.15 max.; Mo, 1	B, C, HR, P, S, T	
133	Croloy 5	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 4-6; C, 0.15 max.; Mo, 0.45-0.65	B, C, HR, D, P, S, R, T, W	C & H
134	Croloy 7	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 7; C, 0.15 max.; Mo, 0.55; Si, 0.5-1	B, C, HR, P, S, T	Corrosion
135	Croloy 9	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 8-10; C, 0.15 max.; Mo, 1.2-1.5	B, C, P, S, R, T, W	Corrosion
136	Croloy 16-13-3	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 17; Ni, 13; C, 0.10 max.; Mo, 2.75	B, C, CR, HR, P, S, R, T, W	Corrosion
137	Dopploy 30	Sowers Mfg. Co., Buffalo, N. Y.	Fe; Cr, 2.35; Ni, 18.5; C, 2.85; Mn, 1	Castings	Corrosion
138	Duraloy 25-20M	Duraloy Co., Scottdale, Pa.	Fe; Cr, 24-26; Ni, 19-21; C, 0.20; Mo, 2-3	Castings	C & H
139	Durichlor	Duriron Co., Dayton, Ohio	Fe; C, 0.85; Si, 14.5; Mo, 3; Mn, 0.35	Castings	Corrosion
140	Durimet T	Duriron Co., Dayton, Ohio	Fe; Cr, 19; Ni, 22; C, 0.07 max.; Mo, 2; Cu, 1; Si, 1	B, C, D, HR, P, R, S, W	Corrosion
141	Durimet 20	Duriron Co., Dayton, Ohio	Fe; Cr, 20; Ni, 29; C, 0.07 max.; Mo, 2; Cu, 4; Si, 1	Castings	Corrosion
142	Duriron	Duriron Co., Dayton, Ohio	Fe; C, 0.80; Si, 14.50; Mn, 0.35	Castings	Corrosion
143	Elverite A	Babcock & Wilcox Co., New York, N. Y.	Fe; C, 3-3.5; Mn, 0.35; Si, 0.25-1		Abrasion
144	Elverite B	Babcock & Wilcox Co., New York, N. Y.	Fe; Cr, 1-1.8; Ni, 3.75-4.75; C, 3-3.5; Si, 0.25-1		Abrasion
145	Elverite C	Babcock & Wilcox Co., New York, N. Y.	Fe; Cr, 1-1.8; C, 3-3.5; Si, 0.25-1; Ni, 3.75-4.75		Abrasion
146	Genesee 255	Symington-Gould Corp., Rochester, N. Y.	Fe; Cr, 5; C, 0.20; Mn, 0.70; Mo, 0.50		C &H
147	Genesee 4-12	Symington-Gould Corp., Rochester, N. Y.	Fe; C, 1.10; Mn, 11-14	Castings	Abrasion
148	Ing[illegible] Stainless Clad Steels	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	See footnote 2	HR, P, S	Corrosion
149	Invar	Midvale Co., Philadelphia, Pa.	Fe; Ni, 26; C, 0.25; Mn, 0.60; Si, 0.20	B, C, HR, F	
150	K-4	Key Co., E. St. Louis, Ill.	Fe; Cr, 5; C, 0.25; Mn, 0.75; Mo, 0.50		C & H
151	K-8	Key Co., E. St. Louis, Ill.	Fe; Cr, 9; C, 0.15; Mo, 1.25; Mn, 0.75		Corrosion
152	Kanthal A	C. O. Jelliff Mfg. Corp., Southport, Conn.	Fe; Cr, 20-25; Co, 1-3; Al, 6	W, Ribbon	Heat
153	Kanthal A-1	C. O. Jelliff Mfg. Corp., Southport, Conn.	Fe; Cr; Co; Al	W, Ribbon	Heat
154	Kanthal D	C. O. Jelliff Mfg. Corp., Southport, Conn.	Fe; Cr, 20-25; Co, 1-3; Al, 4-5	W, Ribbon	Heat
155	Manganese Molybdenum Steel	Lukens Steel Co., Coatesville, Pa.	Fe; C, 0.25 max.; Mn, 1.65 max.; Mo, 0.75 max.; Si, 0.25	HR, P, S	Abrasion
156	Mayari R	Bethlehem Steel Co., Bethlehem, Pa.	Fe; Cr, 0.2-1; Ni, 0.25-0.75; C, 0.12 max.; Cu, 0.5-0.7; Mn, 0.5-1	B, CR, HR, P, R, S, T, W	Abrasion
157	Midvaloy ATV-1	Midvale Co., Philadelphia, Pa.	Fe; Cr, 10-12; Ni, 33-39; C, 0.25-0.35; Mn, 1.1-1.3	B, C, HR, F	H & C
158	Mivaloy ATV-3	Midvale Co., Philadelphia, Pa.	Fe; Cr, 13-15; Ni, 25-28; C, 0.40-0.55; W, 2.8-4.0; Mn, 1-1.6; Si, 0.95-1.75	B, C, HR, F	H & C
159	Midvaloy Hy X	Midvale Co., Philadelphia, Pa.	Fe; Cr, 7.75-8.5; Ni, 21-23; C, 0.45-0.55; Cu, 0.9-1.1; Si, 1 max.	B, C, HR, F	H & C
160	Midvaloy 13-0-Mo	Midvale Co., Philadelphia, Pa.	Fe; Cr, 13; Ni, 0.5; C, 0.15; Mo, 0.5; Mn, 0.4	B, C, HR, F	Corrosion
161	Midvaloy 1500	Midvale Co., Philadelphia, Pa.	Fe; Cr, 14-16; C, 0.3-0.4; Mn, 0.50; Si, 0.15-0.30	B, C, HR, F	Corrosion
162	Midvaloy 18-8-Se	Midvale Co., Philadelphia, Pa.	Fe; Cr, 20; Ni, 10; C, 0.8 max.; Si, 1; Mn, 0.5; Se, 0.3	B, C, HR, F	Corrosion
163	Midvaloy 25-12	Midvale Co., Philadelphia, Pa.	Fe; Cr, 22-26; Ni, 11-13; C, 0.25 max.; Mn, 0.25-1	B, C, HR, F	C & H
164	Milwaukee 28-12	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; Cr, 27-30; Ni, 11-13; C, 0.25 max.	Castings	C & H
165	Milwaukee 15-26	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; Cr, 14-17; Ni, 25-28; C, 0.45 max.	Castings	Heat
166	Milwaukee M-3	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; Cr, 13-15; Ni, 0.5-1; C, 0.12-0.20	Castings	Corrosion
167	Milwaukee M-4	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; Cr, 13-15; Ni, 0.50-1; C, 0.12-0.20; Mo, 0.9-1	Castings	Corrosion
168	Milwaukee K-G	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; Cr, 11-12; C, 1.45-1.60; Mo, 0.9-1; V, 0.20-0.25	Castings	Abrasion
169	Milwaukee Si-Cu	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; C, 0.25 max.; Si, 2-2.5; Cu, 1-1.25	Castings	
170	Milwaukee 22Cr-1.2C	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; Cr, 20-22; C, 1.25-1.50; Ni, 0.25 max.; Mo, 0.5-0.6; Si, 2-2.5	Castings	Abrasion
171	Miscrome 4	Michigan Steel Casting Co., Detroit, Mich.	Fe; Cr, 11.5-13; C, 0.12 max.; Ni, 0.80 max.	Castings	Corrosion

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
172	Nichrome	Driver Harris Co., Harrison, N. J.	Fe; Cr, 15; Ni, 60	B, CR, HR, P, R, S, T, W	Heat
173	2% Nickel Steel	Lukens Steel Co., Coatsville, Pa.	Fe; Ni, 2 min.; C, 0.25 max.	HR, P,S	
174	Ni-Hard	International Nickel Co., New York, N. Y.	Fe; Cr, 1.4–1.6; Ni, 4.4–4.6; C, 2.75–3.6; Si, 0.5–1	Castings	Abrasion
175	Nilstain	Wilbur B. Driver Co., Newark, N. J.	Fe; Cr, 18–20; Ni, 8–10; C, >.20; Mn, 2 max.	D, HR, R, W	Corrosion
176	Ni-Resist	International Nickel Co., New York, N. Y.	Fe; Ni, 13–15; Cu, 5.5–7; C, 2.95–3.1; Cr, 1.5–2.5; Mn, 1–1.75[7]	Castings	Corrosion
177	Pyrasteel 20	Chicago Steel Fdry, Co., Chicago, Ill.	Fe; Cr, 16–18; Ni, 35	Castings	Heat
178	Pyrasteel 2000	Chicago Steel Fdry. Co., Chicago, Ill.	Fe; Cr, 26; Ni, 12–14	Castings	Heat
179	Pyrasteel 14	Chicago Steel Fdry. Co., Chicago, Ill.	Fe; Cr, 6; Mo, 0.40–0.60	Castings	C & H
180	Pyrocast	Pacific Foundry Co., San Francisco, Calif.	Fe; Cr, 22–30	Castings	Heat
181	Rex Z Metal	Chain Belt Co., Milwaukee, Wis.	Fe; C, 2.5; Si, 1–1.5; Cu, 1; Mn, 0.8	Castings	
182	Sivyer 5% Cr	Sivyer Steel Castings Co., Milwaukee, Wis.	Fe; Cr, 4.5–6.5; C, 0.25 max.; Mo, 0.45–0.65	Castings	C & H
183	Spang Chalfant 1	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; C, 0.15; Cr, 1.75–2.25; Mn, 0.3–0.6; Mo, 0.45–0.65	HR, T	
184	Spang Chalfant 2	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; C, 0.1–0.2; Mn, 0.3–0.6; Si, 0.25 max.	HR	
185	Spang Chalfant 3	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; C, 0.1–0.2; Mo, 0.45–0.65; Mn, 0.3–0.6	HR	
186	Stainless Steel	Cooper Alloy Fdry. Co., Elizabeth, N. J.	Fe; Cr, 15; Ni, 65; C, 0.40	Castings	Heat
187	Steel	Generally available	Fe; C, 0.92; Si, 0.20; P, 0.042		
188	Steel	Generally available	Fe; C, 0.42; Si, 0.33; P, 0.02		
189	Steel	Generally available	Fe; C, 0.39; Si, 0.19; P, 0.044		
190	Ni Steel	Generally available	Fe; C, 0.39; Ni, 3.04; Mn, 0.65		
191	Timken 16–13–3	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 15.5–17; Ni, 12.5–14.5; C, 0.13 max.; Mo, 2.5–3.25; Mn, 1.5 max.	B, D, HR, R, T, W	Corrosion
192	Timken 2512	Timken Roller Bearing Co., Canton, Ohio	Fe; Ni, 4.75–5.25; C, 0.20 max.	T	Corrosion
193	Timken 2% Cr–0.5% Mo	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 1.75–2.25; C, 0.15 max.; Mo, 0.45–0.65; Mn, 0.3–0.6	B, HR, T	Corrosion
194	Timken 5 Cr-Mo plus Ti	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 4.6; C, 0.12 max.; Mn, 0.50 max.; Mo, 0.45–0.65; Ti, 4XC min, 0.70 max.	B, HR, R, T	C & H
195	Timken DM	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 1–1.5; C, 0.15 max.; Mn, 0.3–0.6; Mo, 0.45–0.65	B, HR, R, T	
196	Timken Silcromo 5 S	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 4–6; C, 0.15 max.; Si, 1–2; Mn, 0.5 max.	B, HR, R, T	C & H
197	Timken Silcromo 7	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 6–8; C, 0.15 max.; Si, 0.5–1; Mn, 0.50 max.	B, D, HR, R, T, W	C & H
198	Timken Silcromo 7M	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 6–8; C, 0.15 max.; Mo, 0.9–1.1; Mn, 0.50 max.; Si, 0.5–1	B, D, HR, W, R, T	C & H
199	Timken Silcromo 9M	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 8–10; C, 0.15 max.; Mn, 0.50 max.; Mo, 0.9–1.1	B, D, HR, R, T, W	C & H
200	Tophet C	Wilbur B. Driver Co., Newark, N. J.	Fe; Ni, 60; Cr, 15	D, HR, R, W	Heat
201	Tophet D	Wilbur B. Driver Co., Newark, N. J.	Fe; Ni, 35; Cr, 18.5	B, CR, D, HR, R, W	Heat
202	Utiloy 46	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; Cr, 4–7; C, 0.25 max.; Mo, 0.5; Mn, 0.75; Si, 0.4	Castings	C & H
203	Utiloy 12	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; Cr, 11–13; C, 0.12 max.; Mn, 0.4; Si, 0.9	Castings	Corrosion
204	Utiloy 12N	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; Cr, 11–13; C, 0.12 max.; Ni, 1.75–2.5	Castings	C & H
205	Utiloy X	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; Cr, 18; Ni, 8; C, 0.15 max.; Si, 0.9; Mn, 0.5	Castings	Corrosion
206	Utiloy XX	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; Cr, 18; Ni, 8; C, 0.07 max.; Mo, 3.5–4.5	Castings	Corrosion
207	Utiloy H	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; Cr, 23–26; Ni, 11–13; C, 0.28–0.32; Si, 0.9–1.1; Mn, 0.6–0.8	Castings	Heat
208	Warman 5M	Warman Steel Casting Co., Los Angeles, Calif.	Fe; Cr, 5–7; C, as specified; Mo, 0.5–0.6	Castings	C & H
209	Worthite	Worthington Pump and Machinery Corp., Harrison, N. J.	Fe; Cr, 20; Ni, 24; C, 0.07 max.; Si, 3.25; Mo, 3; Cu, 1.75; Mn, 0.5	B, C, CR, HR, R, W	Corrosion
210	Wrought Iron, Genuine	A. M. Byers Co., Pittsburgh, Pa.	Fe; C, 0.02; Mn, 0.03; P, 0.12; Si, 0.15; S, 0.02	B, HR, P, R, S, T	Corrosion

NON-FERROUS ALLOYS

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
211	Admiralty	Generally available	Cu, 70; Sn, 1; Zn, 29	CR, D, P, S, T	Corrosion
212	Advance	Driver Harris Co., Harrison, N. J.	Cu, 55; Ni, 45	B, CR, HR, P, R, S, W	Heat
213	Alcoa 2S	Aluminum Co. of Amer., Pittsburgh, Pa.	Al, 99 min.	B, C, CR, P, S, R, T, W, Shapes	Corrosion
214	Alcoa 3S	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mn, 1.2	B, CR, P, S, R, W, Shapes	Corrosion
215	Alcoa 52S	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 2.5; Cr, 0.25	B, CR, P, S, R, T, W	Corrosion
216	Alcoa 53S	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 1.3; Si, 0.7; Cr, 0.25	B, CR, P, S, R, W, Shapes	Corrosion
217	Alcoa Alclad (72S) 3S	Aluminum Co. of Amer., Pittsburgh, Pa.	See footnote 3		Corrosion
218	Alcoa 61S	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 1; Si, 0.6; Cr, 0.25; Cu, 0.25	CR, P, S, T	Corrosion
219	Alcoa 43	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Si, 5	Castings	Corrosion
220	Alcoa 100	Aluminum Co. of Amer., Pittsburgh, Pa.	Al, 99 min.	Castings	Corrosion
221	Alcoa 220–T4	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 10	Castings	Corrosion
222	Alcoa 356	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 0.3; Si, 7	Castings	Corrosion
224	Alcumite	Duriron Co., Dayton, Ohio	Cu, 89.75; Al, 9; Fe, 1.25	Castings	Corrosion
225	Alloy A	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 78–80; Cr, 20 max.; Si, 1.5 max.	CR, D, HR, R, W	Heat
226	Alloy C	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 58–62; Cr, 14–18; Si, 1.5 max.	CR, D, HR, R, W	Heat
227	Alloy D	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 30–35; Cr, 15–20; Si, 1.5 max.	CR, D, HR, R, W	Heat
228	Alloy 45	C. O. Jelliff Mfg. Corp., Southport, Conn.	Cu, 55; Ni, 45	W, Ribbon	C & H
229	Alray A	Alloy Metal Wire Co., Prospect Park, Pa.	Ni, 80; Cr, 20	W, R, Strip	Heat
230	Aluminum 2S	Reynolds Metals Co., Louisville, Ky.	Al, 99.0 min.; Fe + Si, 1.0 max.; Cu, 0.20 max.	B, R, W	Corrosion
231	Aluminum 3S	Reynolds Metals Co., Louisville, Ky.	Al; Mn, 1–1.5; Fe, 0.7 max.; Si, 0.60 max.; Cu, 0.2	B, R, W	Corrosion
232	Aluminum 14S	Reynolds Metals Co., Louisville, Ky.	Al; Cu, 3.9–5; Si, 0.5–1.2; Fe, 1.0 max.; Mn, 0.4–1.2; Mg, 0.2–0.8	B, R, W	Corrosion
233	Aluminum 17S	Reynolds Metals Co., Louisville, Ky.	Al; Cu, 3.5–4.5; Si, 0.8 max.; Fe, 1.0 max.; Mn, 0.4–1; Mg, 0.2–0.8	B, R, W	Corrosion
234	Aluminum 18S	Reynolds Metals Co., Louisville, Ky.	Al; Cu, 3.5–4.5; Ni, 1.7–2.3; Si, 0.90 max.; Fe, 1.0 max.; Mg, 0.45–0.90	B, R, W	Corrosion
235	Aluminum 24S	Reynolds Metals Co., Louisville, Ky.	Al; Cu, 3.8–4.9; Mg, 1.2–1.8; Si, 0.50 max.	B, R, W	Corrosion
236	Aluminum 24S Pureclad	Reynolds Metals Co., Louisville, Ky.	See footnote 4		Corrosion
237	Aluminum 25S	Reynolds Metals Co., Louisville, Ky.	Al; Cu, 3.9–5; Si, 0.5–1.2; Fe, 1.0 max.	B, R, W	Corrosion
238	Aluminum 32S	Reynolds Metals Co., Louisville, Ky.	Al; Si, 11–13.5; Cu, 0.5–1.3; Fe, 1.0 max.; Mg, 0.8–1.3; Ni, 0.5–1.3	B, R, W	Corrosion

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
239	Aluminum A 51S	Reynolds Metals Co., Louisville, Ky.	Al; Si, 0.6–1.2; Fe, 1.0 max.; Cu, 0.35; Mg, 0.45–0.80	B, R, W	Corrosion
240	Aluminum 52S	Reynolds Metals Co., Louisville, Ky.	Al; Mg, 2.2–2.8; Fe + Si, 0.45 max.; Cu, 0.1 max.	B, R, W	Corrosion
241	Aluminum 53S	Reynolds Metals Co., Louisville, Ky.	Al; Fe, 0.35 max.; Mg, 1.1–1.4; Cr, 0.15–0.35	B, R, W	Corrosion
242	Aluminum 61S	Reynolds Metals Co., Louisville, Ky.	Al; Si, 0.4–0.8; Fe, 0.7 max.; Mg, 0.8–1.2	B, R, W	Corrosion
243	Aluminum R 301	Reynolds Metals Co., Louisville, Ky.	See footnote 5	S, P	Corrosion
244	Aluminum Bronze	Amer. Brass Co., Waterbury, Conn.	Cu, 82–95; Al, 5–9.5; Fe, Mn, Ni, Sn	C, CR, F, HR, P, R, S, T, W	Corrosion
245	Aluminum Bronze	Hills McCanna Co., Chicago, Ill.	Cu, 85–89; Al, 9–10; Fe, 1.4; Mn, 0.5	Castings	Corrosion
246	Aluminum Bronze 5%	Revere Copper & Brass, New York, N. Y.	Cu, 95; Al, 5	T	Corrosion
247	Aluminum Bronze 5%	Amer. Brass Co., Waterbury, Conn.	Cu, 95; Al, 5		Corrosion
248	Aluminum Brass	Generally available	Cu, 76; Zn, 21.5–22; Al, 2–2.5	CR, D, T	
249	Ambrac 850	Amer. Brass Co., Waterbury, Conn.	Cu, 75; Ni, 20; Zn, 5	B, C, CR, D, HR, P, R, S, T, W	Corrosion
250	Ampco 12	Ampco Metal, Inc., Milwaukee, Wis.	Cu; Al, 8.5–9.3; Fe, 2.5–3.25	B, C, R, T	C & H
251	Ampco 15	Ampco Metal, Inc., Milwaukee, Wis.	Cu; Al, 9–10; Fe, 2.75–3.5	B, C, P, S, R, T	C & H
252	Ampco 18	Ampco Metal, Inc., Milwaukee, Wis	Cu; Al, 10.5–11.2; Fe, 3–4	B, C, R, T	C & A
253	Ampco 18–23	Ampco Metal, Inc., Milwaukee, Wis.	Cu; Al, 10.5–11.2; Fe, 3–4	B, C, R, T	C & A
254	Ampcoloy A-3	Ampco Metal, Inc., Milwaukee, Wis.	Cu; Al, 9.5–10.5; Fe, 0.1 max.	B, C	C & H
256	Ampcoloy 40	Ampco Metal, Inc., Milwaukee, Wis.	Cu; Al, 9.5–10.5; Fe, 0.1 max.	B, C	C & H
257	Antimonial Admiralty	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 72; Zn, 27; Sb, 0.07; Sn, 1	S, T, W	Corrosion
258	Arsenical Admiralty	Amer. Brass Co., Waterbury, Conn.	Cu, 70; Zn, 28.95; Sn, 1; As, 0.05	T	Corrosion
259	Arsenical Copper	Generally available [6]	Cu; As, 0.15–0.75	D, T	Corrosion
260	Beraloy	Wilbur B. Driver Co., Newark, N. J.	Cu; Be, 1.9; Co, 0.5	B, CR, D, HR	
261	Beraloy 175	Wilbur B. Driver Co., Newark, N. J.	Cu; Be, 1.9; Ni, 0.5 max.	B, CR, D, HR	
262	Beryllium Copper	Amer. Brass Co., Waterbury, Conn.	Cu, 97.4; Be, 2.25; Ni, 0.35	B, C, CR, D, HR, P, R, S, W	Corrosion
263	Beryllium Copper	Riverside Metal Co., Riverside, N. J.	Cu, 97.65; Be, 2.0; Ni, 0.35	B, CR, D, P, R, S, W	
264	Cadmium Copper	Phelps Dodge Copper Products Corp., New York, N. Y.	Cu, 99; Cd, 1	B, CR, D, HR, R, W	
265	Chromel A	Hoskins Mfg. Co., Detroit, Mich.	Ni, 78; Cr, 20; Mn, 2 max.; C, 0.06	B, CR, D, HR, R, W	Heat
266	Chromium Copper	Amer. Brass Co., Waterbury, Conn.	Cu, 99.05; Cr, 0.85; Si, 0.10	B, C, CR, D, HR, P, R, S, W	Corrosion
267	Colmonoy 4	Wall-Colmonoy Corp., Detroit, Mich.	Ni, 80; Cr, 11; B, 2; Fe + Si + C, 8 max.	B, C, R	C & A
268	Colmonoy 5	Wall-Colmonoy Corp., Detroit, Mich.	Ni, 76; Cr, 13; B, 3; Fe + Si + C, 9 max.	B, C, R	C & H
269	Colmonoy 6	Wall-Colmonoy Corp., Detroit, Mich.	Ni, 68; Cr, 18; B, 4; Fe + Si + C, 10 max.	B, C, R	C & H
270	Colmonoy 20	Wall-Colmonoy Corp., Detroit, Mich.	Ni, 85; Cr, 7; B, 1.5; Fe + Si + C, 7 max.	B, C, R	C & H
271	Colmonoy 300C	Wall-Colmonoy Corp., Detroit, Mich.	Ni, 77; Cr, 19; B, 4	B, C, R	C & H
272	Commercial Bronze	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 90; Zn, 10	CR, D, S, T, W	Corrosion
273	Commercial Bronze F. C.	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 89; Zn, 9; Pb, 2	B, D, R	Corrosion
274	Cupron	Wilbur B. Driver Co., Newark, N. J.	Cu; Ni, 45	B, CR, D, HR	
275	20% Cupro-Nickel	Generally available [6]	Cu, 80; Ni, 20	P, T	
276	30% Cupro-Nickel	Generally available [6]	Cu, 70; Ni, 30	B, C, CR, D, HR, P, R, S, T, W	
277	Deoxidized Copper	Generally available [6]	Cu, 99.9 +; P, 0.01–0.03	B, C, CR, D, HR, P, R, S, T, W	Corrosion
278	Dowmetal C	Dow Chemical Co., Midland, Mich.	Mg; Al, 9; Mn, 0.1; Zn, 2	Castings	Corrosion
279	Dowmetal J	Dow Chemical Co., Midland, Mich.	Mg; Al, 6.5; Mn, 0.2; Zn, 1		
280	Dowmetal M	Dow Chemical Co., Midland, Mich.	Mg; Mn, 1.5		
281	Dowmetal O	Dow Chemical Co., Midland, Mich.	Mg; Al, 8.5; Mn, 0.2; Zn, 0.5		
282	Durco D-10	Duriron Co., Dayton, Ohio	Ni, 57; Cr, 23; Cu, 8; Mo, 4; W, 2; Mn, 1		
283	Everdur 1000	Amer. Brass Co., Waterbury, Conn.	Cu, 94.9; Si, 4; Mn, 1.1		Corrosion
284	Everdur 1010	Amer. Brass Co., Waterbury, Conn.	Cu, 95.8; Si, 3.1; Mn, 1.1	B, CR, D, HR, P, R, S, T, W	Corrosion
285	Everdur 1015	Amer. Brass Co., Waterbury, Conn.	Cu, 98.25; Si, 1.5; Mn, 0.25	B, CR, D, HR, P, R, S, T, W	Corrosion
286	Frontier 5	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu, 89; Al, 10; Fe, 1	Castings	Corrosion
287	Frontier 11	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu, 88; Ni, 5; Sn, 5; Zn, 2	Castings	Corrosion
288	Frontier 40	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu, Zn, 5; Mg, 0.5; Cr, 0.5; Ti, 0.2	Castings	Corrosion
289	Gold	Baker & Co., Newark, N. J.	Au, 99.99	B, CR, C, D, HR, P, R, S, T, W	Corrosion
290	Hastelloy A	Haynes Stellite Co., Kokomo, Ind.	Ni; Mo, 23 max.; Fe, 23 max.	B, C, HR, P, R, S, T, W	Corrosion
291	Hastelloy B	Haynes Stellite Co., Kokomo, Ind.	Ni; Mo, 33 max.; Fe, 7 max.	B, C, HR, P, R, S, T, W	Corrosion
292	Hastelloy C	Haynes Stellite Co., Kokomo, Ind.	Ni; Cr, 18 max.; Fe, 7 max.; W, 6 max.	B, C, P, S, T	Corrosion
293	Hastelloy D	Haynes Stellite Co., Kokomo, Ind.	Ni; Si, 11 max.; Cu, 4 max.	B, C	Corrosion
294	Hardware Bronze	Scovill Mfg. Co., Waterbury, Conn.	Cu, 89; Zn, 8; Pb, 2; Ni, 1	D, R, W	Corrosion
295	Herculoy A	Revere Copper & Brass, New York, N. Y.	Cu, 96; Si, 3; Mn, 1; Sn, 0.5	B, CR, D, HR, P, R, S, W	Corrosion
296	Herculoy B	Revere Copper & Brass, New York, N. Y.	Cu, 98; Si, 1.75; Sn, 0.25	B, CR, D, HR, P, R, S, T, W	Corrosion
297	High Brass	Generally available [6]	Cu, 66; Zn, 34		Corrosion
298	High Silicon Bronze	Phelps Dodge Copper Products Corp., New York, N. Y.	Cu, 97.3; Sn, 1.65; Si, 1.05	B, CR, D, HR, R, W	
299	Hytensl Bronze	Amer. Manganese Bronze Co., Philadelphia, Pa.	Cu, 63; Zn, 23; Al, 4; Fe, 3; Mn, 3	C, HR, S	
300	Illium G	Burgess-Parr Co., Freeport, Ill.	Ni, 56; Cr, 22; Mo, 6; Fe, 6; Cu, 6; Mn; Si; C	Castings	
301	Illium R	Burgess-Parr Co., Freeport, Ill.	Ni, 55–60; Cr, 18–24; Mo, 5–8; Fe, 5–8; Cu, 2–6; Mn, 0.5–1.75; Si; C	B, C, CR, P, R, S, T, W	
302	Inconel	International Nickel Co., New York, N. Y.	Ni, 79.5; Cr, 13; Fe, 6.5; C, 0.08; Cu, 0.2; Mn, 0.25	B, C, CR, D, HR, P, R, S, T, W	C & H
303	Inconel Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni, 79.5; Cr, 13; Fe, 6.5; C, 0.08; Cu, 0.2; Mn, 0.25		C & H
304	Indium Metal	Amer. Smelting & Ref. Co., New York, N. Y.	In	B, C, CR, R, S, T, W	Corrosion
305	Iridio Platinum	Baker & Co., Inc., Newark, N. J.	Pt; Ir, 5–30	B, C, CR, D, HR, P, R, S, T, W	Corrosion
306	10% Iridium Platinum	J. Bishop & Co., Malvern, Pa.	Pt, 90; Ir, 10	B, C, CR, D, HR, P, R, S, T, W	Corrosion
307	30% Iridium Platinum	J. Bishop & Co., Malvern, Pa.	Pt, 70; Ir, 30	B, C, CR, D, HR, P, R, S, T, W	Corrosion
308	Lead, Antimonial	Amer. Smelting & Ref. Co., New York, N. Y. National Lead Co., New York, N. Y.	Pb, 94; Sb, 6	C, CR, D, R, S, T, W	Corrosion
309	Lead, Antimonial	Northwest Lead Co., Seattle, Wash.	Pb, 93.45; Sb, 6.5; Cu, 0.04–0.08	C, S, T, W	Corrosion
310	Lead, Asarco Acid	Amer. Smelting & Ref. Co., New York, N. Y.	Pb; Cu, 0.06; Bi, 0.02	C, CR, R, S, T, W	Corrosion

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available*	Primarily for
311	Lead, Chemical	Amer. Smelting & Ref. Co., New York, N. Y. National Lead Co., New York, N. Y.	Pb, 99.93; Cu, 0.06	B, C, CR, R, S, T, W	Corrosion
312	Lead, Chemical	Northwest Lead Co., Seattle, Wash.	Pb, 99.95; Cu, 0.04–0.08	C, S, T, W	Corrosion
313	Lead, Chemical Tellurium	Northwest Lead Co., Seattle, Wash.	Pb, 99.9; Te, 0.02–0.06; Cu, 0.04–0.08	C, S, T, W	Corrosion
314	Lead, Tellurium	Amer. Smelting & Ref. Co., New York, N. Y. National Lead Co., New York, N. Y.	Pb, 99.88; Cu, 0.06; Te, 0.045	B, C, CR, R, S, T, W	Corrosion
315	Leaded Commercial Bronze	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 89; Zn, 9; Pb, 2	B, D, R	Corrosion
316	Monel	International Nickel Co., New York, N. Y.	Ni, 67; Cu, 30; Fe, 1.4; Si, 0.1; C, 0.15	B, C, CR, D, HR, R, S, T, W, P	Corrosion
317	Monel Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni, 67; Cu, 30; Fe, 1.4; Si, 0.1; C, 0.15		Corrosion
318	Muntz	Generally available[6]	Cu, 60; Zn, 40	R, S, T, W	Corrosion
319	National Alloy 40	National Smelting Co., Cleveland, Ohio	Al; Cu, 4	Castings	Corrosion
320	National Alloy 40M	National Smelting Co., Cleveland, Ohio	Al; Mg, 4	Castings	Corrosion
321	National Alloy 42	National Smelting Co., Cleveland, Ohio	Al; Cu, 4; Si, 2		Corrosion
322	National Alloy 70S	National Smelting Co., Cleveland, Ohio	Al; Si, 7.5	Castings	Corrosion
323	National Alloy 5 Si	National Smelting Co., Cleveland, Ohio	Al; Si, 5		Corrosion
324	National Alloy Red X10	National Smelting Co., Cleveland, Ohio	Al; Si, 10; Cu, 1.5; Mn, 0.6; Mg, 0.5	Castings	Corrosion
325	National Alloy Y	National Smelting Co., Cleveland, Ohio	Al; Cu, 4; Ni, 1.5; Mg, 1.5	Castings	Corrosion
326	National Alloy 99+	National Smelting Co., Cleveland, Ohio	Al, 99+	Castings	Corrosion
327	National Alloy 98-99	National Smelting Co., Cleveland, Ohio	Al, 98–99	Castings	Corrosion
328	Naval Brass	Generally available[6]	Cu, 60; Zn, 39.25; Sn, 0.75	D, R, T, W	Corrosion
329	Nichrome V	Driver-Harris Co., Newark, N. J.	Ni, 80; Cr, 20	B, CR, D, HR, P, R, S, T, W	Heat
330	Nickel	International Nickel Co., New York, N. Y.	Ni, 99.4; Mn, 0.2; Cu, 0.1; Fe, 0.15; Si, 0.05	B, C, CR, HR, D, P, R, S, T, W	C & H
331	Nickel Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni, 99.4; Mn, 0.2; Cu, 0.1; Fe, 0.15; Si, 0.05	HR, P, S	C & H
332	Nickelchrome	Generally available	Ni, 85; Cr, 15		Heat
335	Nickelchrome	Generally available	Ni, 80; Cr, 14–20; Fe		Heat
336	Nickelchrome	Generally available	Ni, 60; Cr, 15; Fe		Heat
337	Nickel Silver 18%	Generally available[6]	Cu, 65; Ni, 18; Zn, 17	B, C, CR, D, P, R, S, T, W	Corrosion
338	Nickel Silver 18%	Generally available[6]	Cu, 55; Zn, 27; Ni, 18	B, C, CR, D, P, R, S	Corrosion
339	Nirex	Driver-Harris Co., Harrison, N. J.	Ni, 80; Cr, 14; Fe, 6	B, CR, HR, P, R, S, W	Heat
340	O. F. H. C. Copper	Amer. Metal Wire Co., Prospect Park, Pa.	Cu, 99.985	B, C, CR, D, HR, P, R, S, T, W	Corrosion
341	Olds Bearing Bronze	Olds Alloys, Pasadena, Calif.	Cu, 65; Ni		C & A
342	Oldsmoloy	Olds Alloys, Pasadena, Calif.	Cu, 40; Zn, 40; Ni, 15; Sn, 5; Mo, 1.5; Fe, 1		C & A
343	Olympic Bronze A	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 96; Si, 3; Zn, 1	CR, HR, D, S, R, T, W	Corrosion
344	Olympic Bronze B	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 97.5; Si, 1.5; Zn, 1	R, W	Corrosion
345	P. D. C. P. Copper	Phelps Dodge Copper Products Corp., New York, N. Y.	Cu, 99.985	B, C, D, CR, HR, R, T, W	Corrosion
346	Palladium	Baker & Co., Newark, N. J.	Pd, 99.991	B, C, CR, D, HR, P, R, S, T, W	Corrosion
347	Permite 1008	Aluminum Industries, Cincinnati, Ohio	Al; Cu, 4–5; Fe, 1.0 max.; Si, 2–3	Castings	Corrosion
348	Permite 1020-2020	Aluminum Industries, Cincinnati, Ohio	Al; Si, 6.5–7.5; Fe, 0.6 max.; Mg, 0.2–0.4	Castings	Corrosion
349	Permite 2010	Aluminum Industries, Cincinnati, Ohio	Al; Cu, 4–5; Si, 1.5 max.; Fe, 1.0 max.	Castings	Corrosion
350	Phosphor Bronze A	Generally available[6]	Cu, 94.8–95.5; Sn, 4.3–5.0; P	B, CR, D, P, R, S, T, W	Corrosion
351	Phosphor Bronze C	Generally available[6]	Cu; Sn, 7–9; P, 0.03–0.25		Corrosion
352	Phosphor Bronze D	Generally available[6]	Cu, 89.5–90; Sn, 10–10.5; P	B, CR, D, P, R, S, T, W	Corrosion
353	Phosphor Bronze F. C	Generally available[6]	Cu, 88; Zn, 4; Sn, 4; Pb, 4	B, CR, D, P, R, S	Corrosion
354	Phosphorized Admiralty	Scovill Mfg. Co., Waterbury, Conn.	Cu, 70; Zn, 29; Sn, 1; P, 0.03		Corrosion
355	Phosphorized Copper	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 99.9+; P, trace	CR, D, S, T	Corrosion
356	Pioneer	Pioneer Alloy Products Co., Cleveland, Ohio	Ni, 65; Cr; Mo; Fe		Heat
357	Platinum	Baker & Co., Newark, N. J.	Pt, 99.99	B, C, CR, D, HR, P, R, S, T, W	Corrosion
358	Platinum	J. Bishop & Co., Malvern, Pa.	Pt, 99.95	B, C, CR, D, HR, P, R, S, T, W	Corrosion
359	Red Brass	Generally available[6]	Cu, 85; Zn, 15		Corrosion
360	Resistac	Amer. Manganese Bronze Co., Holmesburg, Philadelphia, Pa.	Cu, 88; Al, 10; Fe, 2	C, HR, P, S	
361	Rhodio Platinum	Baker & Co., Newark, N. J.	Pt; Rh, 5–40	B, C, CR, D, HR, P, R, S, T, W	C & H
362	Roofloy	Amer. Smelting & Ref. Co., New York, N. Y.	Pb; Sn, 0.25; Mg, 0.02; Bi, 0.02	CR, R, T	Corrosion
363	Silver, Fine	Baker & Co., Newark, N. J.	Ag, 99.9+		Corrosion
364	Silver, Fine	Handy & Harman, New York, N. Y.	Ag, 99.9+	B, C, CR, D, P, R, S, T, W	Corrosion
365	Stellite 1	Haynes Stellite Co., Kokomo, Ind.	Co; Cr; W	C, Welding rod	Abrasion
366	Stellite 6	Haynes Stellite Co., Kokomo, Ind.	Co, 55 min.; Cr, 33 max.; W, 6 max.	Welding rod	Abrasion
367	Stellite 98M2	Haynes Stellite Co., Kokomo, Ind.	Cr, 35; max. Co, 35 min.; W, 20 max.		Abrasion
368	Stellite Star J-Metal	Haynes Stellite Co., Kokomo, Ind.	Co, 40 min.; Cr, 35 max.; W, 20 max.		Abrasion
369	Super Nickel Clad Steel	Lukens Steel Co., Coatesville, Pa.		HR, P, S	Corrosion
370	Tantalum	Fansteel Metallurgical Corp., N. Chicago, Ill.	Ta, 99.9+	D, R, S, T, W	Corrosion
371	Tellurium Copper	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 99.5; Te, 0.5	B, D, R, T, W	Corrosion
372	Telnic Bronze	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 98.3; Ni, 1; Te, 0.5; P, 0.2	D, R	Corrosion
373	Tobin Bronze	Amer. Brass Co., Waterbury, Conn.	Cu, 60; Zn, 39.25; Sn, 0.75	D, HR, R, W, B, CR, P, S, T	Corrosion
374	Tophet A	Wilbur B. Driver Co., Newark, N. J.	Ni, 80; Cr, 20	D, HR, R, W	Heat

* Forms available: B, bars; C, castings; CR, cold-rolled; D, drawn; HR, hot rolled; P, plates; R, rods; S, sheets; T, tubes; W, wire. [1] Types 501 and 502 stainless steels with additions of W, Al, Cu or Co may be obtained for special applications from Allegheny Ludlum Corp. [2] Clad stainless steels are available in many of the standard compositions. [3] Surface layer of aluminum alloy which is anodic to the core and will therefore protect the latter electrolytically. [4] Aluminum 24S core covered with aluminum of high purity. [5] High strength aluminum alloy core clad with corrosion-resistant aluminum alloy of intermediate strength. [6] Copper and copper alloys are available from such companies as the following: American Brass Co., Waterbury, Conn.; Bridgeport Brass Co., Bridgeport, Conn.; Bristol Brass Corp., Bristol, Conn.; Chase Brass and Copper Co., Waterbury, Conn.; Mueller Brass Co., Huron, Mich.; New England Brass Co., Taunton, Mass.; Phelps Dodge Products Corp., New York, N. Y.; Revere Copper and Brass, Inc., New York, N. Y.; Riverside Metal Co., Riverside, N. J.; Scovill Mfg. Co., Waterbury, Conn.; Seymour Mfg. Co., Seymour, Conn.; Wolverine Tube Co., Detroit, Mich. [7] Where copper contamination is undesirable a copper-free Ni-Resist is available.

CORROSION RESISTANCE

Of Metallic Materials of Construction

At the repeated demand of its readers for concrete information on the resistance to corrosion of the various materials available for the construction of chemical engineering equipment, *Chem. & Met.* has, with the cooperation of manufacturers, compiled this tabulation of the properties of the metals and alloys. The 80 chemicals for which information is given are arranged alphabetically. The numbers in the first column refer to the Directory of Metals on pages 101-106 of this issue. The second column is intended to give only a general idea of the composition of the material. To identify the specific metal or alloy the reader is referred to the corresponding number in the directory. The unit in which the data are expressed, inches penetration per year, represents, for the most part, an average penetration as calculated from loss in weight suffered by the metal while exposed to attack.

ACETALDEHYDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Commercial grade	< 0.001 at cold
	All copper base alloys		Recommended
370	Tantalum	Any conc.	None at any temp.

ACETIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)	
2	Stainless	10–80% sol.	< 0.0042 at 70° to 180°	
		10–60% sol.	0.042–0.12 at boiling	
		90% aerated	0.042–0.12 at 180°	
		80% sol.	0.12–0.24 at boiling	
		100%	< 0.0042 from 70° to 180°	
		100%	0.042–0.12 at boiling	
		100% at 150 psi.	> 0.12 at 400°	
5	Stainless		70°	180°
		3% sol.	0.0047	0.000
		20% sol.	0.0043	0.000
		40% sol.	0.0216	0.0086
9	Stainless	All conc.	< 0 0042 from 70° to 180°	
		10–33% sol.	< 0.0042 at boiling	
		50–100% sol.	0.0042–0.042 at boiling	
		100% sol. at 150 psi.	0.042–0.12 at 400°	
15	Stainless	5–10% agitated	< 0.0042 at 70°	
		5–10% aerated	< 0.0042 at 70°	
		5% sol.	> 0.1 at 130°	
		20% agitated or aerated	0.042–0.12 at 70°	
18	Stainless	5% sol.[1]	0.00634 at 68°	
		15% sol.[1]	0.00541 at 68°	
		33% sol.[1]	0.00541 at 68°	
19	Stainless		70°	100°
		5% agitated or aerated	<0.0042	0.0042–0.042
		10% agitated or aerated	< 0.0042	
		15% agitated or aerated		> 0.12
		20%	< 0.0042	
		33, 60%	0.042–0.12	0.12–0.42
		80%	0.0042–0.042	0.0042–0.042
		100%	< 0.0042	<0.0042
21	Stainless	10% [1]	< 0.0046 at 68° to boiling	
		50% — conc.[1]	< 0.0046 at 68°	
		50% — conc.[1]	< 0.046 at 68°	
30	Stainless	0.5, 10%	R at room temp.	
			Room temp.	Boiling
32	Stainless	0.5, 10%	R	R

No.	Material	Exposure Conditions	Room temp.	95°	Boil
32	Stainless	Glacial		< 0.001	nil
33	Stainless	0.5, 10%	R		R
		Glacial		nil	0.031
34	Stainless	0.5–100%	R		R
35	Stainless	0.5, 10%	R		R
		80%	R		
		Glacial	R	nil	0.036
36	Stainless	0.5, 10%	R		R
		80%	R		
		Glacial	< 0.001		0.09
37	Stainless	Glacial		< 0.001	0.09
38, 43, 44, 47, 50,52, 53,58, 80	Stainless	0.5–100%	R		R
41	Stainless	0.5, 10%	R		R
42	Stainless	0.5–80%	R		R
		100%	< 0.001		0.003
46, 55, 68, 81	Stainless	0.5–100%	R		
56	Stainless	0.5, 10%	R		R
		80%	R		
		Glacial	R	nil	0.058
59	Stainless	0.5–80%	R		R
		100%	R		0.0017
61	Stainless	0.5–100%	R		
		Glacial	R	nil	0.15
71	Stainless	10%	R		
91	Cr Ni Steel	0.5–100%	R		R
103	Cast Iron	33% [1]			0.322
105	Ni Cr Steel	0.5–100%	R		R
125	Cr Steel	0.5, 10%	R		R
		80%	R		
129	High Si Iron	0.5–100%	R		R
136	Fe Cr Ni Mo	0.5–100%	R		R
137	Ni Cr Cast Iron	0.5%	0.0019		0.0033
138	Fe Cr Ni Mo	0.5–100%	R		R
139	High Si Mo Iron	Any conc.	R		R
140, 141	Fe Ni Cr Cu Mo	0.5-80%	R		R
		100%	R		
142	High Si Iron	Any conc.	R		R
164	Cr Ni Steel	0.5- 100%	R		
172	Ni Fe Cr	0.5–100%	R		R
175	Cr Ni Steel	0.5–100%	R		R
176	Fe Ni Cu Cr	0.5%	R		R

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
			Room temp.		Boil
176	FeNiCuCr	10%	0.0021		R
180	Cr Cast Iron	0.5–100%	R		R
187	Steel	33%[1]			0.076
189	Steel	33%[1]			0.091
190	Steel	33%[1]			0.037
200	Ni Cr Fe	0.5–100%	R		R
206	Fe Cr Ni Mo	0.5–100%	R	176°	R
209	Fe Ni Cr Si Mo Cu	0.5–100%	< 0.001	< 0.001	
211	Admiralty	0.5, 10%	R		R
		80, 100%	R		
213	Aluminum	0.5%	0.0013		
		10%	0.0012		
		55%			0.2
		80%	< 0.001		
		100%	< 0.001		
214	Al Alloy	5, 10%	0.0013		
		55%			0.31
		100%	< 0.001		
215	Al Alloy	5, 10%	0.0014		
		80%	0.001		
		100%	< 0.001		
216	Al Alloy	5%	0.0038		
		10%	0.0017		
		80%	0.0011		
		100%	< 0.001		
224	Al Bronze	0.5%	R		
225, 226, 227	Ni Cr Si	0.5–100%	R		R
229	Ni Cr Alloy	0.5–100%	R		R
244	Al Bronze	0.5–100%	R		R
245	Al Bronze	0.5%	R		R
		10%	R		
249	Cu Ni Zn	0.5–100%	R		R
257	Admiralty	0.5, 10%	R		R
266	Cr Copper	0.5–100%	R		R
273	Bronze	0.5, 10%	R		R
		80, 100%	R		
277	Deox. Copper	0.5–100%	R		R
283–285	Cu Si Mn	0.5–100%	R		R
286	Al Bronze	0.5–100%	R		R
289	Gold	0.5–100%	R		R
				158°	
290	Ni Mo Fe	10%	0.002		0.0024
		99% (glacial)	< 0.001		0.0084
		Crude, aerated		0.02	
291	Ni Mo Fe	0.5–100%	R		R
292	Ni Cr Fe W	10%	0.000		0.000
		99%	0.000		0.000
		Crude, aerated		0.000	
293	Ni Si Cu	10%	0.0036		0.0044
		99%	0.0054		0.0044
		Crude, aerated		0.0089	
295	Cu Si Mn Sn	0.5–100%	R		R
296	Cu Si Sn	0.5–100%	R		
297	High-brass	0.5%	R		R
300	Ni Cr Cu Mo Fe	5%–conc.			<0.004
		80% plus 2% $KMnO_4$			<0.004
302	Ni Cr Fe	5% aerated	< 0.001 at 86°		
		10% aerated, refluxed	0.13 at boiling		
		80% storage tank	0.028		
		Glacial, distilling column	0.006 at boil.		
			Room temp.		Boiling
304	Indium	0.5–100%	R		
305, 306, 307	Ir Platinum	0.5–100%	R		R
308	Sb Lead	0.5–80%	R		
311, 314	Lead	0.5, 10%	0.020		
316	Ni Cu Alloy	5% aerated	0.034 at 86°		
		5% unaerated, refluxed	0.001 at boiling		
		10% aerated	0.016 at 86°		
		50% unaerated, refluxed	0.002 at boiling		
		80% in storage tank	0.002		
		Glacial, aerated	0.001 at 86°		
		Glacial, distill. column	0.003 at boiling		
		Vapors	0.007 at 220°		
329	Ni Cr Alloy	0.5–100%	R at room temp., boil.		
330	Nickel	5% unaerated, reflux.	0.010 at boiling		
		10% unaerated, reflux.	0.052 at boiling		
		10% aerated	0.09 at 86°		
		50% unaerated, reflux.	0.019 at boiling		
		80% in storage tank	0.018		
		Glacial, aerated	0.32 at 86°		
		Glacial, distill. column	0.003 at boiling		
		Vapors	0.007 at 220°		

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)	
334	Ni Cr Alloy	30%[1]	0.010 at 68°	
		Glacial[1]	0.055 at 68°	
335, 336	Ni Cr Steel	10, 100%[1]	< 0.004 at 68°	
		10, 100%[1]	0.040 at boiling	
			Room temp.	Boiling
337, 338	Nickel Silver	0.5–100%	R	R
343	Bronze	0.5, 10%	R	R
		80, 100%	R	
346	Palladium	0.5–100%	R	R
350, 352, 353	P Bronze	0.5–100%	R	R
357, 358	Platinum	0.5–100%	R	R
361	Rh Platinum	0.5–100%	R	R
363, 364	Silver	0.5–100%	R	R
365–368	Co Cr W	0.5–100%	R	R
370	Tantalum	0.5–100%	R	R
374	Ni Cr Alloy	0.5–100%	R	R

ACETIC ANHYDRIDE

No.	Material	Exposure Conditions	70°	180°	Boiling
2	Stainless	90%	<0.0042		<0.0042
		90% aerated		>0.12	
		60%		0.0042–0.042	
		30%		>0.12	
		Commercial grade	<0.003		
5	Stainless				<0.004
5–11	Stainless	Commercial grade	<0.003		
9	Stainless	90%	<0.0042		<0.0042
		90% aerated		0.042–0.12	
		30, 60%		0.0042–0.042	
12	Stainless	Commercial grade	<0.030		
15	Stainless	Commercial grade	<0.030		
		Pure[1]	<0.0046		<0.038
19	Stainless	90%	<0.0042		0.042–0.12
		Pure[1]	<0.0046		<0.038
104	Fe Ni Cu Cr		<0.001 at 80°		
139	High Si Mo Iron	Any conc.	Recom. to boiling		
142	High Si Iron	Any conc.	Recom. to boiling		
209	Fe Ni Cr Si Mo Cu	Commercial grade	No loss at cold		
216	Al Alloy		0.003 at room temp.		
213–222	Al Alloys	All Al alloys are expected to be same as 216.			
244, 247	Al Bronze		Recommended		
249	Cu Ni Zn		Recommended		
257	Admiralty		Slight to moderate		
259, 262, 266, 277	Copper		Recommended		
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate		
275, 276	Cu Ni Alloy		Recommended		
283–285	Cu Si Mn		Recommended		
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.		
292	Ni Cr Fe W	All conc.	Preferred to 290, 291, 293		
293	Ni Si Cu	All conc.	Recom. at all temp.		
337, 338	Nickel Silver		Recommended		
350–353	P Bronze		Recommended		
355, 371	Copper		Slight to moderate		
359	Red Brass		Recommended		
364	Silver		Not appreciably attacked		
365–368	Co Cr W	All conc.	Recom. at all temp.		
370	Tantalum	Any conc.	None at any temp.		

ACETONE

No.	Material	Exposure Conditions	Corrosion
2	Stainless		<0.0042 at 70° to boil.
5–11	Stainless	Conc.	<0.003 at 70°
9	Stainless		<0.0042 at 70° to boil.
12, 15, 18–20	Stainless		<0.040 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
218	Al Alloy	Exposed for one year	Only mildly stained
	All copper base alloys		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
308	Sb Lead		Probably OK
311	Chem. Lead		Probably OK
314	Te Lead		Probably OK
316	Ni Cu Alloy	C. P. sol.	0.013 at room temp.
		Vapors of C. P. sol.	<0.001 at boiling

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
330	Nickel	C. P. sol.	0.007 at room temp.
		Vapors of C. P. sol.	<0.001 at boiling
364	Silver		No attack
365–368	Co Cr W	All conc.	Recom. at all temp.

ACETYLENE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Conc.	<0.003 at 70°
5–11	Stainless	Conc.	<0.003 at 70°
12, 15	Stainless		<0.005 at 70°
19, 25	Stainless	Commercially pure	<0.003 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
213–222	Al Alloys	Dry acetylene	No attack expected
257	Admiralty		Little to none
272, 273, 315, 343, 344, 372	Bronze		Little to none
308	Sb Lead		Probably OK
311	Chem. Lead		Probably OK
314	Te Lead		Probably OK
318	Muntz		Recommended
328	Naval Brass		Recommended
355, 371	Copper		Little to none
364	Silver		Rapid attack at 1,100°
373	Tobin Bronze		Recommended

ALUM

No.	Material	Exposure Conditions	Corrosion 70°	Corrosion Boiling
2	Stainless	2, 10% sol.	<0.0042[2]	<0.0042[2]
		Sat. sol.; no free H_2SO_4	<0.0042[2]	0.0042–0.042[2]
5–11	Stainless	Sat. sol.; no free H_2SO_4	<0.0042	
9	Stainless	10% sol.[1]	<0.0044	<0.0044
		Sat. sol.[1]		<0.044
12, 15	Stainless	Sat. sol.	<0.01	
19	Stainless	2% sol.	<0.0042[2]	
		10% sol.	0.0042–0.042[2]	0.042–0.12[2]
		Sat. sol.		0.12–0.42[2]
20	Stainless	10% sol.[1]	<0.0046	<0.0046
		Sat. sol[1]		<0.0046
104	Fe Ni Cu Cr	12.5%	0.0057 at 125°	
129	High Si Iron	10.75%	<0.001 at room temp.	
139	High Si Mo Iron	Any conc.	Recom. to boiling	
142	High Si Iron	Any conc.	Recom. to boiling	
209	Fe Ni Cr Si Mo Cu	Paper makers	<0.001 at 150°	
244, 247	Al Bronze		Recommended	
249	Cu Ni Zn		Recommended	
257	Admiralty		Slight to moderate	
259, 262, 266, 277	Copper		Recommended	
265	Ni Cr Alloy	Sat. Sol.[1]	0.0878 at 184°	
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate	
275, 276	Cu Ni Alloy		Recommended	
283–285	Cu Si Mn		Recommended	
308	Sb Lead	Various conc.	OK at various temp.	
311	Chem. Lead	Various conc.	OK at various temp.	
314	Te Lead	Various conc.	OK at various temp.	
336	Ni Cr Steel		0.004 at 68°[1]	
337, 338	Nickel Silver		Recommended	
350–353	P Bronze		Recommended	
355, 371	Copper		Slight to moderate	
359	Red Brass		Recommended	
364	Silver	In dyestuff plants	No attack	

ALUMINUM CHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	10, 25%	0.12–0.42 at 70°
		Sat. sol.	<0.003 at 70°[2]
5	Stainless		Not recom. at 70°
		Sat. sol.	<0.003 at 70°[2]
6, 7, 8	Stainless	Sat. sol.	<0.003 at 70°[2]
9	Stainless	10, 25%	0.042–0.12 at 70°
10, 11	Stainless	Sat. sol.	<0.003 at 70°[2]
12	Stainless	Sat. sol.	Attacked
15, 18–20	Stainless		Not recom. at 70
83	Ni Steel	4.6 gm. HCl + 6.7 gm. $AlCl_3$ per 100 cc sol.	0.000 at 85°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Low conc.	Satisfactory at cold
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290	Ni Mo Fe	All conc.	Recom. to 158°
291	Ni Mo Fe	All conc.	Preferred to 290, 292
292	Ni Cr Fe W	All conc.	Recom. to 122°
308	Sb Lead		Not recom.
311	Chem. Lead		Not recom.
314	Te Lead		Not recom.
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Severe
359	Red Brass		Recommended
370	Tantalum	Any conc.	None at any temp.

ALUMINUM SULPHATE

No.	Material	Exposure Conditions	Corrosion 70°	Corrosion 150°	Corrosion Boiling
2	Stainless	5%		<0.0042[2]	
		10%, sat. sol.	<0.0042[2]		0.0042–0.042[2]
5	Stainless	10%	0.004		0.04
		Sat. sol.	<0.004[3]		
6–11	Stainless	Sat. sol.	<0.004[3]		
9	Stainless	5%		<0.0042	
		10%, sat. sol.	<0.0042		<0.0042
12, 15, 18, 19	Stainless	5%[2]		<0.0042	
		10%, sat. sol.[2]	0.12–0.42		>0.42
20	Stainless	10%	NR		NR
83	Ni Steel	10%	0.0032		
139	High Si Mo Iron	Any conc.	Recom. to boiling		
142	High Si Iron	Any conc.	Recom. to boiling		
161	Cr Steel	10%	0.0503 at 70°		
176	Fe Ni Cu Cr	0.1–5%	0.002–0.016 at room temp.		
244, 247	Al Bronze		Recommended		
249	Cu Ni Zn		Recommended		
257	Admiralty		Slight to moderate		
259, 262, 266, 277	Copper		Recommended		
272, 273, 315, 343, 344, 372	Bronze		Recommended		
275, 276	Cu Ni Alloy		Recommended		
283–285	Cu Si Mn		Recommended		
292	Ni Cr Fe W	All conc.	Recom. at all temp.		
293	Ni Si Cu	All conc.	Recom. at all temp.		
300	Ni Cr Cu Mo Fe	H_2SO_4 boil of clay	>0.125 at 300°		
		Effluent from clay boil	<0.004 at 210°		
302	Ni Cr Fe	In evaporator concentrating to 57%	0.051 at 240°		
308	Sb Lead	Various conc.	OK at various temps.		
311	Chem. Lead	Various conc.	OK at various temps.		
314	Te Lead	Various conc.	OK at various temps.		
316	Ni Cu Alloy	0.1% sol.	0.002 at 60°		
		5% sol.	0.007 at 60°		
		25% sol. (storage tank)	0.002 at 95°		
		In evaporator concentrating to 57%	0.016 at 240°		
330	Nickel	25% sol. (storage tank)	<0.001 at 95°		
		In evaporator concentrating to 57%	0.059 at 240°		
335, 336	Ni Cr Steel	50% sol[1]	<0.0038 at 68°		
		50% sol.[1]	<0.0038 at 212°		
337, 338	Nickel Silver		Recommended		
350–353	P Bronze		Recommended		
355, 371	Copper		Slight to moderate		
359	Red Brass		Recommended		
364	Silver	In dyestuff plant	No attack		
365–368	Co Cr W	All conc.	Recom. at all temp.		
370	Tantalum	Any conc.	None at any temp.		

AMMONIA

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Any conc. sol.	<0.0042 at 70° to boil.
		Anhydrous	<0.004 at 70°
		Gas	0.12–0.42 at hot
5–11	Stainless	Anhydrous or sol.	<0.004 at 70°
9	Stainless	Any conc. sol.	<0.0042 to boiling
12, 15	Stainless	Anhydrous	<0.004 at 70°
		Any conc. sol.	<0.005 at 70°
		Gas[1]	No attack at 68°
19	Stainless	Anhydrous	<0.004 at 70°
		Any conc. sol.	<0.0042 at 70° to boil.

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
19	Stainless	Gas	0.12–0.42 at hot
20, 21	Stainless	Any conc. sol.	<0.004 at 70°
25	Stainless	Anhydrous	<0.004 at 70°
		Any conc. sol.	<0.004 at 70°
104	Fe Ni Cu Cr	Anhydrous or sol.	No attack
139	High Si Mo Iron	Any conc. sol.	Recom. to boiling
142	High Si Iron	Any conc. sol.	Recom. to boiling
176	Fe Ni Cu Cr	5% — conc. sol.	<0.001 at room temp.
188	Steel	Conc. sol.[1]	0.0084 at 68°
190	Ni Steel	Gas[1]	Strong attack at 932°
209	Fe Ni Cr Si Mo Cu	Anhydrous	No loss at cold
		Solutions	No loss at all temp.
	All Cu alloys	Anhydrous — perfectly dry	Recommended
		Solutions	Attacked
213	Aluminum	10% sol.	0.0057 at room temp.
214	Al Alloy	10% sol.	0.0093 at room temp.
215	Al Alloy	10% sol.	0.0143 at room temp.
216	Al Alloy	10% sol.	0.0101 at room temp.
218	Al Alloy	10% sol.	0.0158 at room temp.
290, 291	Ni Mo Fe	Anhydrous	Recom. at all temp.
		Any conc. sol.	Recom. at all temp.
292	Ni Cr Fe W	Anhydrous	Recom. at all temp.
		Any conc. sol.	Recom. at all temp.
293	Ni Si Cu	Anhydrous	Recom. at all temp.
		Any conc. sol.	Recom. at all temp.
300	Ni Cr Cu Mo Fe	Anhydrous	<0.004 at 70°
		28% sol.; agitated	<0.004 at 70°
		Conc. sol.; quiet	<0.004 at 70°
		Conc. sol.; agitated	0.004–0.015 at 70°
302	Ni Cr Fe	5–23% sol.; aerated	<0.001 at 86°
308	Sb Lead	Anhydrous	OK
		Various conc. sol.	OK at various temp.
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
316	Ni Cu Alloy	2.7% sol., aerated	<0.001 at room temp.
		3.6% sol., aerated	0.070 at room temp.
		12.5% sol., aerated	0.376 at room temp.
		25.8% sol. aerated	0.036 at room temp.
330	Nickel	1.1% sol.; aerated	<0.001 at room temp.
		2.5% sol.; aerated	0.532 at room temp.
		27% sol.; aerated	0.187 at room temp.
335, 336	Ni Cr Steel	Solutions[1]	0.0038 at 68°
364	Silver	Anhydrous	Attacked at high temp.
		O_2-free sol.	No attack at 70°
365–368	Co Cr W	Anhydrous	Recom. at all temp
		Any conc. sol.	Recom. at all temp.
370	Tantalum	Solutions	Attacked at high temp.

AMMONIUM CHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	1% sol.; quiet, agitated, or aerated[2]	<0.0042 at 70°
		10, 20% sol.[2]	<0.0042 at boiling
		28, 50% sol.[2]	0.0042–0.042 at boil.
		Sat. sol.[1, 2]	<0.0044 at 212°
		Sat. sol.[2]	<0.004 at 70°
4	Stainless	50%	<0.04 at boiling
5–8	Stainless	Sat. sol.[2]	<0.004 at 70°
9	Stainless	1% sol.; quiet, agitated, or aerated	<0.0042 at 70°
		10% — conc. sol.[2]	<0.0042 at boiling
		Sat. sol.	<0.004 at 70°
10, 11	Stainless	Sat. sol.[2]	<0.004 at 70°
12, 15	Stainless	1% sol.; quiet, agitated, or aerated	<0.0042
		Sat. sol.	<0.01 at 70°
19	Stainless	1% sol.; quiet, agitated, or aerated[2]	<0.0042 at 70°
		10% sol.[1]	<0.0456 at boiling
		25% sol.[1]	<0.0456 at boiling
		Sat. sol.[1]	<0.456 at boiling
20	Stainless	10% — sat. sol.[1]	<0.00456 at boiling
	Stainless	10% sol.[1]	<0.00456 at boiling
21		25% sol.[1]	<0.0456 at boiling
		Sat. sol.[1]	<0.456 at boiling
103	Cast Iron	5% sol[1].	0.0066 at 68°
104	Fe Ni Cu Cr	25% NH_4Cl + 1% HCl sol.	0.0977
129	High Si Iron	27% sol., quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc. sol.	Recom. to boiling
142	High Si Iron	Any conc. sol.	Recom. to boiling
176	Fe Ni Cu Cr	5–35% sol.	0.003–0.01 at 70°–200°
190	Ni Steel	5% sol.[1]	0.0075 at 68°
	All Cu-base Alloys		Attacked
265	Ni Cr Alloy	Sat. sol.[1]	0.411 at 68°
290	Ni Mo Fe	All conc. sol	Recom. to 158°
291	Ni Mo Fe	All conc. sol.	Preferred to 290, 292
292	Ni Cr Fe W	All conc. sol.	Recom. to 122°
300	Ni Cr Cu Mo Fe	25% sol.	<0.004 at 70°
		30% sol.	<0.004 at 330°

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
302	Ni Cr Fe	Concentrating from 28 to 40% in evaporator	<0.001
		35% sol + <0.5% NH_3	0.002 at boiling
308	Sb Lead	Various conc.	OK at various temp.
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
			60° 200°
316	Ni Cu Alloy	5% sol.	0.002 0.011
		10% sol.	0.010 0.011
		20% sol.	0.013 0.006
		35% sol. + <0.5% NH_3	0.005 at boiling
		Concentrating from 28 to 40% in evaporator	0.012
330	Nickel	35% sol. + <0.5% NH_3	0.005 at boiling
		Concentrating from 28 to 40% in evaporator	0.012
335	Ni Cr Steel	Dilute sol.[1]	<0.004 at 68°
		Sat. sol.[1]	>0.004 at 68°
364	Silver	In dyestuff plant	No attack at cold
		10% C. P., refluxed	<0.001 at boiling
370	Tantalum	Any conc. sol.	None at any temp.

AMMONIUM NITRATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	All conc.; agitated or aerated	<0.0042 at 70°
		Sat. sol.	<0.0042 at boiling
5–11	Stainless	Sat. sol.	<0.004 at 70°
5	Stainless		<0.004 at 70°, boiling
9	Stainless	All conc.; agitated or aerated	<0.0042 at 70°
		Sat. sol.	<0.0042 at boiling
12, 15	Stainless	All conc.; agitated or aerated	<0.0042 at 70°
		Sat. sol.	<0.0042 at boiling
18	Stainless		<0.004 at 70°, boil.
19, 20	Stainless	All conc.; agitated or aerated	<0.0042 at 70°
		Sat. sol.	<0.0042 at 70°, boil.
25	Stainless	Sat. sol.	<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at 120°
	All Cu — Base Alloys		Attacked
308, 311, 314	Lead		Not recommended

AMMONIUM PHOSPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2, 5	Stainless	5% sol.	<0.0042 at 70°
		Sat. sol.	<0.004 at 70°
6–11	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	5% sol.	<0.004 at 70°
12, 15	Stainless	5% sol.	<0.004 at 70°
		Sat. sol.	<0.005 at 70°
18–20	Stainless	5% sol.	<0.004 at 70°
25	Stainless	5% sol.	<0.004 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at 150°
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
308	Sb Lead	Various conc.	OK at various temp
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
316	Ni Cu Alloy	Solutions[1]	<0.004 at 68°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended

AMMONIUM SULPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	1, 5% sol.; agitated or aerated	<0.0042 at 70°
		10% sol.[1]	<0.0044 at 68°[2]
		10% sol.	0.0042–0.042 at boil.[2]
		Sat. sol.	<0.004 at 70°
		Sat. sol.	0.0042–0.042 at boil.
5	Stainless	10%	<0.040 at boiling
		Sat. sol.	<0.004 at 70°

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
6-11	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	1, 5% sol.; agitated or aerated	<0.0042 at 70°
		10% sol.	<0.0042 at 70°, boil.[2]
		Sat. sol.	<0.0042 at 70°, boil.
12, 15	Stainless	1, 5% sol.; agitated or aerated	0.0042-0.042 at 70°
		10%	Slight attack at 70°
		Sat. sol.	<0.010 at 70°
19	Stainless	1, 5% sol.; agitated or aerated	<0.0042 at 70°
		10% sol.	<0.004 at 70°[3]
20	Stainless	Sol.[1]	<0.0046 at 70°
25	Stainless	10% sol.	<0.004 at 70°[3]
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	5-25% sol.	<0.006 at room temp.
209	Fe Ni Cr Si Mo Cu	Sat. sol. + 7% H_2SO_4	<0.001 at 150°
214	Al Alloy	1, 5%	No attack at 70°
213-222	Al Alloys	All Al alloys expected to be same as 214.	
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283-285	Cu Si Mn		Recommended
292	Ni Cr Fe W		Recommended
293	Ni Si Cu		Recommended
308	Sb Lead	Various conc.	OK at various temp.
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
316	Ni Cu Alloy	5, 10% sol.	<0.001 at 60°
		25% sol.	<0.002 at 60°
		Sat. sol.	<0.001 at 203°
337, 338	Nickel Silver		Recommended
350-353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
365-368	Co Cr W		Recommended

AMYL ACETATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2,5-12, 15,19,25	Stainless	Conc. sol.	<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at 150°
	All Cu — Base Alloys		Recommended
213-222	Al alloys		None expected

AMYL CHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2, 9	Stainless		No attack
15, 19	Stainless		Slight attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
211, 258	Admiralty		Recommended
244, 247	Al Bronze		Recommended
248	Al Brass		Recommended
249	Cu Ni Zn		Recommended
259, 262, 266 277	Copper		Recommended
275, 276	Cu Ni Alloy		Recommended
283-285	Cu Si. Mn		Recommended
337, 338	Nickel Silver		Recommended
350-353	P Bronze		Recommended
359	Red Brass		Recommended
370	Tantalum	Any conc.	None at any temp.

ANILINE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2, 9, 19	Stainless	3% sol.	<0.0042 at 70°
		Conc. crude	<0.0042 at 70°
5, 20	Stainless	Conc. crude	<0.004
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
	All Cu — Base Alloys		Attacked
213	Aluminum	Boiling for 16 hr.	Pitted
364	Silver	In preparing dyestuff	Successfully used
370	Tantalum	Any conc.	None at any temp.

BARIUM SULPHIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Sol.	Little or none
		Sat. sol.	<0.004 at 70°
5-11	Stainless	Sat. sol.	<0.004 at 70°
9,15,19	Stainless	Sol.	Little or none
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at cold
211, 258	Admiralty	Dil. sol. or at room temp.	Recommended
248	Al Brass		Same as 211
257	Admiralty		Severe attack
272, 273, 315, 343, 344, 372	Bronze		Severe attack
297	High Brass		Same as 211
308, 311, 314	Lead	Solutions of Ba from which BaS is pptd.	OK
318	Muntz		Same as 211
328	Naval Brass		Same as 211
355, 371	Copper		Severe attack
373	Tobin Bronze		Same as 211

BENZALDEHYDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
	All Cu — Base Alloys		Recommended
364	Silver		Attacked at 122°

BENZOL

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		<0.0042 at 70° to hot
		Pure[1]	<0.0044 at 176°
		Conc.	<0.004 at 70°
5	Stainless	Conc.	<0.004 at 70°
			<0.004 at hot
		50% + 50% aviation gas	<0.001 at 70°
6-11	Stainless	Conc.	<0.004 at 70°
9	Stainless		<0.0042 at 70° to hot
		Pure[1]	<0.0044 at 176°
		Sat. sol.	<0.004 at 70°
12, 15	Stainless	Sat. sol.	<0.005 at 70°
			Slight attack at hot
19	Stainless		<0.0042 at hot
		Commercially pure	<0.004 at 70°
25	Stainless	Commercially pure	<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr		0.001-0.008
209	Fe Ni Cr Si Mo Cu	In tar acids	<0.001 at 175°
	All Cu — Base Alloys		Recommended
213-222	Al Alloys		None expected
302	Ni Cr Fe	In vapors and liquid of still	0.001
		In benzol still body	<0.001
308, 311, 314	Lead		Probably OK
316	Ni Cu Alloy	In vapors and liquid of still	0.005
		In benzol still body	0.001
330	Nickel	In vapors and liquid of still	0.004
		In benzol still body	0.001
335, 336	Ni Cr Steel	Pure[1]	<0.004 at 176°
370	Tantalum	Any conc.	None at any temp.

BORIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5% sol.	<0.0042 at hot or cold
		Saturated	<0.004 at 70°[2]
		Saturated	<0.0042 at boil.[2]
5	Stainless	5% sol.	<0.004 at 70°
5-8	Stainless	Sat. sol.	<0.004 at 70°[2]
9	Stainless	Sat. sol.[2], or 5% sol.	<0.0042 at boil.[2], 70°
10, 11	Stainless	Sat. sol.[2]	<0.004 at 70°
12, 15	Stainless	5%[2]	<0.004 at 70°
		Sat. sol.[1]	<0.0046 at 212°
18	Stainless	5% sol.	<0.004 at 70°
19	Stainless	5% sol.	<0.0042 at hot or cold
		Sat. sol.	<0.0042 at boil.[2]
20	Stainless	5% sol.	<0.004 at 70°
		Sol.[1]	<0.0046 at 212°
25	Stainless	2% sol.	<0.004 at 70°
104	Fe Ni Cu Cr	3% sol.	<0.001 at 80°

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Strong	Gain at cold
		Aqueous sol.	Satisfactory at 210°
	All Cu — Base Alloys		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
300	Ni Cr Cu Mo Fe	4% sol.	<0.004 at 70°
308	Sb Lead	Various conc.	OK at various temp.
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
316	Ni Cu Alloy	4% sol.	0.003 at room temp.
		4% sol.	0.005 at 104°
335, 336	Ni Cr Steel	Sol.[1]	<0.004 at 68°
364	Silver	In dyestuff plant	No attack
365–368	Ni Cr Cu Mo Fe	All conc.	Recom. at all temp.
370	Tantalum	Any conc.	None at any temp.

BROMINE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
1–25	Stainless	Bromine; bromine water	Strong attack at 70°
104	Fe Ni Cu Cr		Rapid attack
139	High Si Mo Iron		Not recom.
142	High Si Iron		Not recom.
244, 247	Al Bronze	Perfectly dry gas	Recommended
249	Cu Ni Zn		Same as 244
257	Admiralty		Severe attack
259, 262, 266, 267	Copper		Same as 244
272, 273, 315, 343, 344, 372	Bronze		Severe attack
275, 276	Cu Ni Alloy		Same as 244
283–285	Cu Si Mn		Same as 244
290, 291	Ni Mo Fe	Dry	Recom. at all temp.
292	Ni Cr Fe W		Preferred to 290, 291
300	Ni Cr Cu Mo Fe	Dry	Recommended
		Moist	Not recommended
		Aqueous sol.	>0.125 at 70°
308, 311, 314	Lead		Not recommended
337, 338	Nickel Silver		Same as 244
350–353	P Bronze		Same as 244
355, 371	Copper		Severe attack
359	Red Brass		Same as 244
364	Silver		Slowly at ordinary temp.
370	Tantalum	Any conc.	None at any temp.

BUTYL ACETATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2, 9, 15, 19	Stainless		Little or none
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at cold
	All Cu — Base Alloys		Recommended
216	Al Alloy	In containers, 6 months	Stained only
213–222	Al Alloys	All Al alloys expected to be same as 216.	

CALCIUM CHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Dilute or conc. sol.	0.0042–0.042 at 70°[2]
5	Stainless	Conc. sol.	<0.04 at 70°[3]
9	Stainless	Dilute or conc. sol.	<0.0042 at 70°[2]
		Sat. sol.[1]	<0.0044 at 212°
12, 15	Stainless	Sat. sol.	Attacked at 70°
19	Stainless	Dilute or conc. sol.	0.042–0.12 at 70°[2]
20	Stainless	Sol.[1]	<0.0046 at 68°, boil.
25	Stainless	Sat. sol.	<0.1 at 70°
104	Fe Ni Cu Cr	25% sol.	0.0019 at 80°
139	High S. Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	5% sol.	0.005 at room temp.
209	Fe Ni Cr Si Mo Cu	Sat. sol.	<0.001 at cold
211, 258	Admiralty		Recommended
213, 214	Aluminum	Pure sol.	Little at room temp.
		Add heavy-metal salts	May be severe, room temp.
		Chromate inhibited	Commonly used
244, 247	Al Bronze		Recommended
248	Al Brass		Recommended
249	Cu Ni Zn		Recommended
257.	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
302	Ni Cr Fe	In evaporator concentrating to 35%	<0.001 at 160–320°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	5% aerated	<0.001 at 60°
		16% aerated	0.008 at room temp.
		20% unaerated	<0.001 at room temp.
		46–47%	0.014 at 360°
		In evaporator concentrating to 35%	<0.001 at 160–320°
328	Naval Brass		Recommended
330	Nickel	46–47%	0.010 at 360°
		In evaporator concentrating to 35%	<0.001 at 160–320
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum	Any conc.	None at any temp.
373	Tobin Bronze		Recommended

CALCIUM HYPOCHLORITE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Dry[1]	<0.0044 at 68°
		2%	0.0042–0.042 at 70°
		Water sol.; sp. g. 1.04	0.042–0.12 at 100°
		Sat. sol.; exposed >4 hr.	Attacked at 70°
		Standing solutions	Not recommended
5–8, 10, 11	Stainless	Sat. sol.; exposed >4 hr.	Attacked at 70°
9	Stainless	2%	<0.0042 at 70°
		Water sol.; sp. g. 1.04	<0.0042 at 100°
		150 g./l.[1]	<0.0044 at 68°
		Standing solutions	Not recommended
12, 15	Stainless	Sat. sol.	Attacked
19	Stainless	2%	0.042–0.12 at 70°
		Water sol.; sp. g. 1.04	0.042–0.12 at 100°
25	Stainless	Sat. sol.	Attacked
104	Fe Ni Cu Cr		Rapid attack
129	High Si Iron	1.5% bleach powder	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	0.07%	0.002 at room temp.
209	Fe Ni Cr Si Mo Cu	3.5% available Cl_2	Satisfactory at cold
244, 247	Al Bronze	Dil. sol. or at room temp.	Recommended
249	Cu Ni Zn		Same as 244
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Same as 244
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Same as 244
283–285	Cu Si Mn		Same as 244
290, 291	Ni Mo Fe	Bleach powder; all conc.	Not recom. at any temp.
292	Ni Cr Fe W	Bleach powder; all conc.	Recom. to 105°
293	Ni Si Cu	Bleach powder; all conc.	Not recom. at any temp.
300	Ni Cr Cu Mo Fe	2% available Cl_2	0.015–0.05 at 70°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	0.5 g./l. available Cl_2	<0.001 at room temp.
		2 g./l. available Cl_2	<0.001 at room temp.
		4 g./l. available Cl_2	0.047 at room temp.
		10 g./l. available Cl_2	0.067 at room temp.
		25 g./l. available Cl_2	0.405 at room temp.
337, 338	Nickel Silver		Same as 244
350–353	P Bronze		Same as 244
355, 371	Copper		Slight to moderate
359	Red Brass		Same as 244
365–368	Co Cr W	Bleach powder; all conc.	Recom. at all temp.
370	Tantalum	Any conc.	None at any temp.

CARBON BISULPHIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2, 5, 9, 10	Stainless		<0.0042 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at cold
	All Cu — Base Alloys		Recommended
213–222	Al Alloys		None expected
364	Silver	Vapors	No attack

CARBON TETRACHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	C. P.	<0.0042 at 70°, boil.
		Commercial purity	<0.004 at 70°[2]
		Moist[1]	Attacked at high temp.
5	Stainless	Pure	<0.004 at 70°
		Commercial purity	<0.004 at 70°[2]
6–8	Stainless	Commercial purity	<0.004 at 70°[2]
9	Stainless	C. P.	<0.0042 at 70°, boil.
		Commercial purity	<0.004 at 70°
		Commercial + 1% water	0.0042–0.042 at boil.[2]
		Commercial + 1% HCl	0.0042–0.042 at boil.[2]
10, 11	Stainless	Commercial purity	<0.004 at 70°[2]
15, 18	Stainless	Pure	<0.004 at 70°
19	Stainless	C. P.	<0.0042 at 70°
		Commercial purity	<0.004 at 70°[2]
20, 21	Stainless	Pure	<0.004 at 70°
25	Stainless	Commercial purity	<0.004 at 70°[2]
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr		<0.002 at 70–170°
209	Fe Ni Cr Si Mo Cu	50%	0.0013 at 184°
213–222	Al Alloys	Unstabilized	Severe at boiling
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
300	Ni Cr Cu Mo Fe		<0.004 at boil.
		Saturated with free S	<0.004 at boil.
		Plus 3% Br_2 by vol.	>0.125 at boil.
302	Ni Cr Fe	Vapor space of still	<0.001 at 165°
		Storage tank	<0.001 at room temp.
308	Sb Lead	Anhydrous	OK at ordinary temp.
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
316	Ni Cu Alloy	Vapor space of still	<0.001 at 165°
		Partially immersed in carbon tet. mixture	0.004 at boiling
		Storage tank	<0.001 at room temp.
330	Nickel	Vapor space of still	<0.001 at 165°
		Partially immersed in carbon tet. mixture	0.002 at boiling
		Storage tank	<0.001 at room temp.
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver		No attack
370	Tantalum	Any conc.	None at any temp.

CARBONIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Sat. sol.	<0.004 at 70°
5–11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	Sat. sol.	<0.005 at 70°
19–21	Stainless	Sat. sol.	<0.004 at 70°
25	Stainless	Sat. sol.	<0.004 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr		0.001 at room temp.
209	Fe Ni Cr Si Mo Cu		No loss at cold
211, 258	Admiralty		Recommended
213	Aluminum	Carbonated tap water	<0.001
244, 247	Al Bronze		Recommended
248	Al Brass		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
265	Ni Cr Alloy		Recommended[1]
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
302	Ni Cr Fe	%CO_2 % air	
		H_2O sat. with 30 70	<0.001 at 150°
		H_2O sat. with 70 30	<0.001 at 158°
		H_2O sat. with 80 20	<0.001 at 212°
		H_2O sat. with 80 20	<0.001 at 275°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	%CO_2 % air	
		H_2O sat. with 100 0	<0.001 at 60°
		H_2O sat. with 30 70	0.009 at 150°
		H_2O sat. with 70 30	0.060 at 158°
		H_2O sat. with 80 20	0.032 at 212°
		H_2O sat. with 80 20	0.005 at 275°
330	Nickel	H_2O sat. with 30 70	0.001 at 150°
		H_2O sat. with 70 30	0.092 at 158°
		H_2O sat. with 80 20	0.013 at 212°
		H_2O sat. with 80 20	0.005 at 275°
332	Ni Cr Alloy		Recommended[1]
335, 336	Ni Cr Steel		<0.004 at 68°[1]
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver		Stable at ordinary temp.

CHLORACETIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		>0.12 at 70°
5	Stainless		Not recom. at 70°
9	Stainless		0.042–0.12 at 70°
15, 18	Stainless		Not recom. at 70°
19	Stainless		>0.12 at 70°
20	Stainless		Not recom. at 70°
129	High Si Iron	25%; quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
244, 247	Al Bronze	No air	Recommended
249	Cu Ni Zn	No air	Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper	No air	Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy	No air	Recommended
283–285	Cu Si Mn	No air	Recommended
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
337, 338	Nickel Silver	No air	Recommended
350–353	P Bronze	No air	Recommended
355, 371	Copper		Severe
359	Red Brass	No air	Recommended
370	Tantalum	Any conc.	None at any temp.

CHLORINE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Dry gas	0.042–0.12 at 70°
		Moist gas	0.12–0.42 at 70°
		Gas	>0.42 at 212°
5–8	Stainless		Attacked
9	Stainless	Dry gas	0.0042–0.042 at 70°
		Moist gas	0.042–0.12 at 70°
		Gas	0.12–0.42 at 212°
		Sat. sol.[1]	<0.0437 at 68°
10, 11	Stainless		Attacked
15, 18	Stainless		Not recom. at 70°
19	Stainless		Same as 2
20, 25	Stainless		Not recom. at 70°
104	Fe Ni Cu Cr	Dry	No attack
		Wet	Rapid attack
139	High Si Mo Iron	Wet, any conc.	Recom. at room temp.
142	High Si Iron		Not recommended
209	Fe Ni Cr Si Mo Cu	Liquid anhydrous	Satisfactory at cold
		Wet	Unsatisfactory at cold

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
209	Fe Ni Cr Si Mo Cu	Cl_2 water; 100 ppm.	No loss at cold
213–222	Al Alloys	Dry	None expected at room temp.
244, 247	Al Bronze	Perfectly dry gas	Recommended
249	Cu Ni Zn	Perfectly dry gas	Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper	Perfectly dry gas	Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy	Perfectly dry gas	Recommended
283–285	Cu Si Mn	Perfectly dry gas	Recommended
290, 291	Ni Mo Fe	Wet gas	Not recom. at any temp.
292	Ni Cr Fe W	Wet gas	<0.038 at 70°
293	Ni Si Cu	Wet gas	Not recom. at any temp.
300	Ni Cr Cu Mo Fe	Dry	Recommended
		Moist	>0.125 at 200°
302	Ni Cr Fe	0.1 g. avail. Cl_2/l. H_2O	0.002 at 40°
		3.3 g. avail. Cl_2/l. H_2O	0.005 at 40°
		6.5 g. avail. Cl_2/l. H_2O	0.012 at 40°
		Wet vapors	0.095 at 190°
308	Sb Lead	Anhydrous	OK
311	Chem. Lead	Anhydrous	OK
314	Te Lead	Anhydrous	OK
316	Ni Cu Alloy	0.1 g. avail. Cl_2/l. H_2O	0.004 at 40°
		3.3 g. avail. Cl_2/l. H_2O	0.040 at 40°
		6.5 g. avail. Cl_2/l. H_2O	0.113 at 40°
330	Nickel	0.1 g. avail. Cl_2/l. H_2O	0.004 at 40°
		3.3 g. avail. Cl_2/l. H_2O	0.030 at 40°
		6.5 g. avail. Cl_2/l. H_2O	0.052 at 40°
335, 336	Ni Cr Steel	Pure, H_2O free [1]	<0.004 at 68°
		Moist [1]	<0.04 at 68°
337, 338	Nickel Silver	Perfectly dry gas	Recommended
350–353	P Bronze	Perfectly dry gas	Recommended
355, 371	Copper		Severe
359	Red Brass	Perfectly dry gas	Recommended
364	Silver	Dry	Slight at ordinary temp.
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum		None at any temp.

CHROMIC ACID

No.	Material	Exposure Conditions	70°	Boiling
2	Stainless	5% C. P.	<0.0042	
		10, 50% C. P.	0.004–0.04	0.04–0.12
		50% commercial + SO_3	<0.0042	>0.12
5	Stainless	5%	<0.010	
6–8	Stainless		Attacked	
9	Stainless	5% C. P.	<0.0042	
		10, 50% C. P.	0.004–0.04	0.004–0.04
		50% commercial + SO_3	<0.0042	0.042–0.12
10-12, 15	Stainless		Attacked	
19	Stainless	10% sol.[1]	<0.0046	0.046
		50% sol.[1]	>0.46	>0.46
20	Stainless	10% sol.[1]	<0.0046	<0.0046
		50% sol.[1]	<0.46	>0.456
21	Stainless		Same as 19[1]	
25	Stainless		Attacked at 70°	
139	High Si Mo Iron	Any conc.	Recom. to boiling	
142	High Si Iron	Any conc.	Recom. to boiling	
209	Fe Ni Cr Si Mo Cu	Weak; plating sol.	Satisfactory at warm	
—		Anodizing sol.	Satisfactory	
	All Cu-Base Alloys		Severe attack	
290, 291	Ni Mo Fe		Not recommended	
292	Ni Cr Fe W		Recommended	
293	Ni Si Cu		Not recommended	
300	Ni Cr Cu Mo Fe	25, 50% sol.	>0.125 at boiling	
		25% sol. + 5% by volume H_2SO_4	>0.125 at 180°	
		35% [illegible]	<0.004 at 70°	
		[illegible] 36% acid	Recommended at 70°	
302	Ni Cr Fe	[illegible] % Na_2SO_4	<0.001 at room temp.	
308	Sb Lead	20–40%	OK to 120°	
311	Chem. Lead	20–40%	OK to 120°	
314	Te Lead	20–40%	OK to 120°	
316	Ni Cu Alloy	3.4% sol. + 2% Na_2SO_4	<0.001 at room temp.	
		5% sol., unaerated	0.001 at 86°	
330	Nickel	3.4% sol., + 2% Na_2SO_4	<0.001 at room temp.	
336	Ni Cr Steel	50% sol.[1]	>0.038 at boiling	
364	Silver		Readily attacked	
365–368	Co Cr W		Recommended	
370	Tantalum		0.425 at 302°	

CITRIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5% quiet	<0.0042 at 70°–150°
		10–50%	<0.0042 at 70°
2	Stainless	10, 15%	0.0042–0.042 at boil.
		25, 50%	0.12–0.42 at boil.
		Conc.	0.042–0.12 at boil.
		5% sol. at 45 psi.	0.12–0.42 at 284°
		Sat. sol.	<0.004 at 70°
		25% sol. + 0.6% H_2SO_4[1]	<0.0044 at 68°
		25% sol. + 0.75% H_2SO_4[1]	<0.131 at 68°
		50% sol. + 0.6% H_2SO_4[1]	<0.0044 at 68°
5	Stainless	15% sol., sat. sol.	<0.004 at 70°
		15% sol.	<0.040 at boil.
6, 7, 8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	5% quiet	<0.0042 at 70°–150°
		10–50%	<0.0042 at 70° — boil.
		Conc.	0.0042–0.042 at boil.
		5% sol. at 45 psi.	0.0042–0.042 at 284°
		Sat. sol.	<0.004 at 70°
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12	Stainless	Sat. sol.[2]	<0.005 at 70°
15	Stainless	5% quiet	<0.0042 at 70°–150°
		Sat. sol.[2]	<0.005 at 70°
18	Stainless	6% sol.[1]	0.005 at 64°
19	Stainless	5% quiet	<0.0042 at 70°–150°
		10%	<0.0042 at 70°
		15%	<0.0042 at boil.
		33%[1]	0.007 at 64°
20	Stainless	1–50%[1]	<0.0046 at 68°, boil.
25	Stainless	5%	<0.004 at 70°
104	Fe Ni Cu Cr	5%	0.067 at 80°
129	High Si Iron	25% quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	5%	0.09 at room temp.
190	Ni Steel	5%	0.018 at 68°
209	Fe Ni Cr Si Mo Cu	Strong water sol.	No loss at warm
213–216	Al Alloys	10%	<0.001 at 86°
		10%	0.0055 at 122°
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
300	Ni Cr Cu Mo Fe		Recommended
302	Ni Cr Fe	7% sol.	0.004 at boiling
		Concentrating from 75% to 90% sol. in vac. pan	0.002 at 126°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	1% sol., aerated	0.001 at 77°
		5% sol., aerated	0.001 at 60°
		15% sol., exposed to air	0.003 at 149°
		30% sol., unaerated	0.001 at atmos. temp.
		30% sol., unaerated	0.007 at 140°
		58% sol.	0.006 at boiling
		60–62%, some aeration	<0.001 at 80–150°
330	Nickel	1% sol., unaerated	<0.001 at 77°
		1% sol., aerated	0.002 at 77°
		15% sol., exposed to air	0.004 at 149°
		58% sol.	0.017at boiling
		60–62%, some aeration	<0.001 at 80–150°
336	Ni Cr Steel	5% sol.[1]	>0.004 at 68°
		20% sol.[1]	>0.004 at 68°
		Sat. sol.[1]	>0.004 at 212°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass.		Recommended
364	Silver		No attack
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum		None at any temp.

COPPER SULPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	50% saturated sol.	<0.0044 at 212°[1]
		+ 10% H_2SO_4	<0.0044 at 68°[1]
		Sol. + 3% H_2SO_4	<0.0046 at 68°[1]

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5%, agitate or aerate	<0.0042 at 70°
		Sat. sol.	<0.0042 at boiling
5	Stainless	Sat. sol.	<0.004 at 70°, boil.
6, 7, 8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless		Same as 2
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	5%, agitate or aerate	<0.0042 at 70°
		Sat. sol.	<0.005 at 70°
		Sat. sol. (neutral)[1]	Recom. at high temp.
19	Stainless	5%, agitate or aerate	<0.0042 at 70°
		Sat. sol.	<0.004 at 70°[3]
		Sat. sol. (neutral)[1]	Recom. at high temp.
20	Stainless	Sol. + 3% H_2SO_4[1]	<0.0046 at 68°
25	Stainless	Sat. sol.	<0.004 at 70°[3]
104	Fe Ni Cu Cr		Rapid attack
129	High Si Iron	25%, quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	0.1–10%	0.04–0.5 at room temp.
209	Fe Ni Cr Si Mo Cu	Sat. sol.	No loss at cold
		Sat. sol + 10% H_2SO_4	Satisfactory at 200°
213	Aluminum	10% sol.	0.011 at room temp.
		1% sol.	0.011 at room temp.
		0.1% sol.	0.0027 at room temp.
214–222	Al Alloys		Expect to be same as 213
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Not recom. at any temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
	Corrosion of 292 increases with increase of conc or temp.		
293	Ni Si Cu	All conc.	Not recom. at any temp.
300	Ni Cr Cu Mo Fe	25% sol.	<0.004 at 70°
		9–18% sol.	<0.004 at boiling
		25% + 12.5% H_2SO_4	0.004–0.015 at boil.
		5% + 12.5% H_2SO_4	0.004–0.015 at boil.
		2.5% + 12.5% H_2SO_4	0.004–0.015 at boil.
308	Sb Lead	Strongly acid — H_2SO_4	OK
311	Chem. Lead		Same as 308
314	Te Lead		Same as 308
316	Ni Cu Alloy	0.1% sol., aerated	<0.001 at 60°
		0.5% sol., aerated	0.002 at 60°
		10% sol., aerated	0.004 at 60°
		20% sol., some aeration	0.002 at room temp.
		20% sol., unaerated	0.044 at 214°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver		Recommended
365–368	Co Cr W	All conc.	Recom. at all temp.
	Corrosion increases with increase in conc. and temp.		
370	Tantalum		None at any temp.

ETHYL ACETATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Conc. sol.	<0.003 at 70°
5–11	Stainless	Conc. sol.	<0.003 at 70°
12, 15	Stainless	Conc. sol.	<0.005 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	85%	No loss at cold
	All Cu-Base Alloys		Recommended
218	Al Alloy	In storage container	None at room temp.
300	Ni Cr Cu Mo Fe	Crude	0.004–0.015 at 167°
		Distillation of crude	0.004–0.015 at 212°

ETHYL ALCOHOL

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		<0.0042 at 70°, boil.
		10–100% alcohol[1]	<0.0044 at 68°
5–11	Stainless	Conc.	<0.004 at 70°
9	Stainless		<0.0042 at 70°, boil.
12, 15	Stainless		<0.005 at 70°
19–21	Stainless		<0.0042 at 70°, boil.
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
	All Cu-Base Alloys		Recommended
218	Al Alloy	In storage container	Stained, etched only; at 70°
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
308	Sb Lead		Probably OK
311	Chem. Lead		Probably OK
314	Te Lead		Probably OK
316	Ni Cu Alloy	70% sol. by vol., unaerated	<0.001 at 104°
335, 336	Ni Cr Steel	96% sol.[1]	<0.004 at 68°
365–368	Co Cr W	All conc.	Recom. at all temp.

ETHYLENE GLYCOL

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Conc.	<0.003 at 70°
5–11	Stainless	Conc.	<0.003 at 70°
12, 15	Stainless	Conc.	<0.005 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
	All Cu-Base Alloys		Recommended
213	Aluminum	In container 9 mo.	Only mild stain at 70°
218	Al Alloy	In container 9 mo.	Only mild stain at 70°
308	Sb Lead		Probably OK
311	Chem. Lead		Probably OK
314	Te Lead		Probably OK

FATTY ACIDS

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		<0.004 at 70°
5–11	Stainless		<0.004 at 70°
20	Stainless		<0.0046[1]
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr		0.008–0.03 at 200° — boil.
209	Fe Ni Cr Si Mo Cu		<0.001 at 180°
244, 247	Al Bronze[4]		Recommended
249	Cu Ni Zn[4]		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper[4]		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy[4]		Recommended
283–285	Cu Si Mn[4]		Recommended
300	Ni Cr Cu Mo Fe		Recommended
302	Ni Cr Fe	Storage of conc. acids from fishoils	<0.001 at 200°
		Distillation acids from fish oils	<0.001 at 475°
		Distillation acids from cottonseed	0.002 at 530°
		Distillation acid from linseed	<0.001 at 700°
308	Sb Lead	In absence of O_2	OK
311	Chem. Lead	In absence of O_2	OK
314	Te Lead	In absence of O_2	OK
316	Ni Cu Alloy	Storage of conc. acids from fish oils	0.002 at 200°
		Distillation acids from fish oils	0.006 at 475°
		Distillation acids from fish oils	0.010 at 530°
		Distillation acids from linseed	0.007 at 700°
330	Nickel	Storage of conc. acids from fish oils	0.003 at 200°
		Distillation acids from fish oils	0.005 at 475°
		Distillation acids from cottonseed	0.012 at 530°
		Distillation acids from linseed	0.010 at 700°
337, 338	Nickel Silver[4]		Recommended
350–353	P Bronze[4]		Re[illegible]nded
355, 371	Copper		[illegible]
359	Red Brass[4]		[illegible]ed
364	Silver		Resistan[illegible]
370	Tantalum		None at any temp.

FERRIC CHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	1%[2,3]	0.0042–0.042 at 70°
		1%[2,3]	0.12–0.42 at boil.
		Sat. sol.	Attacked at 70°
5	Stainless	5%	Not recom. at 70°
		Sat. sol.	Attacked at 70°
6,7,8	Stainless	Sat. sol.	Attacked at 70°
9	Stainless	1%[2,3]	<0.0042 at 70°
		1%[2,3]	0.042–0.12 at boil.

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
		10%[2,3]	<0.004 at 70°
9	Stainless	10%[2,3].	<0.004 at 70°
10, 11	Stainless	Sat. sol.	Attacked at 70°
12,15,18	Stainless	5%, sat. sol.	Not recom. at 70°
19	Stainless	1%[2,3]	0.0042–0.042 at 70°
		1%[2,3]	0.12–0.42 at 70°
		5%, sat. sol.	Not recom. at 70°
20, 25	Stainless	5%, sat. sol.	Not recom. at 70°
104	Fe Ni Cu Cr		Attacked
129	High Si Iron	48%, quiet	0.0041 at room temp.
139	High Si Mo Iron	Consult manufacturer	
142	High Si Iron	Consult manufacturer	
209	Fe Ni Cr Si Mo Cu		Not recom. at cold
	All Cu — Base Alloys		Attacked
213	Aluminum	0.1%	0.002 at room temp.
		1.0%	0.11 at room temp.
		10%	0.053 at room temp.
214–222	Al Alloys	Expected to be same as 213.	
290, 291	Ni Mo Fe	All conc.	Not recom. at any temp.
292	Ni Mo Fe Cr	10%	Recom. to 158°
	Corrosion of 292 increases with increase in conc. or temp.		
293	Ni Si Cu	All conc.	Not recom. at any temp.
300	Ni Cr Cu Mo Fe	43% sol.	>0.125 at 176°
302	Ni Cr Fe	10%, complete immersion	1.2 at 85°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	10%, alternate immersion	3.2 at atmos. temp.
330	Nickel	10%, alternate immersion	2.9 at atmos. temp.
336	Ni Cr Steel	50% sol.[1]	>0.038 at 122°
364	Silver	10% C. P., refluxed	0.020 at boiling
365–368	Co Cr W	All conc.	Recom. to 105°
	Corrosion of 365–368 increases with increase in conc. or temp.		
370	Tantalum		None at any temp.

FERRIC SULPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	1, 5% quiet, agitated, or aerated	<0.0042 at 70°
		10%	<0.0042 at boiling
		Sat. sol.	<0.004 at 70°
5	Stainless	5%[2]	<0.004 at 70°
		Sat. sol.	<0.004 at 70°
6–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	1, 5% quiet, agitated, or aerated	<0.0042 at 70°
		10%	<0.0042 at boiling
		Sat. sol.	<0.004 at 70°
10, 11	Stainless	Sat. sol.	<0.004 at 70°
15, 18	Stainless	5%	<0.004 at 70°
19, 20, 21, 25	Stainless	1, 5% quiet, agitated, or aerated	<0.0042 at 70°
		Sat. sol.	<0.004 at 70°
104	Fe Ni Cu Cr		Attacked
129	High Si Iron	50%, quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	0.5% + 10% H_2SO_4 Ferrisul Inhibitor	0.0010 at 212°
		5% + 10% H_2SO_4 Ferrisul Inhibitor	0.0016 at 212°
211, 258	Admiralty		Attacked
244, 247	Al Bronze		Attacked
248	Al Brass		Attacked
249	Cu Ni Zn		Attacked
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Attacked
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Attacked
283–285	Cu Si Mn		Attacked
290, 291	Ni Mo Fe	All conc.	Not recom. at any temp.
292	Ni Cr Fe W	All conc.	Recom. to 105°
293	Ni Si Cu	All conc.	Not recom. at any temp.
297	High Brass		Attacked
308	Sb Lead		OK
311	Chem. Lead		OK
314	Te Lead		OK
318	Muntz		Attacked
328	Naval Brass		Attacked
337, 338	Nickel Silver		Attacked
350–353	P Bronze		Attacked
355, 371	Copper		Slight to moderate
359	Red Brass		Attacked

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
364	Silver		Attacked at boiling
365–368	Co Cr W	All conc.	Recom. to 105°
373	Tobin Bronze		Attacked

FERROUS CHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
9	Stainless	Sat. sol.	<0.004 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
370	Tantalum		None at any temp.

FERROUS SULPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	10% sol.[2]	<0.0042 at 70° — boil.
		Sat. sol.	<0.004 at 70°
5	Stainless	Dil. sol.	<0.004 at 70°
		Sat. sol.	<0.004 at 70°
6–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	Dil. sol.	<0.004 at 70°
		10% sol.	<0.0042 at 70° — boil.
		Sat. sol.	<0.004 at 70°
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	Dil. sol.	<0.004 at 70°
		Sat. sol.	<0.005 at 70°
18	Stainless	Dil. sol.	<0.004 at 70°
19, 20, 25	Stainless	Dil. sol.[2]	<0.004 at 70°
		Sat. sol.	<0.004 at 70°
104	Fe Ni Cu Cr	10% sol.	0.059 at 80°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
213	Aluminum	0.1% sol.	<0.001 at room temp.
		1% sol.	0.001 at room temp.
		10% sol.	0.0026 at room temp.
214–222	Al alloys	All Al alloys expected to be same as 213	
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Preferred to 290, 291, 293
293	Ni Si Cu	All conc.	Recom. at all temp.
300	Ni Cr Cu Mo Fe	2.5% + 5% H_2SO_4	<0.004 at boiling
		2.5% + 12.5% H_2SO_4	<0.004 at boiling
		5% + 5% H_2SO_4	<0.004 at boiling
		Sat. sol.; equal parts with 25% H_2SO_4	0.004–0.015 at boiling
308	Sb Lead		OK
311	Chem. Lead		OK
314	Te Lead		OK
316	Ni Cu Alloy	20% sol.	0.040 at boiling
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver		Attacked on heating

FORMALDEHYDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	40% sol.[2]	<0.004 at 70°
5–8	Stainless	40% sol.[2]	<0.004 at 70°
9	Stainless	40% sol.	<0.004 at 70°
10, 11	Stainless	40% sol.[2]	<0.004 at 70°
12, 15	Stainless	40% sol.[2]	<0.005 at 70°

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
19, 20	Stainless	40% sol.[2]	<0.004 at 70°
21, 25	Stainless	40% sol.[2]	<0.004 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		Satisfactory at cold
	All Cu — Base Alloys		Recommended
216	Al Alloy	38% sol.	0.010 at room temp.
213–222	Al Alloys	All Al alloys expected to be same as 216.	
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
300	Ni Cr Cu Mo Fe	40% sol.	<0.004 at 70°
302	Ni Cr Fe	37% sol., storage tank	<0.001 at 75°
		Wet vapors	<0.001 at 148°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy		Same as 302
330	Nickel		Same as 302
364	Silver	Silver-lined containers	Highly resistant
365–368	Co Cr W	All conc.	Recom. to boiling

FORMIC ACID

No.	Material	Exposure Conditions	Room temp.	Boiling
	Stainless	5% sol.	<0.0042	0.004–0.040
		10% sol.	<0.0042	0.004–0.040
		50% sol.	<0.0042	0.004–0.040
		90% sol.	<0.0042	
		100%	<0.0042	0.004–0.040
5–8	Stainless	5% sol.	<0.004	
9	Stainless	5% sol.	<0.0042	
		10% sol.	<0.0042	<0.0042
		50% sol.	<0.0042	<0.0042
		90% sol.		<0.0042
		100%	<0.0042	0.004–0.040
10, 11	Stainless	5% sol.	<0.004	
12, 15	Stainless		Attacked	Attacked
19	Stainless	5% sol.	0.004–0.040	
		10% sol.	0.004–0.040	>0.42
		50% sol.	0.004–0.040	>0.42
20	Stainless	10% sol.[1]	<0.0046	<0.0046
		50% sol.[1]	<0.0046	<0.0046
		80% sol.[1]	<0.0046	<0.0046
		100%[1]	<0.0046	<0.0046

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
104	Fe Ni Cu Cr		0.0577 at 80°
129	High Si Iron	25% sol., quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		Satisfactory at cold
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
265	Ni Cr Alloy	0.34% sol.[1]	0.011 at 68°
		85% sol.[1]	0.009 at 68°
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290	Ni Mo Fe	10% sol., aerated	0.028 at 158°
		60% sol., aerated	0.040 at 158°
		85% (conc.), aerated	0.036 at 158°
292	Ni Cr Fe W	10% sol., aerated	<0.001 at 158°
		60% sol., aerated	0.0012 at 158°
		85% (conc.), aerated	0.0012 at 158°
293	Ni Si Cu	10% sol., aerated	0.018 at 158°
		60% sol., aerated	0.031 at 158°
		85% (conc.), aerated	0.018 at 158°
300	Ni Cr Cu Mo Fe	25% sol.	<0.004 at 70°
		80% sol.	<0.004 at boiling
302	Ni Cr Fe	90% sol., storage tank	0.006 at room temp.
		90% sol., in still	0.020 at 212°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	1% sol.	0.016 at boiling
		2.2% sol., aerated	0.014 at 72°
		30% sol., unaerated	0.003 at atmos. temp.
		30% sol., unaerated	0.023 at 140°
		90% sol., storage tank	0.010 at room temp.
316	Ni Cu Alloy	90% sol., in still	0.013 at 212°
330	Nickel	90% sol., storage tank	0.004 at room temp.
		90% sol., in still	0.018 at 212°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver	In dyestuff plants	Highly resistant
370	Tantalum		None at any temp.

FURFURAL

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
5, 9	Stainless		<0.004 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
211, 258	Admiralty		Recommended
216	Al Alloy	In storage container 6 mo.	Only stained, room temp.
213–222	Al Alloys	All Al alloys expected to be same as 216	
244, 247	Al Bronze		Recommended
248	Al Brass		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended

GELATINE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2, 9, 15, 19	Stainless		Little or none
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
	All Cu — Base Alloys except High Brass and Muntz		Recommended
209	Fe Ni Cr Si Mo Cu	pH 4.0–4.5 with HCl	<0.031 at 130°
302	Ni Cr Fe	Cooking 15–20% animal gel.	<0.001 at 180°
		Conc. sol. from 4 to 20% in evaporator	<0.001 at 172°
316	Ni Cu Alloy	Cooking 15–20% animal gel.	0.004 at 180°
330	Nickel	Cooking 15–20% animal gel.	0.004 at 180°
		Conc. sol. from 4 to 20% in evaporator	0.002 at 172°
364	Silver		No attack

GLUE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Dry	<0.0042 at 70°
		Acid sol.[2]	0.0042–0.042 at 70 & 140°
5	Stainless	Acid sol.[2]	<0.004 at 70 & 150°
6–8	Stainless	Sol.	<0.004 at 70°[2]
9	Stainless	Dry	<0.0042 at 70°
		Acid sol.	<0.0042 at 70 & 140°
10, 11	Stainless	Sol.	<0.004 at 70°[2]
12, 15	Stainless	Dry	<0.0042 at 70°
		Sol.	<0.005 at 70°[2]
19–21	Stainless	Dry	<0.0042 at 70°
		Sol.[1]	<0.0046 at 68°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	5% sol.	<0.001 at 140–190°
	All Cu — Base Alloys except High Brass and Muntz		Recommended
302	Ni Cr Fe	6% animal glue sol.	<0.001 at 180°
		12.5% glue size sol.	0.001 at 120°
316	Ni Cu Alloy		Same as 302
330	Nickel	6% animal glue sol.	<0.001 at 180°
		12.5% glue size sol.	0.003 at 120°
364	Silver	In ordinary glue	No attack

GLYCERINE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2–21	Stainless		<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
142	High Si Iron	Any conc.	Recom. to boiling		
176	Fe Ni Cu Cr		0.002 at 130°		
209	Fe Ni Cr Si Mo Cu	Recovery from spent soap lye	0.0035 at 320°		
	All Cu — Base Alloys except High Brass and Muntz		Recommended		
213	Aluminum	30% glycerine	0.001 at room temp.		
		Pure glycerine, 4 days	No attack at 300°		
214–222	Al Alloys	All Al alloys expected to be same as 213.			
302	Ni Cr Fe	Crude	<0.001 at 240°		
		Conc. and sat. with salt	<0.001 at 300°		
316	Ni Cu Alloy	50% water sol.	<0.001 at boiling		
		Crude	<0.001 at 240°		
		Conc. and sat. with salt	0.002 at 300°		
330	Nickel	50% water sol.	0.002 at boiling		
		Crude	<0.001 at 240°		
		Conc. and sat. with salt	0.002 at 300°		
364	Silver	In Ag-lined barrels	No attack		

HYDROCHLORIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
2–25	Stainless	All conc.	>0.42 at 70°		
31–33	Stainless	1, 5% sol.	>0.5 at 95°		
35	Stainless	1% sol.	0.080 at room temp.		
		1% sol.	0.1–0.5 at 95°		
		5% sol.	>0.5 at 95°		
36	Stainless	0.25% sol.	Recom. at room temp.		
37	Stainless	0.25% sol.	Recom. at room temp.		
		1% sol.	Recom. at room temp.		
		1, 5% sol.	0.1–0.2 at 95°		
		1, 5% sol.	>0.5 at boiling		
38	Stainless	0.25, 1% sol.	Recom. at room temp.		
42	Stainless	0.25% sol.	Recom. at room temp.		
		1% sol.	>0.001 at room temp.		
52	Stainless	0.25, 1% sol.	Recom. at room temp.		
56	Stainless	0.25% sol.	Recom. at room temp.		
		1% sol.	0.060 at room temp.		
		1% sol.	0.067 at 95°		
		1% sol.	>0.5 at boiling		
58	Stainless	0.25% sol.	Recom. at room temp., boil.		
		1% sol.	Recom. at room temp.		
		1% sol.	0.003 at boiling		
59	Stainless	0.25% sol.	Recom. at room temp., boil.		
		1% sol.	<0.001 at room temp.		
		1% sol.	0.004 at boiling		
61	Stainless	1% sol.	0.13–0.14 at 95°		
		1% sol.	>0.5 at boiling		
		5% sol.	0.11–0.16 at 95°		
62	Stainless	1% sol.	0.15 at 95°		
		5% sol.	0.18 at 95°		
80	Stainless	0.25, 1% sol.	Recom. at room temp., boil.		
		5, 20%, conc. sol.	Recom. at room temp.		
			70°	180°	Boiling
83	Ni Steel	3% sol.	0.011	>0.1	
		20% sol.	0.014	>0.1	
		40% sol.	0.032	>0.1	
91	Cr Ni Steel	0.25, 1% sol.	R		R
		5% sol.	R		
104	Fe Ni Cu Cr		Severe		
105	Ni Cr Steel	0.25–5% sol.	R		R
		20%, conc. sol.	R		
122	Fe Ni Cr Cu Mo	50% sol.	0.0084		
127	Fe Ni Cr Mo	Consult mfgr.			
129	High Si Iron	0.25, 1% sol.	R		R
		5% sol., quiet	0.0015		
137	Ni Cr Cast Iron	0.25% sol.	0.105	176°	0.142
139	High Si Mo Iron	30% sol.		0.050	
140	Fe Ni Cr Mo Cu	0.25%—conc. sol.	R		
141	Fe Ni Cr Cu Mo	0.25%—conc. sol.	R		
142	High Si Iron	0.25–1% sol.	R		
		5% sol.	0.003		
		20% sol.	0.006		
		Conc. sol.	0.010	180°	
157	Ni Cr Steel	3% sol.	0.0273	>0.1	
		20% sol.	0.0337	>0.1	
		40% sol.	0.0647	>0.1	
158	Fe Ni Cr W	3% sol.	0.0173	>0.1	
		20% sol.	0.0242	>0.1	
		40% sol.	0.0414	>0.1	
159	Fe Ni Cr Cu	3% sol.	0.039	>0.1	
		20% sol.	0.060	>0.1	
		40% sol.	>0.1	>0.1	
172	Ni Fe Cr	0.25, 1% sol.	R		R
		5, 20%, conc. sol.	R		

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
			70°		
175	Cr Ni Steel	Conc. sol.	R		
176	Fe Ni Cu Cr	5–50% sol.	0.01–0.04		
		75% sol.	0.12		
		Conc. sol.	0.37		
206	Fe Cr Ni Mo	0.25, 1% sol.	R	176°	
209	Fe Ni Cr Si Mo Cu	2% sol.	0.025	0.089	
				140°	
		5% sol.	0.028	0.094	
				176°	
		5% sol.		0.692	
		10% sol.	0.042		
		15% sol.	0.036		
		20% sol.	0.034		Boil
		25% sol.	0.140		
211	Admiralty	0.25–5% sol.	R		R
		20% sol.	R		
213	Aluminum	0.25% sol.	0.005		
		1% sol.	0.017		
		5% sol.	0.075		
214	Al Alloy	0.25% sol.	0.011		
		1% sol.	0.041		
		5% sol.	0.061		
215	Al Alloy	0.25% sol.	0.012		
		1% sol.	0.036		
		5% sol.	0.089		
216	Al Alloy	0.25% sol.	0.015		
		1% sol.	0.036		
		5% sol.	0.18		
224	Al Bronze	0.25, 1% sol.	R		
225	Ni Cr Si	0.25, 1% sol	R		R
		5, 20% sol.	R		
226, 227	Ni Cr Si	0.25% sol.	R		R
		1, 5, 20% sol.	R		
229	Ni Cr Alloy	0.25, 1% sol.	R		R
		5, 20%, conc. sol.	R		
244	Al Bronze	0.25–20% sol.	R		R
		Conc. sol.	R		
249	Cu Ni Zn	0.25–20% sol.	R		R
		Conc. sol.	R		
257	Admiralty	0.25% sol.	R		R
		1% sol.	R		
266, 277	Copper	0.25–20% sol.	R		R
		Conc. sol.	R		
273	Bronze	0.25, 1% sol.	R		
276	Cu Ni Alloy		Same as 266		
283–285	Cu Si Mn	0.25–20% sol.	R		R
		Conc.	R		
289	Gold	0.25%—conc. sol.	R		R
			70° aerated	158° aerated	Boiling unaerated
290	Ni Mo Fe	1% sol.	0.040	0.089	0.083
		5% sol.	0.028	0.13	0.37
		15% sol.	0.014	0.16	>0.5
		25% sol.	0.0049	0.041	0.13
		37% sol., (conc.)	0.004	0.035	0.370
291	Ni Mo Fe	1% sol.	0.0036	0.023	0.0088
		5% sol.	0.0089	0.032	0.012
		15% sol.	0.0042	0.043	0.014
		25% sol.	0.0036	0.018	0.020
		37% sol., (conc.)	0.0018	0.019	0.017
292	Ni Cr Fe W	1% sol.	<0.001	0.0017	0.10
		5% sol.	0.0071	0.16	0.49
		15% sol.	0.022	0.23	>0.5
		25% sol.	0.014	>0.5	>0.5
		37% sol., (conc.)	0.018	>0.5	>0.5
293	Ni Si Cu	1% sol.	0.023	0.064	0.010
		5% sol.	0.026	0.160	>0.50
		15% sol.	0.037	0.490	>0.50
		25% sol.	0.059	0.440	>0.50
		37% sol., (conc.)	0.140	0.350	>0.50
295	Cu Si Mn Sn	0.25–5% sol.	Recom. at 70° & boil.		
		20%, conc. sol.	Recom. at 70°		
296	Cu Si Sn	0.25%—conc. sol.	Recom. at 70°		
300	Ni Cr Cu Mo Fe	1% sol., wash liquor	Recommended		
		5% sol.	<0.004 at 70°		
		7% sol.	0.004–0.015 at 70°		
		7% sol.	>0.125 at 120°		
		10% sol.	<0.004 at 70°		
		10% sol., aerated	0.015–0.050 at 100°		
		16% sol.	>0.125 at 120°		
		22% sol.	0.050–0.125 at 70°		
		22% sol.	>0.125 at 120°		
		32% sol.	>0.125 at 105°		
		Conc. sol.	>0.125 at 70°		

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
300	NiCrCuMoFe	Conc. sol.	>0.125 at 100°
		Conc. fumes	<0.004 at 113°
302	Ni Cr Fe	2% sol., apple washer	0.076 at 80–120°
		5% sol., aerated	0.098 at 86°
		5% sol., sat. with H_2	0.013 at 86°
		5% sol., aerated	1.6 at 185°
305–307	Ir Platinum	0.25%—conc. sol.	Recom. at 70° & boil.
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	0.5% sol., aerated	0.016 at boiling
		2% sol., apple washer	0.073 at 80–120°
		3.6% sol., unaerated	0.036 at 140°
		5% sol., unaerated	0.005 at 77°
		5% sol., aerated	0.083 at 86°
		10% sol., unaerated	0.416 at 105°
		20% sol., unaerated	0.022 at 77°
		25% sol., unaerated	0.15 at atm. temp.
329	Ni Cr Alloy	0.25, 1% sol.	Recom. at 70° & boil.
		5% sol.	Recom. at 70°
		15% sol.[1]	0.0144 at 77°
		37% sol.[1]	0.0108 at 77°
330	Nickel	2% sol., apple washer	0.074 at 80–120°
		3.6% sol., unaerated	0.089 at 140°
		5% sol., unaerated	0.012 at 77°
		5% sol., aerated	0.052 at 86°
		20% sol., unaerated	0.023 at 77°
335	Ni Cr Steel	3.3% sol.[1]	<0.004 at 68°
337, 338	Nickel Silver	0.25–20% sol.	Recom. at 70° & boil.
		Conc. sol.	Recom. at 70°
343	Bronze	0.25% sol.	Recom. at 70° & boil.
		1% sol.	Recom. at 70°
346	Palladium	0.25–20% sol.	Recom. at 70° & boil.
		Conc. sol.	Recom. at 70°
350, 352	P. Bronze	0.25–20% sol.	Recom. at 70° & boil.
353		Conc. sol.	Recom. at 70°
357, 358	Platinum	0.25%—conc. sol.	Recom. at 70° & boil.
361	Rh Platinum		Same as 357
363	Silver	0.25%—conc. sol.	Recom. at 70°
364	Silver	0.25%—conc. sol.	Recom. at 70° & Boil.
		15% sol., C. P.	0.012 at 77°
370	Tantalum	Any conc.	None at any temp.

HYDROFLUORIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2–25	Stainless		Attacked
104	Fe Ni Cu Cr		Rapid attack
139	High Si Mo Iron		Not recommended
142	High Si Iron		Not recommended
176	Fe Ni Cu Cr	10% sol.	0.001 at 60°
209	Fe Ni Cr Si Mo Cu	0.5% in 4% H_3PO_4	0.001 at cold
		0.5% in 4% H_3PO_4	0.055 at 176°
213	Aluminum	0.1% sol.	0.7 at room temp.
		1% sol.	1.6 at room temp.
		10% sol.	8.3 at room temp.
214–222	Al Alloys	All Al alloys expected to be same as 213	
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at 70°
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at 70°
	Corrosion of 290–293 is more severe in vapor phase than in liquid when alloy is partly immersed.		
300	Ni Cr Cu Mo Fe	Anhydrous	<0.004 at 70°
		Anhydrous + 5% by vol. of 98% H_2SO_4	<0.004 at 70°
		Anhydrous + 57% by vol. of 98% H_2SO_4	<0.004 at 70°
		Anhydrous + 77% by vol. of 98% H_2SO_4	<0.004 at 70°
		5% sol.	<0.004 at 70°
302	Ni Cr Fe	6% sol., pickling tank	0.063 at 170°
		10% sol., pickling tank	<0.001 at 50–70°
		98% sol., unaerated	0.002 at 100°
311	Chem. Lead	Dil. sol.	Fair resist.; ordinary temp.
314	Te Lead	Dil. sol.	Fair resist.; ordinary temp.
316	Ni Cu Alloy	<50% sol., unaerated	<0.001 at 86°
		6% sol., pickling tank	0.001 at 170°
		25% sol., sat. with air	0.037 at 86°
316	Ni Cu Alloy	25% sol., sat. with air	0.011 at 176°
		25% sol., unaerated	0.002 at 176°
		50% sol., sat. with air	0.008 at 86°
		50% sol., sat. with air	0.039 at 176°
		50% sol., unaerated	<0.001 at 176°
		98% sol., unaerated	0.002 at 100°
330	Nickel	6% sol., pickling tank	0.352 at 170°
		10% sol., pickling tank	<0.001 at 50–70°
		98% sol., unaerated	0.002 at 100°
336	Ni Cr Steel	40% sol.[1]	<0.001 at 68°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Severe
359	Red Brass		Recommended
364	Silver	Aqueous sol.	Little or none
		48% sol., C. P.	<0.001
365–368	Co Cr W	All conc.	Recom. at 70°
	Corrosion of 365–368 is more severe in vapor phase than in liquid when alloy is partly immersed.		
370	Tantalum		Attacked

HYDROGEN PEROXIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	In absence of H_2SO_4	<0.0042 at 70°
		In absence of H_2SO_4	0.0042–0.042 at boil.
5–8	Stainless	Acid free	<0.001 at 70°
9	Stainless		<0.001 at 70° & boil.
10–12, 15	Stainless	Acid free	<0.001 at 70°
19	Stainless	In absence of H_2SO_4	<0.0042 at 70°
		In absence of H_2SO_4	0.0042–0.042 at boil.
20, 21, 25	Stainless	Acid free	<0.001 at 70°
104	Fe Ni Cu Cr	U. S. P.	0.000 at 80°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Bleaching sol.	No loss at cold
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
300	Ni Cr Cu Mo Fe		Recommended
311	Chem. Lead	Dilute sol.	Fair resist.; ordinary temp.
314	Te Lead	Dilute sol.	Fair resist.; ordinary temp.
328	Naval Brass		Recommended
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Severe
359	Red Brass		Recommended
370	Tantalum		None at any temp.
373	Tobin Bronze		Recommended

IODINE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2–8	Stainless		>0.42 at 70°
9	Stainless		0.12–0.42 at 70°
10–25	Stainless		>0.42 at 70°
139	High Si Mo Iron		Not recommended
142	High Si Iron		Not recommended
244, 258	Al Bronze	Perfectly dry	Recommended
249	Cu Ni Zn	Perfectly dry	Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper	Perfectly dry	Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy	Perfectly dry	Recommended
283–285	Cu Si Mn	Perfectly dry	Recommended
292	Ni Cr Fe W	All conc.	Recom. at all temp.
300	Ni Cr Cu Mo Fe	Evaporating H_2O sol.	Not recom. at boil.
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	5% U. S. P. tinc. in H_2O	0.037 at atm. temp.
		5% U. S. P. tinc. in H_2O	0.035 at 140°
337,338	Nickel Silver	Perfectly dry	Recommended
350–353	P Bronze	Perfectly dry	Recommended
355,371	Copper		Severe
359	Red Brass	Perfectly dry	Recommended

No	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum		None at any temp.

LACTIC ACID

No	Material	Exposure Conditions	70°	150°	Boil.
2	Stainless	1% sol.	<0.004		<0.004
		5% sol.	<0.004	0.004–0.04	0.004–0.04
		10% sol.	<0.004	0.04–0.12	0.12–0.42
		Conc. sol.	<0.004		0.042–0.12
5–8	Stainless	5% sol.	<0.004		
9	Stainless	1% sol.	<0.004		<0.004
		5% sol.	<0.004	<0.004	<0.004
		10% sol.	<0.004	0.004–0.04	0.004–0.04
		Conc. sol.	<0.004		0.004–0.04
10, 11	Stainless		<0.004		
12, 15	Stainless		<0.1		
19	Stainless	1% sol.	<0.004		0.004–0.04
		5% sol.	0.004–0.04		0.004–0.04
		10% sol.	0.004–0.04		>0.4
20	Stainless	10% sol.[1]	<0.005		<0.005
		Conc. sol.[1]	<0.005		<0.005
21	Stainless	10% sol.[1]	<0.05		<0.05
		Conc. sol.[1]	<0.05		<0.5
25	Stainless	10% sol.	<0.04		
129	High Si Iron	25% sol., quiet	<0.001 at room temp.		
139	High Si Mo Iron	Any conc.	Recom. to boiling		
142	High Si Iron	Any conc.	Recom. to boiling		
176	Fe Ni Cu Cr	10–25% sol.	0.67 at 130°		
209	Fe Ni Cr Si Mo Cu		<0.001 at cold		
244, 247	Al Bronze		Recommended		
249	Cu Ni Zn		Recommended		
257	Admiralty		Slight to moderate		
259, 262, 266, 277	Copper		Recommended		
265	Ni Cr Alloy	25% sol.[1]	0.0058 at 67°		
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate		
275, 276	Cu Ni Alloy		Recommended		
283–285	Cu Si Mn		Recommended		
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.		
292	Ni Cr Fe W	All conc.	Recom. at all temp.		
293	Ni Si Cu	All conc.	Recom. at all temp.		
300	Ni Cr Cu Mo Fe	10% sol.	<0.004 at 70–160°		
302	Ni Cr Fe	Conc. 5% to 48% in evaporator	0.004 under vacuum		
		Conc. 10% to 22% in evaporator	0.008 at 130°		
		45% sol., aerated	<0.001 at atm. temp.		
		45% sol., unaerated	<0.001 at atm. temp.		
316	Ni Cu Alloy	Conc. 5% to 48% in evaporator	0.006 under vacuum		
		Conc. 10% to 22% in evaporator	0.056 at 130°		
		45% sol., aerated	0.020 at atm. temp.		
		45% sol., unaerated	0.008 at atm. temp.		
330	Nickel	Conc. 5% to 48% in evaporator	0.005 under vacuum		
		Conc. 10% to 22% in evaporator	0.051 at 130°		
		45% sol., aerated	0.021 at atm. temp.		
		45% sol., unaerated	0.008 at atm. temp.		
336	Ni Cr Steel	1.5% sol.[1]	<0.004 at 67°		
		10% sol.[1]	<0.004 at 67°		
		10% sol.[1]	<0.040 at 194°		
337, 338	Nickel Silver		Recommended		
350–353	P Bronze		Recommended		
355, 371	Copper		Slight to moderate		
359	Red Brass		Recommended		
364	Silver	50% by vol.	0.010 at boiling		
365–368	Co Cr W	All conc.	Recom. at all temp.		

MAGNESIUM CHLORIDE

No	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	1, 5% sol., quiet	<0.0042 at 70°[2]
		1, 5% sol., quiet	0.042–0.12 at hot[2]
		10–30% sol.[1]	<0.0044 at 68°[2]
		Sat. sol.	<0.004 at 70°[2]
5	Stainless	5% sol.	<0.007 at 70°[2]
		Sat. sol.	<0.004 at 70°[2]
6–8	Stainless	Sat. sol.	<0.004 at 70°[2]
9	Stainless	1, 5% sol., quiet	<0.0042 at 70°
		1, 5% sol., quiet	0.0042–0.042 at hot[2]
		Sat. sol.	<0.004 at 70°
10, 11	Stainless	Sat. sol.	<0.004 at 70°[2]
12, 15	Stainless	5% sol.	<0.040 at 70°[2]
		Sat. sol.	<0.100 at 70°[2]
19, 25	Stainless	1, 5% sol., quiet	<0.0042 at 70°[2]
		Sat. sol.	<0.004 at 70°[2]
104	Fe Ni Cu Cr		Suitable
129	High Si Iron	25% sol., quiet	<0.001 at room temp.
139	High Si Mo Iron		Consult mfgr.
142	High Si Iron		Not recommended
187	Steel	1% sol.[1]	0.0021 at 68°
189	Steel	1% sol.[1]	0.0022 at 68°
190	Ni-Steel	1% sol.[1]	0.0021 at 68°
209	Fe Ni Cr Si Mo Cu	40% sol.	0.0029 at 274°
		35% (6% H_2O); pH 6.0	0.0027 at 175°
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
302	Ni Cr Fe	42%, aerated, refluxed	<0.001, boiling at 311°
		48%, unaerated	0.006 at 330°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	5% sol., aerated	<0.001 at 60°
		42% aerated, refluxed	0.025, boiling at 311°
		42% sol., unaerated	<0.001 at 275°
		48% sol., unaerated	0.006 at 330°
330	Nickel	42%, aerated, refluxed	0.006, boiling at 311°
		48%, unaerated	0.004 at 330°
335, 336	Cr Ni Steel	10–30% sol.[1]	0.004 at 68°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver	In dyestuff plant	No attack
370	Tantalum		None at any temp.

METHANOL

No	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		<0.0042 at 70°
			0.042–0.12 at 150°[2]
5–8	Stainless		<0.004 at 70°
9	Stainless		<0.0042 at 70°
			0.0042–0.042 at 150°
10, 11	Stainless		<0.004 at 70°
12, 15, 18	Stainless		<0.004 at 70°
19	Stainless		<0.0042 at 70°
			0.042–0.12 at 150°
20, 21, 25	Stainless		<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
161	Cr Steel	100%	<0.001 at 70°
176	Fe Ni Cu Cr	Crude	0.004 at 160°
209	Fe Ni Cr. Si Mo Cu	Commercial	No loss at cold
	All Cu—Base Alloys		Recommended
213	Aluminum	Exposed 3 mo.	No attack
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
233	Ni Si Cu	All conc.	Recom. at all temp.
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum		None at any temp.

MIXED ACIDS

No	Material	H_2SO_4, %	HNO_3, %	Corrosion (Inches per Year @ Deg. F.)
2, 9	Stainless	15	5	<0.044 at 230°[1]
		30	5	<0.0044 at 203°[1]
		30	5	<0.044 at 230°[1]
		58	40	<0.0044 at 140°[1]
		58	40	<0.044 at 203°[1]
		58	40	>0.131 at 230°[1]
		70	10	<0.0044 at 140°
		70	10	<0.044 at 203°[1]
		1	99	<0.044 at boiling[1]
		10	90	<0.044 at boiling[1]
139	High Si Mo Iron	Any conc.		Recom. to boiling

No.	Material	Exposure Conditions		Corrosion (Inches per Year @ Deg. F.)
142	High Si Iron	Any conc.		Recom. to boiling
209	Fe Ni Cr Si Mo Cu	61% H_2SO_4 + 36% HNO_3		<0.001 at 176°
	All Cu—Base Alloys			Attacked
		H_2SO_4, %	HNO_3, %	
213	Aluminum	90	4	0.90 at room temp.
		85	8	1.0 at room temp.
		80	20	0.45 at room temp.
		80	5	1.24 at room temp.
		60	40	0.47 at room temp.
		60	26	0.95 at room temp.
		40	60	0.38 at room temp.
		20	80	0.09 at room temp.
		20	55	0.14 at room temp.
		14	60	0.095 at room temp.
300	Ni Cr Cu Mo Fe	12.5	12.5	0.004–0.015 at boil.
		12.5	5	0.004–0.015 at boil.
		92.5	7.5	<0.004 at 54°
311	Chem. Lead	Mixed acid sol.		Fair resist.
	Te Lead	Mixed acid sol.		Fair resist.

NITRIC ACID

No.	Material	Exposure Conditions	70°	110°	Boil.
2	Stainless	5–50% sol.	<0.0042		0.0042
		65% sol.	<0.0042		0.004–0.04
		Conc. sol.	<0.0042		0.04–0.12
		Fuming conc.	<0.004	<0.004	0.12–0.42
5	Stainless	5% sol.	<0.004	0.013	
		20% sol.	<0.004		
		65% sol.			<0.030
		Conc. sol.	<0.004		
6, 7	Stainless	Conc. sol.	<0.004		
8	Stainless	5% sol.		0.0084	
		Conc. sol.	<0.004		
9	Stainless	5–50% sol.	<0.0042		<0.0042
		65% sol.	<0.0042		0.004–0.04
		Conc. sol.	<0.004		0.04–0.12
		Fuming conc.	<0.004	<0.004	0.12–0.42
10, 11	Stainless	Conc. sol.	<0.004		
12, 15	Stainless	5% sol.	<0.020		
		20% sol.	<0.020		
		65% sol.			NR
		Conc. sol.	<0.005		
18	Stainless	5% sol.	<0.020		
		20% sol.	<0.020		
		65% sol.			>0.42
		Conc. sol.	<0.0042		>0.42
19	Stainless	5% sol.	<0.0042		0.042–0.12
		20–50% sol.	<0.0042		0.004–0.04
		65% sol.	<0.0042		0.042–0.12
		Conc. sol.	<0.0042		0.12–0.42
		Fuming conc.	<0.004	<0.004	0.12–0.42
20, 21	Stainless	10% sol.[1]	<0.0046		<0.0046
		25% sol.[1]	<0.0046		<0.046
		50%—conc. sol.[1]	<0.0046		<0.46
25	Stainless	Conc. sol.	<0.004		
30	Stainless	20% sol.	R		
		65% sol.	R		0.13–0.16
31	Stainless	20% sol.	R		
		65% sol.	R		0.45
32	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.20
33	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.02–0.04
34	Stainless	0.5–65% sol.	R		R
35	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.020
36	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.008
37	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.02–0.03
38	Stainless	0.5–65% sol.	R		R
39	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.05–0.4
41	Stainless	0.5–65% sol.	R		R
42	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.018
44, 46, 50, 52, 53, 55	Stainless	0.5–65% sol.	R		R
56	Stainless	0.5–20% sol.	R		R
		65% sol.	R		0.016
58	Stainless	0.5–20% sol.	R		R

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
			70°		Boiling
58	Stainless	65%	R		0.018
59	Stainless	0.5–20%	R		R
		65%	R		0.010
61	Stainless	0.5–20%	R	176°	R
		65%	<0.001	0.004–0.007	0.01–0.03
62	Stainless	65%			0.042
67, 68, 71	Stainless	0.5–65%	R		R
80	Stainless	0.5, 5%	R		R
		20, 65%	R		
81	Stainless	0.5–65%	R		R
91	Cr Ni Steel	0.5–65%	R		R
104	Fe Ni Cu Cr		Rapid attack		
105	Ni Cr Steel	0.5, 5% sol.	R		R
		20, 65% sol.	R		
122	Fe Ni Cr Cu Mo	65% sol.			0.0086
125	Cr Steel	0.5–65% sol.	R		R
129	High Si Iron	0.5–70% sol.	R		R
136	Fe Cr Ni Mo	0.5–65% sol.	R		R
138	Fe Cr Ni Mo	0.5–65% sol.	R		R
139	High Si Mo Iron	Any conc.	R		R
140	Fe Ni Cr Mo Cu	0.5–65% sol.	R		R
141	Fe Ni Cr Cu Mo	0.5–65% sol.	R		R
142	High Si Iron	Any conc.	R		R
150	Cr Mo Steel	20% sol., aerated	>0.5		
151	Cr Mo Steel	20% sol., aerated	0.4	110°	
163	Cr Ni Steel	5% sol.		<0.001	
164	Cr Ni Steel	0.5–65% sol.	R		R
171	Cr Steel	20, 65% sol.	R		
172	Ni Fe Cr	0.5, 5% sol.	R		R
		20, 65% sol.	R		
175	Cr Ni Steel	0.5–20% sol.	R		R
		65% sol.	R		
176	Fe Ni Cu Cr	5%—conc. sol.	0.75–2.0		
180	Cr Cast Iron	0.5, 5, 65% sol.	R		R
188	Steel	50% sol.[1]	4.9		
200	Ni Cr Fe	0.5–65% sol.	R		R
205	Cr Ni Steel	0.5–65% sol.	R		R
206	Fe Cr Ni Mo	0.5–65% sol.	R	176°	R
209	Fe Ni Cr Si Mo Cu	Commercial, all conc.		<0.001	
	All Cu—Base Alloys		Attacked		
213	Aluminum	0.5% sol.	0.005		
		5% sol.	0.041		
		20% sol.	0.11		
		65% sol.	0.049	135°	
		93% sol.		0.004	
		95% sol.		<0.001	
214	Al Alloy	0.5% sol.	0.005		
		5% sol.	0.061		
		20% sol.	0.15		
		65% sol.	0.049		
		93% sol.		0.014	
		95% sol.		0.005	
215	Al Alloy	0.5% sol.	0.010		
		5% sol.	0.066		
		20% sol.	0.14		
		65% sol.	0.055		
216	Al Alloy	0.5% sol.	0.001		
		5% sol.	0.020		
		20% sol.	0.16		
		65% sol.	0.108		
218	Al Alloy	95% sol. in tank car	Unaffected		
225–227	Ni Cr Si	0.5–20% sol.	R		R
		65% sol.	R		
229	Ni Cr Alloy	0.5–65% sol.	R		R
282	Ni Cr Cu Mo W	0.5–65% sol.	R		R
289	Gold	0.5–65% sol.	R	158°	R
292	Ni Cr Fe W	10%	0.0115	0.038	0.043
		20%	0.050		0.18
		50%	0.0092	0.140	
		70%	0.0047	0.120	1.980
300	Ni Cr Cu Mo Fe	0.5% sol.			R
		7.5–30% sol.			<0.004
		35% sol.		100°	0.004–0.015
		50% sol.		<0.004	
		62% sol.	<0.004	109°	
		70% sol.	<0.004	<0.004	0.05–0.125
		Conc. sol.	R	R	
302	Ni Cr Fe	5% sol., aerated	0.006 at atm. temp.		
		25% sol., aerated	0.002 at atm. temp.		
		25% sol., unaerated	0.001 at atm. temp.		
		65% sol., unaerated	0.003 at atm. temp.		
305–307	Ir Platinum	0.5–65% sol.	Recom. at room temp., boil.		
308	Sb Lead		Not recommended		

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	5% sol., aerated	0.065 at atm. temp.
		25% sol., unaerated	0.331 at atm. temp.
320	Ni Cr Alloy	0.5, 5% sol.	Recom. at room temp., boil.
		20, 65% sol.	Recom. at room temp.
330	Nickel	5% sol., aerated	0.135 at atm. temp.
335, 336	Ni Cr Steel	1–65% sol.[1]	<0.0038 at 68°
346	Palladium	0.5, 5% sol.	Recom. at room temp., boil.
		20, 65% sol.	Recom. at room temp.
357, 358	Platinum	0.5–65% sol.	Recom. at room temp., boil.
361	Rh Platinum	0.5–65% sol.	Recom. at room temp., boil.
364	Silver		Readily attacked
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum	0.5–65% sol.	None at any temp.
374	Ni Cr Alloy	0.5–65% sol.	Recom. at room temp., boil.

OLEIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		<0.0042 at 70–400°[2]
5–8	Stainless		<0.004 at 70°
9	Stainless		<0.0042 at 70–400°
10, 11	Stainless		<0.004 at 70°
15, 18	Stainless		<0.004 at 70°
19	Stainless		0.004–0.04 at 70° & 300°[2]
20, 21	Stainless		<0.004 at 70°
104	Fe Ni Cu Cr	Technical grade	0.0066 at 150°
129	High Si Iron	Commercial	None at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr		0.001 at room temp., boil.
209	Fe Ni Cr Si Mo Cu	In fatty acids	<0.001 at 176°
216	Al Alloy	In storage container	<0.001 at room temp.
244, 247	Al Bronze		Recommended[4]
249	Cu Ni Zn		Recommended[4]
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended[4]
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended[4]
283–285	Cu Si Mn		Recommended[4]
300	Ni Cr Cu Mo Fe	Commercial grade	<0.004 at 70°
302	Ni Cr Fe	In washing oleic with 0.75% H_2SO_4	<0.001 at atm. temp.
		Oleic + linolenic, linoleic, abietic	0.002 at 560–590°
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	In washing oleic with 0.75% H_2SO_4	<0.001 at atm. temp.
		Oleic + linolenic, linoleic, abietic	0.008 at 560–590°
330	Nickel	In washing oleic with 0.75% H_2SO_4	0.001 at atm. temp.
		Oleic + linolenic, linoleic, abietic	0.005 at 560–590°
337, 338	Nickel Silver		Recommended[4]
350–353	P Bronze		Recommended[4]
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended[4]
364	Silver		No attack

OXALIC ACID

No.	Material	Exposure Conditions	70°	104°	Boil.
2	Stainless	5% sol.	<0.0042		<0.0042
		10% sol.	<0.0042		0.12–0.42
		50% sol.			0.12–0.42
		Sat. sol.[1]	<0.0044	<0.0044	>0.44
5	Stainless	10% sol.	<0.004		NR
		Sat. sol.[2]	<0.004		
6–8	Stainless	Sat. sol.[2]	<0.004		
9	Stainless	5% sol.	<0.004		<0.004
		10% sol.	<0.004		0.04–0.12
		50% sol.			0.04–0.12
		Sat. sol.[1]	<0.004	<0.004	0.146
10, 11	Stainless	Sat. sol.[2]	<0.004		
12, 15	Stainless	5% sol.	0.004–0.04 at hot or cold		
		10% sol.[1]	<0.046 at 68°		
		10% sol.[1]	>0.46 at boiling		
19	Stainless	5% sol.	<0.0042 at 70°, boil.		
		10% sol.	0.0042–0.042 at 70°		
		10% sol.	>0.42 at boiling		
		Sat. sol.[2]	<0.004 at 70°		
20	Stainless	10% sol.[1]	<0.0046 at 70°		
		10–50% sol.[1]	<0.46 at boiling		
25	Stainless	Sat. sol.[2]	<0.004 at 70°		

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
129	High Si Iron	2.1–7.9% sol., quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		<0.001 at cold
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
300	Ni Cr Cu Mo Fe	8% sol.	<0.004 at 70°
		15% sol.	0.004–0.015 at boiling
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	30% sol.	<0.001 at room temp.—140°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver		Slight attack

PHENOL

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	C. P.+ 10% water	<0.0042 at boiling
		C. P.	<0.0042 at 70° — boiling
		Crude	<0.0042 at 212°
		Crude	<0.0042 at boiling
5–8	Stainless	Commercial grade[2]	<0.004 at 70°
9	Stainless	C. P.+ 10% water	<0.0042 at boiling
		C. P.	<0.0042 at 70° — boiling
		Crude	<0.0042 at 212°
		Crude	<0.0042 at boiling
10, 11	Stainless	Commercial grade[2]	<0.004 at 70°
15, 18	Stainless		<0.040
19	Stainless	C. P. + 10% water	<0.0042 at boiling
		C. P.	<0.0042 at 70°
		Commercial grade[2]	<0.004 at 70°
20, 21	Stainless	Sol.[1]	<0.0046 at 68° — boil.
25	Stainless	Commercial grade[2]	<0.004 at 70°
104	Fe Ni Cu Cr	U. S. P.	No attack at 80°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	15% sol.	0.009 at 60°
209	Fe Ni Cr Si Mo Cu		<0.001 at 370°
213–222	Al Alloys	Solid phenol	No attach at room temp.
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu-Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
302	Ni Cr Fe	Storage tank, unaerated	<0.001 at 365°
308	Sb Lead		OK
311	Chem. Lead		OK
314	Te Lead		OK
316	Ni Cu Alloy	5% aerated	<0.001 at 60°
		5% unaerated	<0.001 at 104°
330	Nickel	Storage tank, unaerated	<0.001 at 365°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Severe
359	Red Brass		Recommended
364	Silver	Water-free; partly immersed	<0.001
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum		None at any temp.

PHOSPHORIC ACID

No.	Material	Exposure Conditions	70°	Boiling
2	Stainless	1, 5% sol.	<0.0042	<0.0042
		10% sol., quiet	0.004–0.04	

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
			70°		
2	Stainless	10% sol., agitated	0.04–0.12		
		10% sol., aerated	0.04–0.12		
5	Stainless	1% sol.	<0.0042		
		10% sol., agitated	<0.12		Boil
6–8	Stainless		<0.0012		
9	Stainless	1, 10% sol.	<0.0042		<0.0042
		25, 50% sol.	<0.0042		0.004–0.04
		85%	<0.0042		0.04–0.12
		Attack on 9 in cold sol. may be increased to 0.042 by agitation or aeration.			
10, 11	Stainless		<0.0042		
12, 15, 18	Stainless	1, 5% sol.	<0.0042		
		10% sol.	0.12–0.42		
19	Stainless	1, 5% sol.	<0.0042		<0.040[1]
		10% sol., quiet	0.04–0.12		0.12–0.42
		10% sol., agitated	0.04–0.12		0.12–0.42
		10% sol., aerated	0.04–0.12		0.12–0.42
20	Stainless	1–45% sol.[1]	<0.0046		<0.0046
		Conc. sol.[1]	<0.0046		<0.46
21	Stainless	1–10% sol.[1]	<0.0046		<0.0046
		45% sol.[1]	<0.046		<0.46
		Conc. sol.[1]	<0.046		>0.46
25	Stainless	5% sol.	<0.0042		
32	Stainless	10–85% sol.	R		R
33	Stainless	50% sol.	R	95°	
		85% sol.	R	<0.001	>1.0
34	Stainless	10, 50% sol.	R		R
		85% sol.	R		
35	Stainless	10, 50% sol.	R		
		85% sol.	R		>1.0
36	Stainless	10% sol.	R		R
		50% sol.	R		
		85% sol.	0.001		
37	Stainless	10, 50% sol.	R		R
		85% sol.	R	<0.001	>1.0
38	Stainless	10, 50% sol.	R		R
		85% sol.	R		
41	Stainless	10–85% sol.	R		
42	Stainless	10, 50% sol.	R		R
		85% sol.	<0.001		
44	Stainless	10, 50% sol.	R		R
		85% sol.	R		
46	Stainless	10–85% sol.	R		
47, 50	Stainless	10, 50% sol.	R		R
		85% sol.	R		
52	Stainless	10–85% sol.	R		R
53	Stainless	10, 50% sol.	R		R
		85% sol.	R		
56	Stainless	10% sol.	R		R
		50% sol.	R	95°	
		85% sol.	R	nil	>1.0
58, 59	Stainless	10, 50% sol.	R		R
		85% sol.	R		
61	Stainless	85% sol.	R	nil	>1.0
67	Stainless	10% sol.	R		
68, 81	Stainless	10–85% sol.	R		
91	Cr Ni Steel	10–85% sol.	R	80°	R
104	Fe Ni Cu Cr	75% sol.		0.0042	
122	Fe Ni Cr Cu Mo	85% sol.			0.037
129	High Si Iron	10–87% sol.	<0.001		R
136	Fe Cr Ni Mo	10, 50% sol.	R		R
		85% sol.	R		
138	Fe Cr Ni Mo	10–85% sol.	R		
139	High Si Mo Iron	C. P.; 10–85% sol.	R		R
		Crude, containing HF	NR		NR
140	Fe Ni Cr Mo Cu	10–85% sol.	R		R
141	Fe Ni Cr Cu Mo	10–85% sol.	R		R
142	High Si Iron	C. P.; 10–85% sol.	R		R
		Crude, containing HF	NR		NR
175	Cr Ni Steel	10% sol.	R	86°	
176	Fe Ni Cu Cr	5–25% sol.		0.04–0.12	
				190°	
		5–25% sol.		0.28–0.76	
		50, 85% sol.	R		
180	Cr Cast Iron	50, 85% sol.	R		
200	Ni Cr Fe	10% sol.	R		
205	Cr Ni Steel	10, 50% sol.	R		R
206	Fe Cr Ni Mo	10, 50% sol.	R		R
		85% sol.	R	176°	
209	Fe Ni Cr Si Mo Cu	10–50% sol.	<0.001	<0.001	<0.001
		50–70% sol.	<0.001	<0.001	
		85% sol.	<0.001	140°	
		Slurry, 1.5 sp. g.		R	

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
			70°		Boil.
211	Admiralty	10% sol.	R		R
		50, 85% sol.	R		
213	Aluminum	10% sol.	0.074		
		50% sol.	0.20		
		85% sol.	0.24		
214	Al Alloy	10% sol.	0.09		
		50% sol.	0.25		
		85% sol.	0.27		
215	Al Alloy	10% sol.	0.095		
		50% sol.	0.24		
		85% sol.	0.26		
216	Al Alloy	10% sol.	0.175		
		50% sol.	1.0		
		85% sol.	1.2		
244	Al Bronze	10, 50% sol.	R		R
		85% sol.	R		
245	Al Bronze	10% sol.	R		
249	Cu Ni Zn	10–85% sol.	R		R
257	Admiralty		Severe		
266, 277	Copper	10% sol.	R		R
		50, 85% sol.	R		
275, 276	Cu Ni Alloy	Sol.	R		
283–285	Cu Si Mn	10% sol.	R		R
		50, 85% sol.	R		
290	Ni Mo Fe	10% sol., C. P.	0.0022		0.026
		10% sol., technical	0.0046		0.0098
		50% sol., C. P.	<0.001		0.032
		50% sol., technical	0.0058		0.032
		85% sol., C. P.	<0.001		0.82
		85% sol., technical	0.0044		0.047
291	Ni Mo Fe	10% sol., C. P.	0.0016		0.0018
		10% sol., technical	0.0035		0.0036
		50% sol., C. P.	<0.001		0.0017
		50% sol., technical	0.0041		0.022
		85% sol., C. P.	<0.001		0.0016
		85% sol., technical	0.0030		0.034
292	Ni Cr Fe W	10% sol., C. P.	<0.001		0.0014
		10% sol., technical	<0.001		0.0036
		50% sol., C. P.	<0.001		0.003
		50% sol., technical	<0.001		0.022
		85% sol., C. P.	<0.001		0.480
		85% sol., technical	<0.001		0.030
293	Ni Si Cu	10% sol., C. P.	0.0014		0.0028
		10% sol., technical	0.0044		0.0053
		50% sol., C. P.	<0.001		0.049
		50% sol., technical	0.0043		0.024
		85% sol., C. P.	<0.001		0.320
		85% sol., technical	0.0029		0.037
300	Ni Cr Cu Mo Fe	10% sol.			<0.004
		25% sol.			<0.004
		50% sol.		212°	0.004–0.015
		57% sol.	<0.004	0.004–0.015	
		85% sol.	<0.004	220°	
		90% sol.	<0.004	<0.004	
				Hot	
		Conc. sol.		R	0.05–0.125
				190°	
302	Ni Cr Fe	1.5% sol.		<0.001	
		10, 50% sol.	<0.005		
		85% sol.	<0.010	250°	
308	Sb Lead	1–80% sol.	R	R	
310	Lead	10% sol.	0.001		0.001
		50% sol.	0.001		0.002
		85% sol.	0.002	392°	0.004
311	Chem. Lead	1–80% sol.	R	R	
312	Chem. Lead	10, 50% sol.	R		R
314	Te Lead	1–80% sol.	R	R	
				190°	
316	Ni Cu Alloy	1.5% sol.		0.007	
				205°	
		25% sol., aerated		0.048	
		25% sol., unaerated		0.004	
		85% sol., unaerated		0.002	
				190°	
330	Nickel	1.5% sol.		0.013	
		10, 50% sol.	<0.005		
		85% sol.	<0.015		
337	Nickel Silver	10–85% sol.	R		R
338	Nickel Silver	10, 50% sol.	R		R
		85% sol.	R		
350–353	P Bronze	10% sol.	R		R
		50, 85% sol.	R		
355, 371	Copper		Severe		

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.) 70°	Boil.
361	Rh Platinum	10–85% sol.	R	R
362	Lead	10% sol.	0.001	
		50% sol.	0.002	
		85% sol.	0.003	
363	Silver	10% sol.	R	R
		50, 85% sol.,	R	
364	Silver	10–85% sol.	Recom. at room temp.	
		85% sol., C. P.	Nil at 170°–185°	
		85% sol., C. P.	0.004 at 230°–250°	
		85% sol., C. P.	0.049–0.096 at 430–450°	
366	Co Cr W	All conc.	Recom. at all temp.	
370	Tantalum	10, 50% sol.	None at room temp., boil.	
		85% sol.	Recom. at room temp.	
		Conc. sol.	0.467 at 293°	
371	Ni Cr Alloy	10% sol.	Recom. at room temp.	

PROPYLENE DICHLORIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
130	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss at cold
211, 258	Admiralty		Recommended
244, 247	Al Bronze		Recommended
248	Al Brass		Recommended
249	Cu Ni Zn		Recommended
259, 262, 266, 277	Copper		Recommended
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
359	Red Brass		Recommended

SODIUM BISULPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	10% sol.[1]	<0.0044 at 68–212°
		Sat. sol.	Attacked
5	Stainless	Sol.	<0.004 at 70°
		Sat sol.	Attacked
6–8	Stainless	Sat sol.	Attacked
9	Stainless	2g. + 1g. H_2SO_4 per l.	<0.0044 at 68°[1]
		2g. + 1g. H_2SO_4 per l.	<0.044 at 212°[1]
		Sol.	<0.004 at 70°
10–15	Stainless	Sat. sol.	Attacked
104	Fe Ni Cu Cr		Rapid attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	5–10% sol.	None at 60°
209	Fe Ni Cr Si Mo Cu		<0.001
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
300	Ni Cr Cu Mo Fe	24% sol.	<0.004 at 104°
311	Chem. Lead	All conc.	OK at hot or cold
314	Te Lead	All conc.	OK at hot or cold
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended

SODIUM CARBONATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5–50% sol.	<0.0042 at 70° — boil.
		Sat. sol.	<0.004 at 70°
		Molten	>0.42 at 1650°
5	Stainless	5% sol.	<0.004 at 70–150°
		Sat. sol.	<0.004 at 70°
6–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless		Same as 2
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	10% — sat. sol.[1]	<0.0016 at 68–212°
18	Stainless	5% sol.	<0.004 at 70–150°
19	Stainless	5% sol.	<0.0042 at 70° — boil.
		10% — sat. sol.[1]	<0.0046 at 68–212°
20	Stainless	5% sol.	<0.004 at 70–150°
25	Stainless	Sat. sol.	<0.004 at 70°
27	Stainless	10% — sat. sol.[1]	<0.0046 at 68–212°
104	Fe Ni Cu Cr	5% sol.	No attack at 150°
		20% sol.	0.0014 at 150°
129	High Si Iron	19.4% sol., quiet	<0.001 at room temp.
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Solvay process	No loss at 176°
	All Cu-Base Alloys except 297 & 318		Recommended
213	Aluminum	0.1% sol.	0.0022 at 86°
		1% sol.	0.014 at 86°
		10% sol.	0.33 at 86°
214	Al Alloy	0.1% sol.	0.0022 at 86°
		1% sol.	0.012 at 86°
		10% sol.	0.22 at 86°
215	Al Alloy	0.1% sol.	0.0026 at 86°
		1% sol.	0.012 at 86°
		10% sol.	0.47 at 86°
216	Al Alloy	0.1% sol.	0.0025 at 86°
		1% sol.	0.013 at 86°
		10% sol.	0.46 at 86°
221	Al Alloy	0.1% sol.	0.001 at 86°
		1% sol.	<0.001 at 86°
		10% sol.	0.0031 at 86°
290, 291	Ni Mo Fe	All conc.	Recom. at all temp.
292	Ni Cr Fe W	All conc.	Recom. at all temp.
293	Ni Si Cu	All conc.	Recom. at all temp.
308	Sb Lead		Probably OK
311	Chem. Lead		Probably OK
314	Te Lead		Probably OK
316	Ni Cu Alloy	0.07% sol., aerated	<0.001 at 200°
		10% sol., aerated	<0.001 at 60°
364	Silver	Sol.	None
		Fused salt	Attacked 930°
365–368	Co Cr W	All conc.	Recom. at all temp.

SODIUM CHLORIDE

No.	Material	Exposure Conditions	70°	150°	Boil.
2	Stainless	5% sol.[2]	<0.0042	<0.0042	
		20% sol., aerated[2]	<0.0042		
		Sat. sol.[2]	<0.0042		0.004–0.04
		Sea water and brine[2]	<0.004		
5–8	Stainless	Sea water and brine[2]	<0.004		
9	Stainless	5% sol.	<0.0042	<0.0042	
		20% sol., aerated	<0.0042		
		Sat. sol.	<0.0042		<0.0042
		Sea water and brine[2]	<0.004		
10, 11	Stainless	Sea water and brine[2]	<0.004		
12	Stainless	Sea water and brine[2]	Attacked		
15	Stainless	5% sol.[2]	0.004–0.04	0.004–0.04	
		Sea water and brine[2]	Attacked		
18	Stainless		NR		
19	Stainless	5% sol.[2]	0.004–0.04	0.004–0.04	
		Sea water and brine[2]	<0.1		
104	Fe Ni Cu Cr	Sea water and brine	Suitable		
129	High Si Iron	25% sol., quiet	<0.001 at room temp.		
139	High Si Mo Iron	Any conc.	Recom. to boiling		
142	High Si Iron	Any conc.	Recom. to boiling		
150	Cr Mo Steel	Sea water spray	0.007		
151	Cr Mo Steel	Sea water spray	0.0024		
161	Cr Steel	10% salt spray	0.0132 at 70°		
176	Fe Ni Cu Cr	Sat. sol.	<0.001–0.01 at 180–200°		
209	Fe Ni Cr Si Mo Cu	Oil field salt water	<0.001 at 60° avg. temp.		
	All Cu — Base Alloys except 297 and 318:	Sea water and brine	Recom.		
213	Aluminum	Dichromate inhibited	Satisfactory		
300	Ni Cr Cu Mo Fe	16% salt spray	<0.004 at 85°		
		36% sol. + trace free Cl_2	0.004–0.015 at 122°		
		Conc. sol.; alkaline with NaOH	<0.004 at 150°		
		Sat. sol.	0.015–0.050 at 70°		
302	Ni Cr Fe	Alternate brine, air	<0.001 at 200°		
		Sat. sol. + steam and air	0.001 at 200°		
		Sea water	<0.001		
308	Sb Lead	Sea water and brine	OK at hot or cold		
311	Chem. Lead	Sea water and brine	OK at hot or cold		
314	Te Lead	Sea water and brine	OK at hot or cold		
316	Ni Cu Alloy	Alternate brine, air	<0.001 at 200°		
		Sat. sol. + steam and air	0.003 at 200°		
		Sea water	<0.001		
330	Nickel	Alternate brine, air	<0.001 at 200°		
		Sat. sol. + steam and air	0.002 at 200°		
		Sea water	<0.001		
336	Ni Cr Steel	10% — sat. sol.[1]	<0.004 at 68–212°		
364	Silver	Sea water	None		
370	Tantalum	Sea water and brine	None at any temp.		

SODIUM FERRICYANIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
130	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Severe
359	Red Brass		Recommended

SODIUM HYDROXIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
2	Stainless	20% sol.	<0.0042 at boiling		
		30% sol.	0.0042–0.042 at boiling		
		Molten	0.0042–0.042 at 600°		
5–8	Stainless		<0.004 at 70°		
9	Stainless		Same as 2		
10, 11	Stainless		<0.004 at 70°		
12, 15	Stainless		<0.005 at 70°		
18–27	Stainless		<0.004 at 70°		
			70°		Boil.
30	Stainless	0.5% sol.	R		
32	Stainless	0.5–70% sol.	R		
33	Stainless	0.5% sol.	R		R
		50, 70% sol.	R		
34	Stainless	70% sol.	R		R
35, 36	Stainless	0.5, 50% sol.	R		R
		70% sol.	R		
37, 38	Stainless	0.5–70% sol.	R		R
39	Stainless	0.5% sol.	R		R
41	Stainless	0.5, 50% sol.	R		
		70% sol.	R		R
42	Stainlesss	0.5–70% sol.	R		R
44, 46	Stainless	0.5, 50% sol.	R		R
47, 50, 52	Stainless	0.5–70% sol.	R		R
53	Stainless	0.5, 50% sol.	R		R
56, 58, 59, 61	Stainless	0.5–70% sol.	R		R
71	Stainless	0.5% sol.	R		R
80	Stainless	0.5–70% sol.	R		R
81	Stainless	0.5, 50% sol.	R		R
		70% sol.	R		
91	Cr Ni Steel	0.5–70% sol.	R		R
104	Fe Ni Cu Cr	0.5–70% sol.	R	150°	R
		50% sol.		0.0014	
105	Ni Cr Steel	0.5–70% sol.	R		R
125	Cr Steel	0.5, 50% sol.	R		R
129	High Si Iron	0.5% sol.	R		R
		25% sol., quiet	<0.001		
		50% sol.	R		
136	Fe Cr Ni Mo	0.5% sol.	R		R
		50, 70% sol.	R		
137	Ni Cr Cast Iron	0.5% sol.	<0.001		<0.001
138	Fe Cr Ni Mo	0.5–70%	R		
139	High Si Mo Iron	0.5% sol.	R		R
		50, 70% sol.	R		NR
140	Fe Ni Cr Mo Cu	0.5–70%	R		R
141	Fe Ni Cr Cu Mo	0.5–70%	R		R
142	High Si Iron	0.5% sol.	R		R
		50, 70% sol.	R		NR
172	Ni Fe Cr	0.5–70% sol.	R		R
175	Cr Ni Steel	0.5–70% sol.	R		
176	Fe Ni Cu Cr	0.5–70% sol.	R	Hot	R
		50% sol.		<0.006	
		70% sol.		0.02–0.09	
				1, 240°	
		Molten		0.25	
180	Cr Cast Iron	0.5–70% sol.	R		
200	Ni Cr Fe	0.5–70% sol.	R		R
205	Cr Ni Steel	0.5–70% sol.	R		R
206	Fe Cr Ni Mo	0.5–70% sol.	R	176°	R
209	Fe Ni Cr Si Mo Cu	0.5–70% sol.	<0.001	<0.001	
				200°	
		50% sol., commercial		None	
210	Wrought Iron	0.5–70% sol.	R		R

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)	
			70°	Boil.
211	Admiralty	0.5% sol.	R	R
		50, 70% sol.	R	
213	Aluminum	0.01% sol.	<0.001	
		0.1% sol.	0.021	
		1% sol.	4.0	
214	Al Alloy	0.01% sol.	<0.001	
		0.1% sol.	0.023	
		1% sol.	3.06	
215	Al Alloy	0.01% sol.	<0.001	
		0.1% sol.	0.0087	
		1% sol.	5.91	
216	Al Alloy	0.01% sol.	<0.001	
		0.1% sol.	0.013	
		1% sol.	5.38	
221	Al Alloy	0.01% sol.	<0.001	
		0.1% sol.	<0.001	
		1% sol.	0.153	
224	Al Bronze	0.5% sol.	R	
225–227	Ni Cr Si	0.5–70% sol.	R	R
229	Ni Cr Alloy	0.5–70% sol.	R	R
244	Al Bronze	0.5% sol.	R	R
		50, 70% sol.	R	
249	Cu Ni Zn	0.5–70% sol.	R	R
257	Admiralty		Slight to moderate	
266, 277	Copper	0.5% sol.	R	R
		50, 70% sol.	R	
273	Bronze	0.5–70% sol.	R	R
275, 276	Cu Ni Alloy		R	
278–281	Mg Alloys	0.5% sol.	R	R
		50, 70% sol.	R	
283–285	Cu Si Mn	0.5% sol.	R	R
		50, 70% sol.	R	
290, 291	Ni Mo Fe	All conc.	R	R
292	Ni Cr Fe W	All conc.	R	R
293	Ni Si Cu	All conc.	R	R
295	Cu Si Mn Sn	0.5% sol.	R	
296	Cu Si Sn	0.5% sol.	R	
297	High Brass	0.5% sol.	R	R
300	Ni Cr Cu Mo Fe	5% sol.	<0.004 at 100°	
		25% sol.	<0.004 at 70°	
		36% sol.	<0.004 at 80°	
		48% sol.	<0.004	
		70% sol.	<0.004 at 194°	
		Conc. sol. + Na_2SO_4, NaCl, $NaClO_3$	<0.004 at 160°	
302	Ni Cr Fe	0.5, 50% sol.	<0.001 at 70° — boil.	
		70% sol., storage tank	<0.001 at 195–240°	
		70% sol.	<0.005 at boiling	
305–307	Ir Platinum	0.5–70% sol.	Recom. to boiling	
308	Sb Lead	15% sol.	OK to 200°	
		30% sol.	OK at cold	
309	Sb Lead	0.5–70% sol.	Recom. to boiling	
311	Chem. Lead	15% sol.	OK to 200°	
		30% sol.	OK at cold	
312	Chem. Lead	0.5% sol.	Recom. at 70°	
313	Te Lead	0.5% sol.	Recom. at 70°	
314	Te Lead	15% sol.	OK to 200°	
		30% sol.	OK at cold	
315, 344, 372	Bronze		Slight to moderate	
316	Ni Cu Alloy	0.5, 50% sol.	<0.001 at 70° — boil.	
		70% sol., storage tank	0.001 at 195–240°	
		70% sol.	<0.005 at boiling	
329	Ni Cr Alloy	0.5–70% sol.	Recom. to boiling	
330	Nickel	0.5, 50% sol.	<0.001 at 70° — boil.	
		70% sol., storage tank	<0.001 at 195–240°	
		70% sol.	<0.005 at boiling	
		Concentrating to 70% in evaporator	0.002 at 194–239°	
		95% sol.	0.002 at 600°	
335, 336	Ni Cr Steel	20% sol.[1]	<0.004 at boiling	
		Fused[1]	<0.004 at 604°	
337	Nickel Silver	0.5–70% sol.	Recom. at 70° — boil.	
338	Nickel Silver	0.5, 50% sol.	Recom. at 70° — boil.	
343	Bronze	0.5–70% sol.	Recom. at 70° — boil.	
346	Palladium	0.5–70% sol.	Recom. at 70° — boil.	
350–353	P Bronze	0.5% sol.	Recom. at 70° — boil.	
		50, 70% sol.	Recom. at 70°	
355, 271	Copper		Slight to moderate	
357, 358	Platinum	0.5–70% sol.	Recom. at 70° — boil.	
359	Red Brass		Recommended	
361	Rh Platinum	0.5–70% sol.	Recom. at 70° — boil.	
363	Silver	0.5–70% sol.	Recom. at 70° — boil.	
364	Silver	0.5–70% sol.	Recom. at 70° — boil.	
		Fused	0.001 at 900°	

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
365–368	Co Cr W	All conc.	Recom. at all temp.
370	Tantalum		Attacked
374	Ni Cr Alloy	0.5–70% sol.	Recom. at 70° — boil.

SODIUM HYDROSULPHITE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	In dye liquors	No loss
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Severe
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Severe
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
302	Ni Cr Fe	40% sol. + SO_2 + suspended Zn	<0.001 at 104°
308	Sb Lead	20% sol.	OK at 75°
311	Chem. Lead	20% sol.	OK at 75°
314	Te Lead	20% sol.	OK at 75°
316	Ni Cu Alloy	1% sol.	0.014 at boiling
		40% sol. + SO_2 + suspended Zn	0.001 at 104°
330	Nickel		Same as 302
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Severe
359	Red Brass		Recommended

SODIUM HYPOCHLORITE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5% sol.	0.0042–0.042 at 70°
		Sat. sol.	Attacked except for short periods
5–8	Stainless	Sat. sol.	Same as 2
9	Stainless	5%, sat. sol.	<0.004 at 70°
10, 11	Stainless	Sat. sol.	Same as 2
12, 15	Stainless	Sat. sol.	Attacked
19	Stainless	5% sol.	0.042–0.12 at 70°
32, 33	Stainless	Short immersions only	OK at 70°
35	Stainless	5% free Cl_2	Recom. at 70°
36	Stainless	5, 20% free Cl_2	Recom. at 70°
37, 38	Stainless	5, 20% free Cl_2	Recom. at 70°— boil.
42, 44	Stainless	5, 20% free Cl_2	Recom. at 70°
46	Stainless	5% free Cl_2	Recom. at 70°
50, 52	Stainless	5, 20% free Cl_2	Recom. at 70°— boil.
53	Stainless	5, 20% free Cl_2	Recom. at 70°
56	Stainless	5% free Cl_2	Recom. at 70°— boil.
59	Stainless	5% free Cl_2	Recom. at 70°— boil.
		20% free Cl_2	Recom. at 70°
61	Stainless	5% free Cl_2	Recom. at 70°
91	Cr Ni Steel	5% free Cl_2	Recom. at 70°
104	Fe Ni Cu Cr		Rapid attack
125	Cr Steel	5% free Cl_2	Recom. at 70°— boil.
129	High Si Iron	5% free Cl_2	Recom. at 70°
136	Fe Cr Ni Mo	Short immersions only	OK at 70°
138	Fe Cr Ni Mo	5% free Cl_2	Recom. at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
140	Fe Ni Cr Mo Cu	5, 20% free Cl_2, stable sol. only	Recom. at 70°
141	Fe Ni Cr Cu Mo	5, 20% free Cl_2	Recom. at 70°
142	High Si Iron		Consult mfgr.
176	Fe Ni Cu Cr	0.1%	0.21 at 140°
205	Cr Ni Steel	5, 20% free Cl_2	Recom. at 70°— boil.
206	Fe Cr Ni Mo	5, 20% free Cl_2	Recom. at 70°— boil.
209	Fe Ni Cr Si Mo Cu	3% free Cl_2	Satisfactory at cold
213	Aluminum	5% free Cl_2	0.081 at 70°
214	Al Alloy	5% free Cl_2	0.097 at 70°
215	Al Alloy	5% free Cl_2	0.104 at 70°
216	Al Alloy	5% free Cl_2	0.105 at 70°
225, 226	Ni Cr Si	5, 20% free Cl_2	Recom. at 70°
227	Ni Cr Si	5% free Cl_2	Recom. at 70°
244, 247	Al Bronze	5% free Cl_2	Recom. at 70°
249	Cu Ni Zn	5% free Cl_2	Recom. at 70°— boil.
		20% free Cl_2	Recom. at 70°
257	Admiralty	5% free Cl_2	Recom. at 70°— boil.
260, 277	Copper	5% free Cl_2	Recom. at 70°
273	Bronze	5% free Cl_2	Recom. at 70°— boil.
275, 276	Cu Ni Alloy	Dil. sol. or at room temp.	Recommended
283–285	Cu Si Mn	5% free Cl_2	Recom. at 70°
289	Gold	5, 20% free Cl_2	Recom. at 70°— boil.
292	Ni Cr Fe W	All conc.	Recom. to 105°
300	Ni Cr Cu Mo Fe	5%	Not recom. at 70°
		15% free Cl_2	>0.125 at 87°
302	Ni Cr Fe	See Calcium hypochlorite	
305	Ir Platinum	5, 20% free Cl_2	Recom. at 70°— boil.
306	Ir Platinum	5, 20% free Cl_2	Recom. at 70°
307	Ir Platinum	5, 20% free Cl_2	Recom. at 70°— boil.
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
315, 344, 372	Bronze		Slight to moderate
316	Ni Cu Alloy	See Calcium hypochlorite	
330	Nickel	See Calcium hypochlorite	
337	Nickel Silver	5% free Cl_2	Recom. at 70°— boil.
		20% free Cl_2	Recom. at 70°
338	Nickel Silver	5% free Cl_2	Recom. at 70°
343	Bronze	5% free Cl_2	Recom. at 70°— boil.
346	Palladium	5, 20% free Cl_2	Recom. at 70°— boil.
350–353	P Bronze	5% free Cl_2	Recom. at 70°
355, 371	Copper		Slight to moderate
357	Platinum	5, 20% free Cl_2	Recom. at 70°— boi'
358	Platinum	5, 20% free Cl_2	Recom. at 70°
359	Red Brass	Dil. sol. or at room temp.	Recommended
361	Rh Platinum	5, 20% free Cl_2	Recom. at 70°— boil.
365	Co Cr W	20% free Cl_2	None at 70°
370	Tantalum	5, 20% free Cl_2	None at 70°— boil.

SODIUM NITRATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Sat. sol.	<0.004 at 70°
		Fused	0.0042–0.042
5–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	Sat. sol.	<0.004 at 70°
		Fused	<0.0042
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	Sat. sol.	<0.005 at 70°
19	Stainless	Sat. sol.	<0.004 at 70°
		Fused	0.042–0.12
20, 21	Stainless	Sol.[1]	<0.0046 at 68°
25	Stainless	Sat. sol.	<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu		No loss
213	Aluminum	0.1% sol.	0.0012 at room temp.
		1% sol.	<0.001 at room temp.
		10% sol.	<0.001 at room temp.
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
300	Ni Cr Cu Mo Fe	40% sol.	<0.004 at 70°
316	Ni Cu Alloy	2/3 sat., aerated	<0.001 at 122°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended
364	Silver	Sol.	No attack

SODIUM PHOSPHATE (TRIBASIC)

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2–11	Stainless		<0.004 at 70°
19, 25	Stainless		<0.004 at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
176	Fe Ni Cu Cr	5% sol.	<0.001 at 60°
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
259, 262, 266, 277	Copper		Recommended
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
308	Sb Lead		Probably OK
311	Chem. Lead		Probably OK
314	Te Lead		Probably OK
316	Ni Cu Alloy	<8% sol., aerated	<0.001 at 60°
330	Nickel	<8% sol., aerated	<0.001 at 60°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
359	Red Brass		Recommended
364	Silver	Sol.	Slight attack
		Fused salt	Attacked

SODIUM SULPHATE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5% — sat. sol.	<0.0042 at 70°
		Sat. sol.	<0.0042 at boiling
5–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless		Same as 2
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	5% sol.	No attack
19	Stainless	5% sol.	<0.0042 at 70°
		Conc. sol.	0.042–0.12 at 70°
25	Stainless	Sat. sol.	<0.004 at 70°
103	Cast Iron	10% sol.[1]	0.0015 at 68°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
190	Ni Steel	10% sol.[1]	0.0014 at 68°
209	Fe Ni Cr Si Mo Cu	Saturated; slurry	No loss at 180°
	All Cu-base alloys except 297 & 318		Recommended
213	Aluminum	0.1–10% sol.	<0.001 at room temp.
265	Ni Cr Alloy	Sol.[1]	Recommended
300	Ni Cr Cu Mo Fe	5% or 10% sol. + equal part of 25% H_2SO_4	0.004–0.015 at boil.
302	Ni Cr Fe	In hot vapors from evap.	<0.001
308	Sb Lead	All conc.	OK at 70–250°
311	Chem. Lead	All conc.	OK at all temp.
314	Te Lead	All conc.	OK at all temp.
316	Ni Cu Alloy	8% sol., aerated	<0.001 at atm. temp.
		In hot vapors from evap.	<0.001
		In high conc. of liquor	<0.001 at 200°
329	Ni Cr Alloy	Sol.[1]	Recommended
330	Nickel	8% sol., aerated	None at atm. temp.
		In hot vapors from evap.	0.001
332	Ni Cr Alloy	Sol.[1]	Recommended
335, 336	Ni Cr Steel	Sat. sol.[1]	<0.004 at 140°
364	Silver	In dyestuff plant	No attack

SODIUM SULPHIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5% sol.	Little or none at 70° [2]
		50% sol.[1]	<0.001 at 194° [2]
		Sat. sol.	0.004–0.04 at 70° [2]
5–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless	5% sol.	Little or none at 70°
		50% sol.[1]	<0.001 at 194°
		Sat. sol.	<0.0042 at 70°
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	5% sol.	Slight at 70°
		Sat. sol.[2]	<0.005 at 70°
19	Stainless	5% sol.	Slight at 70°
		50% sol.[1]	>0.46 at boiling
		Sat. sol.	<0.004 at 70°
20, 21, 25	Stainless	Sat. sol.	<0.004 at 70°
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Digestion	<0.001 at 200°
211, 258	Admiralty	Dil. sol. or at room temp.	Recommended
218	Al Brass		Same as 211
257	Admiralty		Severe
272, 273, 315, 343, 344, 372	Bronze		Severe
297	High Brass		Same as 211
300	Ni Cr Cu Mo Fe	8% sol.	Recom. at 70°
302	Ni Cr Fe	0.4% sol. unaerated	<0.001 at 108°
		In evaporator conc. from 25 to 60%	0.011 at 240–330°
		50% sol., unaerated	0.004 at 320°
308	Sb Lead	Dil. sol.	OK
311	Chem. Lead	Dil. sol.	OK
314	Te Lead	Dil. sol.	OK
316	Ni Cu Alloy	0.4% sol., unaerated	<0.001 at 108°
		In evaporator conc. from 25 to 60%	0.019 at 240–330°
		50% sol., unaerated	0.013 at 320°
318	Muntz		Same as 211
328	Naval Brass		Same as 211
330	Nickel	0.4% sol., unaerated	<0.001 at 108°
		In evaporator conc. from 25 to 60%	0.028 at 240–330°
		50% sol., unaerated	0.022 at 320°
355, 371	Copper		Severe
364	Silver	Sol.	Slow attack
		Fused salt	Rapid attack
373	Tobin Bronze		Same as 211

SODIUM SULPHITE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	5% sol.	<0.0042 at 70°
		10% sol.	<0.0042 at 150°
		25% sol.	<0.0042 at boiling
		50% sol.	<0.0042 at boiling
		Sat. sol.	<0.004 at 70°
5	Stainless	5% sol.	<0.004 at 70°
		10% sol.	<0.004 at 150°
		Sat. sol.	<0.004 at 70°
6–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless		Same as 2
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	Sat. sol.[2]	<0.005 at 70°
19	Stainless	5% sol.	0.042–0.12 at 70°
		25% sol.	<0.0042 at boiling
		Sat. sol.	<0.004 at 70°
25	Stainless	Sat. sol.	<0.004 at 70°
139	High Si Mo Iron		Not recommended
142	High Si Iron		Not recommended
209	Fe Ni Cr Si Mo Cu	Photodeveloper	No loss
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
308	Sb Lead	<20% sol.	OK at ordinary temp.
311	Chem. Lead	<20% sol.	OK at ordinary temp.
314	Te Lead	<20% sol.	OK at ordinary temp.
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended

SODIUM THIOSULPHATE (HYPO)

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	25% sol.[3]	<0.0042 at 70°— boil.
		Hypo (acid fixing bath)	<0.0042 at 70°
		Sat. sol.[3]	<0.004 at 70°
5–8	Stainless	Sat. sol.	<0.004 at 70°
9	Stainless		Same as 2
10, 11	Stainless	Sat. sol.	<0.004 at 70°
12, 15	Stainless	Sat. sol.	<0.005 at 70°
104	Fe Ni Cu Cr		Tarnished
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
209	Fe Ni Cr Si Mo Cu	Std. fixing sol.	No loss at cold
211, 258	Admiralty	Dil. sol. or at room temp.	Recommended
214	Al Alloy	1, 5% sol.	None at room temp.
248	Al Brass		Same as 211
257	Admiralty		Slight to moderate
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
297	High Brass		Same as 211
300	Ni Cr Cu Mo Fe	Commercial	Recommended
308	Sb Lead	All conc.	OK at ordinary temp.
311	Chem. Lead	All conc.	OK at ordinary temp.
314	Te Lead	All conc.	OK at ordinary temp.
318	Muntz		Same as 211
328	Naval Brass		Same as 211
355, 371	Copper		Slight to moderate
364	Silver		Strong attack
373	Tobin Bronze		Same as 211

STEARIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless		<0.0044 at 176° [1]
		Concentrated	Little or none at 200°
5–8	Stainless		<0.004
9	Stainless		Same as 2
10, 11	Stainless	-	<0.004
12, 15	Stainless		<0.004
		Concentrated	Little or none at 200°
		100% commercial	>0.1 at 420°
19–21	Stainless		<0.004
139	High Si Mo Iron	Any conc.	Recom. to boiling

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
142	High Si Iron	Any conc.	Recom. to boiling
161	Cr Steel	100% commercial	>0.1 at 420°
209	Fe Ni Cr Si Mo Cu	In fatty acids	No loss at 200°
244, 247	Al Bronze		Recommended [4]
249	Cu Ni Zn		Recommended [4]
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended [4]
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended [4]
283–285	Cu Si Mn		Recommended [4]
302	Ni Cr Fe	In distillation of mixed stearic and oleic	<0.001 at 475°
316	Ni Cu Alloy	In distillation of mixed stearic and oleic	0.023 at 475°
		Pure acid, dry	0.002 at atm. temp.
		Commercial acid	0.009 at 338°
330	Nickel	In distillation of mixed stearic and oleic	0.016 at 475°
335, 336	Ni Cr Steel		<0.004 at 176° [1]
337, 338	Nickel Silver		Recommended [4]
350–353	P Bronze		Recommended [4]
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended [4]
364	Silver		Resistant
370	Tantalum		None at any temp.

SULPHUR DIOXIDE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Moist gas [2]	0.0042–0.042 at 70°
		Dry gas	<0.0042 at 575°
5	Stainless	Moist gas	<0.040 at 70°
		Dry gas	<0.004 at 575°
6–8	Stainless		<0.004 at 70° [2]
9	Stainless	Moist gas	<0.0042 at 70°
		Dry gas	<0.0042 at 575°
10, 11	Stainless		<0.004 at 70° [2]
19	Stainless	Moist gas	0.042–0.12 at 70°
		Dry gas	<0.0042 at 575°
25	Stainless		<0.004 at 70° [2]
139	High Si Mo Iron		Not recommended
142	High Si Iron		Not recommended
160	Ni Steel		0.55 at 1292°
209	Fe Ni Cr Si Mo Cu	6% water sol.	No loss at cold
		6% water sol.	<0.001 at 175°
211, 258	Admiralty	Perfectly dry gas	Recommended
214	Al Alloy		<0.001 at room temp.
244, 247	Al Bronze	Wet or dry gas	Recommended
248	Al Brass	Perfectly dry gas	Recommended
249	Cu Ni Zn	Wet or dry gas	Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper	Wet or dry gas	Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy	Wet or dry gas	Recommended
283–285	Cu Si Mn	Wet or dry gas	Recommended
292	Ni Cr Fe W	Wet gas	Preferred to 293
293	Ni Si Cu	Wet gas	Recom. to 158°
297	High Brass	Perfectly dry gas	Recommended
300	Ni Cr Cu Mo Fe	In sulphur burner	Not recom. at 1,800°
		$SO_2 + SO_3 + CO_2$ gases	0.004–0.015 at 150°
302	Ni Cr Fe	1% sol.	0.011 at 68°
		5–6% sol.	0.024 at 68°
		7% sol.	<0.001 at 68°
		Gas: little SO_2, solids, and moisture	0.002 at 572°
308	Sb Lead	Wet or dry	OK at 70–250°
311	Chem. Lead	Wet or dry	OK at 70–392°
314	Te Lead	Wet or dry	OK at 70–392°
316	Ni Cu Alloy	1% sol.	0.062 at 68°
		7% sol.	0.004 at 68°
		Dil. sol., sat. with air	0.047 at 120°
		Gas: little SO_2, solids, and moisture	0.005 at 572°
318	Muntz	Perfectly dry gas	Recommended
328	Naval Brass	Perfectly dry gas	Recommended
330	Nickel	1% sol.	0.054 at 68°
		7% sol.	0.013 at 68°
		Gas: little SO_2, solids, and moisture	0.003 at 572°
337, 338	Nickel Silver	Wet or dry gas	Recommended
350–353	P Bronze	Wet or dry gas	Recommended
355, 371	Copper		Slight to moderate
359	Red Brass	Wet or dry gas	Recommended
364	Silver		Tarnish at ordinary temp.
			Severe at red heat
365–368	Co Cr W	Wet gas	Recom. at all temp.
373	Tobin Bronze	Perfectly dry gas	Recommended

SULPHURIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.) 70°		Boil.
2	Stainless	5% sol.	0.04–0.12		>0.42
		10% sol.	0.04–0.12		>0.42
		50% sol.	0.12–0.42	300°	>0.42
		Conc. sol.	<0.004	>0.42	0.12–0.42
		Fuming	0.04–0.12		
5	Stainless	3% sol.	0.049	180°	
		3–40% sol.	>0.10	>0.10	
				110°	
		5% sol.		>0.10	
		Conc. sol.	<0.004		
6, 7	Stainless	Conc. sol.	<0.004		
8	Stainless	5% sol.		0.078	
		Conc. sol.	<0.004		
9	Stainless	5% sol.	0.004–0.04		0.04–0.12
		10% sol.	0.004–0.04		0.12–0.42
		50% sol.	0.04–0.12	300°	0.12–0.42
		Conc. sol.	<0.004	>0.42	0.12–0.42
		Fuming	0.004–0.04		
10, 11	Stainless	Conc. sol.	<0.004		
12, 15	Stainless	Conc. sol.	<0.005		
19	Stainless	5% sol.	0.04–0.12		>0.42
		10% sol.	0.04–0.12		>0.42
		50% sol.		300°	>0.42
		Conc. sol.	<0.004	>0.42	0.12–0.42
25	Stainless	Conc. sol.	<0.004	95°	
31	Stainless	2–10% sol.		>1.0	
32	Stainless	2% sol.		0.88	
		10% sol.		>1.0	
33	Stainless	0.5% sol.	R		
		2% sol.		0.29	
		10% sol.		>1.0	
34	Stainless	0.5% sol.	R		R
		2.5% sol.	R		R
		60, 95% sol.	R		
35	Stainless	0.5% sol.	R		
		2% sol.		<0.003	>1.0
		2.5% sol.	0.004		
		10% sol.	0.03	0.03	>1.0
36	Stainless	0.5% sol.	R		
		2.5% sol.	0.2		
		10% sol.	0.7		
37	Stainless	2% sol.		0.001–0.2	>1.0
		10% sol.		0.7	>1.0
38	Stainless	0.5–10%	R		
39	Stainless	2% sol.		0.001–0.002	
		10% sol.		0.02–1.0	
				131°	
		2% sol.		0.004–0.5	
		10% sol.		>0.5	
41	Stainless	0.5, 2.5, 95% sol.	R		
42	Stainless	0.5% sol.	R		
		2.5% sol.	0.002		R
		10% sol.	0.003		
43	Stainless	0.5–10% sol.	R		
44	Stainless	0.5% sol.	R		R
		2.5–95% sol.	R		
46, 47, 50	Stainless	0.5, 2.5, 95% sol.	R		
52	Stainless	0.5–95% sol.	R		
53	Stainless	0.5% sol.	R		R
		2.5–95% sol.	R		
55	Stainless	0.5, 2.5, 95% sol.	R		
56	Stainless	0.5% sol.	R	131°	
		2% sol.	<0.001	0.002–0.01	0.7–3.0
				95°	
		10% sol.	0.005	0.004–0.02	>1.0
58	Stainless	0.5–95% sol.	<0.004		
59	Stainless	0.5% sol.	R		R
		2.5% sol.	<0.001		0.08
		10% sol.	0.001		0.4
		95% sol.	R		
61	Stainless	0.5% sol.	R	95°	
		2% sol.	R	0.16	1.1
		10% sol.		0.12	>1.0
		95% sol.	R		
80	Stainless	0.5–2.5% sol.	R		R
		10–95% sol.	R	180°	
83	Ni Steel	3% sol.	0.02	>0.1	
		20% sol.	0.018	>0.1	

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)		
			70°	180°	Boil.
83	Ni Steel	40% sol.	0.018	>0.1	
91	Cr Ni Steel	0.5% sol.	R		R
		2.5% sol.	R		
102	Cast Iron	48% sol.[1]	0.279		
		61% sol.[1]	0.007		
		73% sol.[1]	0.003		
		84% sol.[1]	0.007		
		91% sol.[1]	0.008		
		94% sol.[1]	0.003		
		99% sol.[1]	0.003		
		100%[1]	0.004		
104	Fe Ni Cu Cr	All conc. except fuming	Suitable at 80°		
		All conc. <60Be′	Suitable to 200°		
105	Ni Cr Steel	0.5–2.5% sol.	R		R
		10–95% sol.	R		
122	Fe Ni Cr Cu Mo	25%			0.036
129	High Si Iron	0.5–10% sol.	R		R
		10% sol.	<0.001		R
		25% sol.	<0.001		R
		25–95% sol.	R		R
		95% sol.	<0.001		R
137	Ni Cr Cast Iron	0.5% sol.	0.012		0.022
138	Fe Cr Ni Mo	0.5% sol.	R		R
		2.5, 95% sol.	R		
139	High Si Mo Iron	Any conc.	R		R
140	Fe Ni Cr Mo Cu	0.5–10% sol.	R		R
		25, 60% sol.	R		
		95% sol.	R	176°	R
141	Fe Ni Cr Cu Mo	0.5–25% sol.	R	R	R
		60, 95% sol.	R	R	
142	High Si Iron	Any conc.	R		R
150	Cr Mo Steel	2% sol., aerated	>1.0		
151	Cr Mo Steel	2% sol., aerated	0.55	180°	
157	Ni Cr Steel	3% sol.	0.023	>0.1	
		20% sol.	0.031	>0.1	
		40% sol.	0.025	>0.1	
158	Fe Ni Cr W	3% sol.	0.041	>0.1	
		20% sol.	0.045	>0.1	
		40% sol.	0.042	>0.1	
159	Fe Ni Cr Cu	3% sol.	0.023	>0.1	
		20% sol.	0.025	>0.1	
		40% sol.	0.028	>0.1	
161	Cr Steel	10% sol.	>0.1	110°	
163	Cr Ni Steel	5% sol.		>0.1	
172	Ni Fe Cr	0.5, 2.5%	R		R
		10–95%	R		
176	Fe Ni Cu Cr	0.5% sol.	Recom. at 70°—boiling		
		5–80% sol.	0.02–0.09 at 86°		
		5–30% sol.	0.38–2.5 at 194°		
		10% sol.	0.0044 at 70°		
		25% sol.	0.001 at 70°		
		80% sol.	0.25–0.5 at 194°		
			70°		Boil.
180	Cr Cast Iron	0.5% sol.	R		
		60, 95% sol.	R		R
188	Steel	10% sol.[1]	0.133		
		Conc. sol.[1]	0.007		
200	Ni Cr Fe	95% sol.	R		
206	Fe Cr Ni Mo	0.5–95% sol.	R		
209	Fe Ni Cr Si Mo Cu	All conc.	<0.001 at cold		
		0.5% sol.	<0.001 at boiling		
		3% sol., C. P.	<0.015 at boiling		
		5% sol., C. P.	0.0274 at 176°		
		5% + 0.5% H_2SO_3	No loss at 176°		
		10% sol., C. P.	<0.0034 at 200°		
		20, 40, 50% sol., C. P.	<0.030 at 176°		
		65% sol., C. P.	Not satisfactory at 176°		
		93% sol., C. P.	0.020 at 140°		
		93% sol., C. P.	Not satisfactory at 176°		
			125°	160°	200°
		94% sol.	0.0076	0.050	0.066
		95% sol.	0.0097	0.032	0.060
210	Wrought Iron	In >77.6% sol.	Reasonably good to boiling		
			70°		Boil.
211	Admiralty	0.5–10% sol.	R		R
		25–95% sol.	R		
213	Aluminum	0.5% sol.	0.012		
		2.5% sol.	0.022		
		10% sol.	0.033		
		25% sol.	0.060		
		60% sol.	0.19		
		95% sol.	0.37		
		100%	0.002		
		105%	0.004		
			70°		
214–216	Al Alloys	0.5 % sol.	0.011–0.015		
		2.5% sol.	0.026–0.030		
		10% sol.	0.043–0.046		
		25% sol.	0.059–0.081		
		60% sol.	0.12–0.22		
		95% sol.	0.41–0.48		
224	Al Bronze	0.5–25% sol.	R		Boil.
225–227	Ni Cr Si	0.5, 2.5% sol.	R		R
		10–95% sol.	R		
229	Ni Cr Alloy	0.5% sol.	R		R
		2.5, 10% sol.	R		
244	Al Bronze	0.5–25% sol.	R		R
		60, 95% sol.	R		
245	Al Bronze	0.5, 2.5% sol.	R		R
		10, 25% sol.	R		
249	Cu Ni Zn	0.5–25% sol.	R		R
		60, 95% sol.	R		
257	Admiralty	0.5% sol.	R		R
		2.5% sol.	R		
266, 277	Copper	0.5–25% sol.	R		R
		60, 95% sol.	R		
273	Bronze	0.5, 2.5% sol.	R		R
276	Cu Ni Alloy	0.5–2.5% sol.	R		R
		60, 95% sol.	R		
282	Ni Cr Cu Mo W	0.5–25% sol.	R		R
		60% sol.	R		
		95% sol.	R		R
283–285	Cu Si Mn	0.5–25% sol.	R		R
		60, 95% sol.	R		
286	Al Bronze	0.5–95% sol.	R		R
289	Gold	0.5–95% sol.	R	158°	R
290	Ni Mo Fe	10% sol.	0.0028	0.028	0.036
		25% sol.	0.0016	0.012	0.048
		60% sol.	<0.001	0.012	3.8
		85% sol.	0.0011	0.019	2.4
		96% sol.	<0.001	0.0079	7.7
291	Ni Mo Fe	10% sol.	0.0018	0.022	0.0024
		25% sol.	0.0012	0.0094	0.0018
		60% sol.	<0.001	0.0022	0.037
		85% sol.	0.0012	<0.001	0.840
		96% sol.	<0.001	0.0012	0.460
292	Ni Cr Fe W	10% sol.	None	0.0038	0.050
		25% sol.	<0.001	0.0077	0.047
		60% sol.	None	0.012	3.6
		85% sol.	<0.001	0.0014	2.2
		96% sol.	None	0.0025	0.31
293	Ni Si Cu	10% sol.	0.0023	0.018	0.013
		25% sol.	0.0013	0.013	0.0089
		60% sol.	<0.001	0.0031	0.089
		85% sol.	0.0023	0.047	0.30
		96% sol.	<0.001	0.0084	0.42
		Evaporated to fumes	0.054		
295	Cu Si Mn Sn	0.5–25% sol.	R		R
		60, 95% sol.	R		
296	Cu Si Sn	0.5–95% sol.	R	170°	
300	Ni Cr Cu Mo Fe	10% sol.	<0.004	<0.004	0.004–0.015
				100°	
		25% sol.		<0.004	0.004–0.015
		50% sol.	<0.004	180°	0.015–0.05
		75% sol.	<0.004	0.015–0.05	>0.125
		95% sol.	<0.004 at 100°		
		95% sol.	>0.125 at 550°		
		98% and fuming (109%)	Recom. at 125°		
302	Ni Cr Fe	0.5% sol.	<0.005		<0.005
		2.5% sol.	<0.005	86°	0.01–0.03
		5% sol., aerated		0.081	
		5% sol., unaerated		0.008	
				180°	
		5% sol., aerated		0.147	
		5% sol., sat. with H_2		0.045	
		10% sol.	<0.01		0.24
		19% sol.			0.64
		25% sol.	<0.01		0.64
		60% sol.	0.046	86°	
		93% sol., aerated		0.01	
305–307	Ir Platinum	0.5–95% sol.	R	250°	R
308	Sb Lead	0.5–80% sol.	R	R	
		80–95% sol.	R		
309	Sb Lead	0.5–10% sol.	R		R
		25–95% sol.	R		
310	Lead	0.5% sol.	<0.001		<0.001
		10, 25% sol.	0.001		0.002
		60% sol.	0.001		0.003
		95% sol.	0.001		R

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)	
			70°	Boil.
311	Chem. Lead	0.5–80% sol.	R	R
		80–95% sol.	R	
312	Chem. Lead	0.5–60% sol.	R	R
		95% sol.	R	
313	Te Lead	0.5–60% sol.	R	R
		95% sol.	R	
314	Te Lead	0.5–80% sol.	R	R
		80–95% sol.	R	
315, 344, 372	Bronze	0.5–5% sol.	Slight to moderate	
316	Ni Cu Alloy	5% sol., aerated	0.039 at 86°	
		5% sol., unaerated	0.007 at 86°	
		5% sol., aerated	0.117 at 180°	
		5% sol., sat. with H_2	0.01 at 180°	
		19% sol.	0.008 at boiling	
		50% sol.	0.65 at boiling	
		70% sol., unaerated	0.016 at 100°	
		93% sol., aerated	0.11 at 86°	
329	Ni Cr Alloy	0.5, 2.5% sol.	Recom. at 70°— boil.	
		10–95% sol.	Recom. at 70°	
330	Nickel	5% sol., aerated	0.087 at 86°	
		5% sol., unaerated	0.003 at 86°	
		5% sol., aerated	0.103 at 170°	
		19% sol.	0.11 at boiling	
		70% sol., unaerated	0.029 at 100°	
		95% sol., aerated	0.047 at 70°	
337, 338	Nickel Silver	0.5–25% sol.	Recom. at 70°— boil.	
		60, 95% sol.	Recom. at 70°	
343	Bronze	0.5, 2.5% sol.	Recom. at 70°— boil.	
346	Palladium	0.5–60% sol.	Recom. at 70°— boil.	
		95% sol.	Recom. at 70°	
350–353	P Bronze	0.5–25% sol.	Recom. at 70°— boil.	
		60, 95% sol.	Recom. at 70°	
355, 371	Copper	0.5–5% sol.	Slight to moderate	
357, 358	Platinum	0.5–95% sol.	Recom. at 70°— boil.	
359	Red Brass		Sometimes suitable	
362	Lead	0.5–10% sol.	<0.001 at 70°	
		25–95% sol.	0.002–0.004 at 70°	
363	Silver	0.5–25% sol.	Recom. at 70°— boil.	
		60, 95% sol.	Recom. at 70°	
364	Silver	>60% sol.	Severe at ordinary temp.	
		Dil. sol.	Slight attack	
		5% sol.	<0.001 at room temp.	
		5% sol.	0.004 at 160°	
		10% sol.	0.0047 at 160°	
		45.5% (sp. gr. 1.355)	0.03 at 253°	
		85% (sp. gr. 1.80)	Dissolved at once, 520°	
365–368	Co Cr W	Any conc.	Recom. at room temp.	
370	Tantalum	0.5–25% sol.	None at 70°— boil.	
		60% sol.	None at 70°	
		60% sol.	Recom. at boiling	
		95% sol.	None at 70°	

SULPHUROUS ACID

Additional data on this material are listed under Sulphur Dioxide.

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Sat. sol.[2]	0.042–0.12 at 70°
		Sat. sol.[2]	0.042–0.12 at 375°, 150 psi.
		Spray[2]	0.12–0.42 at 70°
5	Stainless		Not recom. at 250°
9	Stainless	Sat. sol.[2]	0.0042–0.042 at 70°
		Sat. sol.[2]	0.0042–0.042 at 250°, 60 psi.
		Sat. sol.[2]	0.042–0.12 at 310°, 70–125 psi.
		Sat. sol.[2]	0.042–0.12 at 375°, 150 psi.
		Spray[2]	0.12–0.42 at 70°
15, 18	Stainless		Not recom. at 250°
19	Stainless		Same as 2
20	Stainless		Not recom. at 250°
139	High Si Mo Iron		Not recommended
142	High Si Iron		Not recommended
188	Steel	Conc. sol.[1]	0.13 at 64°
213	Aluminum	3% sol.	0.0096 at room temp.
215	Al Alloy	3% sol.	0.011 at room temp.
244, 247	Al Bronze		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to modrate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
292	Ni Cr Fe W	All conc.	Preferred to 293
293	Ni Si Cu	All conc.	Recom. at all temp.
308	Sb Lead		OK below 250°
311	Chem. Lead		OK below 428°
314	Te Lead		OK below 428°
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended

TANNIC ACID

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Sol.	<0.0042 at 70°
		Sol.	0.0042–0.042 at 150°
		10% sol.[1]	<0.0046 at 68°
		10% sol.[1]	<0.131 at boiling
		50% sol.[1]	<0.0046 at 68°— boil.
5	Stainless	Sol.	<0.004 at 70–150°
6–8	Stainless	Sol.	<0.004 at 70°
9	Stainless	Sol.	<0.0042 at 70–150°
		10% sol.[1]	Same as 2
		50% sol.[1]	Same as 2
10, 11	Stainless	Sol.	<0.004 at 70°
15	Stainless	Sol.	0.0042–0.042 at 70°
		Sol.	0.042–0.12 at 150°
19	Stainless	Sol.	<0.0042 at 70–150°
		Sol.[1]	<0.046 at boiling
104	Fe Ni Cu Cr	Sol.	Tarnished only
209	Fe Ni Cr Si Mo Cu	Tannin extract	No loss at cold
	All Cu — Base Alloys		Recommended
219	Al Alloy	10% sol.	<0.001 at room temp.
308	Sb Lead		Not recommended
311	Chem. Lead		Not recommended
314	Te Lead		Not recommended
316	Ni Cu Alloy	1% sol.	0.003 at boiling
		10, [1]23% sol.	None at boiling
335, 336	Ni Cr Steel	Sol.	<0.004 at 68°

TRICHLORETHYLENE

No.	Material	Exposure Conditions	Corrosion (Inches per Year @ Deg. F.)
2	Stainless	Pure	<0.0044 at 68–189°
5–11	Stainless		<0.004 at 70°[2]
15, 19	Stainless		Little or none at 70°
104	Fe Ni Cu Cr		No attack
139	High Si Mo Iron	Any conc.	Recom. to boiling
142	High Si Iron	Any conc.	Recom. to boiling
211, 258	Admiralty		Recommended
213	Aluminum	Stablized liquid	Suitable at boiling
244, 247	Al Bronze		Recommended
248	Al Brass		Recommended
249	Cu Ni Zn		Recommended
257	Admiralty		Slight to moderate
259, 262, 266, 277	Copper		Recommended
272, 273, 315, 343, 344, 372	Bronze		Slight to moderate
275, 276	Cu Ni Alloy		Recommended
283–285	Cu Si Mn		Recommended
302	Ni Cr Fe	Alternate exposure to solvent + H_2O, and solvent vapor + steam	<0.002 at 212°
		Vapor + entrained liquid + steam	<0.001 at 169–198°
316	Ni Cu Alloy		Same as 302
330	Nickel		Same as 302
337, 338	Nickel Silver		Recommended
350–353	P Bronze		Recommended
355, 371	Copper		Slight to moderate
359	Red Brass		Recommended

CAUTION! Laboratory tests made with chemically pure reagents under carefully controlled conditions seldom if ever approach actual operating conditions of service. The data reported here by the manufacturers are for the most part laboratory data and as such are to be used only as an indication as to whether or not service tests or trial installations are advisable; in no case should they be used to calculate depreciation rate or to estimate the life of equipment.

In writing to manufacturers for supplementary information in regard to specific problems, *Chem. & Met.* urgently recommends the submission of the very fullest information in regard to the actual conditions encountered in the plant. Failure to report a minor constituent such as the presence of an impurity or amount of aeration, agitation, concentration and temperature, may result in the selection of an improper material with needless loss to the user.—Editors.

FOOTNOTES:

[1] Franz Ritter, "Korrosionstabellen metallischer Werkstoffe," Edwards Brothers, Inc., Ann Arbor, Mich. [2] Pitting may occur when allowed to dry, by condensation, or at the air-liquid level. [3] Attack may occur if free acid is present. [4] Preferable to use tin-coated Cu and Cu alloys.

NON-METALLIC MATERIALS

STRUCTURAL CARBON AND GRAPHITE

Makers of Structural Carbon and Graphite Products

MANUFACTURER (Name and Address)	Products	MANUFACTURER (Name and Address)	Products
Acheson Graphite Corp., New York, N. Y.	Graphite electrodes and various shapes	Speer Carbon Co., St. Mary's, Pa.	Carbon and graphite brick, plates, blocks, tubes, cylinders, bushings, shapes
International Graphite & Electrode Corp., St. Mary's, Pa.	Graphite electrodes and various shapes	Stackpole Carbon Co., St. Mary's, Pa.	Various carbon and graphite products
National Carbon Co., Inc., Cleveland, Ohio	Carbon and graphite brick, tile, tower packing, tubes, pipe, special shapes, electrodes		

CHEMICAL STONEWARE, PORCELAIN, CEMENTS

Physical Properties of Chemical Stoneware and Porcelainware

Chemical Stoneware

The accompanying table, which has been prepared for us by the General Ceramics Co., gives the physical properties of an average grade of chemical stoneware. It should be emphasized here that "chemical stoneware" is not the name of a definite material, such as an alloy, but a generic term applied to a wide variety of ceramic compositions, and hence that in any particular composition designed to give optimum properties in one respect, it will ordinarily be impossible to secure optimum properties in all other respects.

Specific gravity	2.2
Hardness, scleroscope	100
Ultimate tensile strength, lb. per sq. in.	2,000–3,000
Ultimate compressive strength, lb. per sq. in.	80,000
Modulus of rupture, lb. per sq. in.	5,000–13,000
Modulus of elasticity, lb. per sq. in.	8,000,000
Specific heat	0.2
Thermal cond., B.t.u. per hr., sq. ft., °F., in.	10–35
Linear thermal expansion, per °F	0.0000020
Water absorption, percent	0–2

Chemical Porcelainware

Data supplied by Lapp Insulator Co.

Specific gravity	2.41
Ultimate tensile strength, lb. per sq. in.	5,–8,000
Ultimate compressive strength, lb. per sq. in.	100,000
Modulus of rupture, lb. per sq. in.	12,–15,000
Modulus of elasticity, lb. per sq. in.	10,400,000
Specific heat	0.2
Thermal cond., B.t.u. per hr., sq. ft., °F., in.	8.4
Linear thermal expansion, per °F	0.0000023
Water absorption, percent	0

Makers of Chemical Stoneware, Porcelain, Acidproof Brick and Stone

MANUFACTURER (Name and Address)	Materials
Chemical Stoneware	
General Ceramics Co., New York, N. Y.	Complete line, see note below
Maurice A. Knight, Akron, Ohio	Complete line, see note below
United States Stoneware Co., Akron, Ohio	Complete line, see note below
Chemical Porcelain	
Coors Porcelain Co., Golden, Colo.	Porcelain laboratory ware
Illinois Electric Porcelain Co., Macomb, Ill.	Chemical porcelain ware of all types
Lapp Insulator Co., LeRoy, N. Y.	Chemical porcelain ware of all types
General Ceramics Co., Keasbey, N. J.	Chemical porcelain ware of all types
Acidproof Brick and Other	
Acme Brick Co., Forth Worth, Tex.	Acidproof brick
Alabama Clay Products Co., Birmingham, Ala.	Acidproof brick
Alberene Stone Corp. of Va., New York, N. Y.	Acidproof stone
Atlas Mineral Products Co., Mertztown, Pa.	Acidproof brick construction
Belden Brick Co., Canton, Ohio	Acidproof brick and tile, rings
Charlotte Chemical Labs., Charlotte, N. C.	Acidproof brick, rings
Claycraft Co., Columbus, Ohio	Acidproof brick, floor brick
Custodis Construction Co., New York, N. Y.	Acidproof brick construction, towers, tanks
Electro-Chemical Supply & Engineering Co., Paoli, Pa.	Acidproof brick and masonry materials
Filtros, Inc., East Rochester, N. Y.	Acidproof mineral as plates, cylinders, etc.
General Refractories Co., Philadelphia, Pa.	Acidproof tower packing, and acidproof brick
Harbison-Walker Refractories Co., Pittsburgh, Pa.	Acidproof brick and tile, tower linings, and tower packings
B. Mifflin Hood Co., Daisy, Tenn.	Acidproof brick tower packings, flooring tiles
Keagler Brick Co., Steubenville, Ohio	Acidproof brick, acidproof paving block, and acidproof flooring tile
Kewaunee Mfg. Co., Kewaunee, Wis.	Karcite acidproof ceramic ware, and Kemrock chemical resistant stone
Laclede-Christy Clay Prod. Co., St. Louis, Mo.	Acidproof brick
McLain Fire Brick Co., Pittsburgh, Pa.	Acidproof brick
McLeod & Henry Co., Troy, N. Y.	Acidproof brick
Metropolitan Paving Brick Co., Canton, Ohio	Acidproof brick
National Carbon Co., Inc., Cleveland, Ohio	Carbon brick
Nukem Products Corp., Buffalo, N. Y.	Acid and alkali proof construction
Parker-Russell Mining & Mfg. Co., St. Louis, Mo.	Acidproof brick
Patterson Foundry & Machine Co., East Liverpool, Ohio	Acidproof lining blocks and grinding balls
Quigley Co., New York, N. Y.	Acidproof brick
Robinson Clay Product Co. of N. Y., New York, N. Y.	Acidproof and vitrified sewer tile
Southern Clay Mfg. Co., Chattanooga, Tenn.	Acidproof brick
Thornton Fire Brick Co., Clarksburg, W. Va.	Acidproof brick
Uhl Pottery Co., Huntingburg, Ind.	Acidproof ceramics

Note: Makers of complete lines of chemical stoneware supply such equipment as acid plants; ball mills; brick and tile; blowers and exhausters; coils; filters; acid-proof laboratory sinks, drain and and vent lines; jars; jugs; kettles; pipe, fittings and valves; stills tourills; towers, tower linings and tower packings; tanks and pumps; and many types of special equipment.

Makers of Cements and Putties for Acidproof Brick and Stoneware

Manufacturers (Name and Address)	Trade Names	Compositions, Applications, Types
Anti-Hydro Waterproofing Co., Newark, N. J.	Anti-Hydro	Water-, acid-, alkali-, oil-resisting concrete mix
Atlas Lumnite Cement Co., New York, N. Y.	Lumnite cement	Cement for corrosion and temp.-resistant concrete
Atlas Mineral Products Co., Mertztown, Pa.	Tegul-Vitrobond, Mineralead, Tileset, Korez, Alkor, Vitrex and Neobon cements	Thiokol-sulphur, chemical-setting silicate and resin cements, synthetic rubber and resin linings for all acid and alkali-proof construction
Charlotte Chemical Labs., Charlotte, N. C.	Carolina Acid-Proof Cement. Acid-proof putty	Acid-proof cements and putty
Chemical Construction Corp., New York, N. Y.	Acipruf	Acidproof cement
Custodis Construction Co., Inc., New York, N. Y.	Custodis resin cement, Penchlor, Asplit	Synthetic resin, sodium silicate & phenolic base cements, resp.
Electro-Chemical Supply & Engineering Co., Paoli, Pa.	Duro Standard, Triple X, Syntho, Brimsto, Kemitite, Alk-Li-Pruf	Cements for all acid and alkali conditions; also water and steam
Filtros, Inc., East Rochester, N. Y.	Filtros	Acidproof cement
General Ceramics Co., Keasbey, N. J.	Ceramet Nos. 1, 2, 3, 4, 5, 6, 7, 8	Plasticized-sulphur base and silicate cement of all types, and resin-base acid-proof cements
B. F. Goodrich Rubber Co., Akron, Ohio	Plastikon	Rubber-base putty
The Haveg Corp., Newark, Del.	Havegit 41, 43, 50	Self-hardening phenolic resin cements for acids and alkali
M. W. Kellogg Co., New York, N. Y.	....	Acidproof cement
Maurice A. Knight, Akron, Ohio	Knight. Acidproof Nos. 1 to 10	Silicate cements for strong acids. Resin cements
Nukem Products Co., Buffalo, N. Y.	Basolit, Plasul, Basolit, Hydro-Plasul, Nukem Resinous Cements, Nu-Mastic, Nukem Primer, Nukem Enamel	Rubberized Sulphur Cements, acid and alkali resin base cements and others for complete acid-proof construction and protection
Paraffine Cos., San Francisco, Calif.	....	Acidproof cement
Patterson Foundry & Machine Co., East Liverpool, Ohio	Porox Cement	Silicate cement for strong acids
Pecora Paint Co., Philadelphia, Pa.	Acitite, Acichlor, Cushion Putty	Slow- and quick-drying cements and elastic putties for acids
Pennsylvania Salt Mfg. Co., Special Chemicals Division, Philadelphia, Pa.	Penchlor Acid-Proof, Penchlor Fire-Proof, Electric Heater, SWD, Asplit, Asplit F, Asplit FK, Causplit, and S-25 cements	Chemical-setting silicate cements, self hardening resin cements, for both acids and alkalis
Philadelphia Quartz Co., Philadelphia, Pa.	"S" Brand and N 380 Sodium Silicates	Sodium silicates for regular and quick-setting acidproof cements
Quigley Co., New York, N. Y.	Acid-proof, black gray, quick setting	Silicate cements for acid gases and mineral acids
Reardon Cement Co., Cincinnati, Ohio	Bedford	Acid and alkali resisting cements and plastics
The Sullivan Co., Memphis, Tenn.	Acidol, Sulsilo	Pouring cements and pre-mixed silicate cements for strong acids
Sauereisen Cements Co., Sharpsburg, Pa.	Insa-Lute Nos. 31, 48, 46, 44	Quick-setting, air-drying, sulphur and bitumastic cements
United States Stoneware Co., Akron, Ohio	Portite, Pre-Mixt, Calktite and others	Silicate cements of all types, resin cements, putties, etc.
Union Bay State Co., Cambridge, Mass.	N Series (neoprene base) cements, and special base cements	Neoprene and special base cements. For painting metals, rubber, wood, or concrete. Coating cloth. As adhesive

GLASS, GLASS-LINED AND FUSED SILICA

Physical Properties of Low-Expansion Glasses, Fused Quartz and Fused Silica

MATERIAL	Specific Gravity	Specific Volume, Cu. in per lb.	Tensile Strength, Lb. per sq. in.	Modulus of Elasticity, Lb. per sq. in. (Multiply by 10⁶)	Hardness*	Thermal Expansion Per °C. (Multiply by 10—⁵)	Thermal Cond., Cal. per sec., cm.², °C., cm. (Multiply by 10⁴)	Specific Heat, Cal. per °C., gm.	Softening Point, °F.	Breakdown Voltage, 60 cycles, v. per mil	Dielectric Constant, 60 cycles	Refractive Index, n D	Transparency†	Forms Available**
Borosilicate glass	2.23	12.4	10,000	98	....	0.32	24.5	0.20	1,505	3,200 (0.1 in.)	4.6	1.47	T, TL	S, R, T, other
96% silica glass	2.18	12.7	......	......	....	0.080	....	......	2,750±90	3,000	4.0	1.458	T	R. T, other
Fused quartz	2.20	12.6	4,000	105–126	4.9	0.054	33.2	0.25	2,600	500 (¼ in.)	Approx. 3.8	1.459	T	S, R, T, other
Fused silica	2.07	13.4	400–800	94–114	....	0.054	33.1	......	2,600	250 (¼ in.)	3.7	......	TL, O	S, R, T, other

* Hardness: 2.5 mm. ball, 25 kg. load, depth in 1/200 mm. † T=transparent; TL=translucent; O=opaque. ** S=sheets; R=rods; T=tubes.

Makers of Glass, Glass-Lined and Fused Silica Equipment

Manufacturers (Name and Address)	Composition, Forms Available
Alsop Engineering Co., Milldale, Conn.	Glass-lined steel tanks and mixers
Amersil Corp., New York, N. Y.	Fused silica ware such as pans, pipes, gas coolers, absorbers, quartz insulators, tubes and plates
Corning Glass Works, Corning, N. Y.	Special heat and corrosion-resisting borosilicate glass supplied in various forms: pipe, columns, etc. Also 96 per cent high silica glassware now available for laboratory use
Ertel Engineering Co., New York, N. Y.	Glass-enameled tanks
General Electric Co., Schenectady, N. Y.	Transparent fused quartz in various small sized articles
Glascote Products, Inc., Euclid, Ohio	Glass-enameled steel equipment
Hanovia Chemical & Mfg. Co., Newark, N. J.	Transparent fused quartz in all shapes
Owens-Corning Fiberglas Corp., Toledo, Ohio	Fibrous glass filter cloths and dust filters
The Pfaudler Co., Rochester, N. Y.	Wide variety of standard and special glass-enameled steel equipment — various formulas
A. O. Smith Corp., Milwaukee, Wis.	Glass-lined steel equipment
The Thermal Syndicate, Ltd., New York, N. Y.	Fused silica (non-transparent) supplied in various large forms; fused quartz (transparent) in smaller sizes
Vitreous Enameling & Stamping Co., New York, N. Y.	Enameled specialities, tanks
Vitreous Steel Products Co., Cleveland, Ohio.	Enameled drying trays and specialties

PLASTICS AS ENGINEERING MATERIALS

Effect on Plastics of Immersion for 7 Days in Chemical Reagents at 25 Deg. C.

	Phenol-Formaldehyde Molded	Phenol-Formaldehyde Cast	Phenol-Formaldehyde Laminated	Urea-Formaldehyde Molded	Urea-Formaldehyde Laminated	Vinyl Chloride-Acetate Resin	Vinyl Butyral Resin	Methyl Methacrylate Resin	Styrene Resin Molded	Cellulose Nitrate	Cellulose Acetate	Ethyl-Cellulose No. 1	Cold-Molded Phenolic	Casein Plastic
30% Sulphuric acid	Surface roughened	None	Edges swollen	Surface roughened	Surface attacked	None	None	None	None	None	Crazed; softened	None	None	Rubbery
3% Sulphuric acid	Surface roughened	None	Edges swollen	Surface roughened	Surface attacked	None	Cloudy	None	None	None	Swollen	None	None	Swollen; rubbery
10% Nitric acid	Surface roughened	None	Edges swollen	Surface roughened	Delaminated	None	Cloudy	None	None	None	Decomposed	None	None	Swollen; cracked
10% Hydrochloric acid	Surface roughened	None	Edges swollen	Surface roughened	Delaminated	None	Cloudy	None	None	None	Decomposed	None	Cracked on drying	Swollen; cracked
5% Acetic acid	None	None	Edges swollen	None	None	None	Cloudy	None	None	None	Swollen	None	None	Rubbery; split
Oleic acid	None	None	None	None	None	None	Tacky	None	None	None	None	Decomposed	None	None
10% Sodium hydroxide	Decomposed	Decomposed	Delaminated	None	Surface attacked	None	None	None	None	Crazed	Decomposed	None	Decomposed	Decomposed
1% Sodium hydroxide	Surface roughened	Decomposed	Edges swollen	None	None	None	Slightly cloudy	None	None	Crazed	Surface attacked	None	Decomposed	Broken up
10% Ammonium hydroxide	Surface dulled	Discolored	Discolored; edges swollen	None	None	None	Opaque	None	Discolored	Crazed; discolored	Opaque; soft	None	None	Swollen; split
2% Sodium carbonate	None	Discolored	Discolored	None	None	None	Slightly cloudy	None	None	None	Swollen	None	None	Swollen; rubbery
10% Sodium chloride	None	None	Edges swollen	None	None	None	None	None	None	None	None	None	None	None
3% Hydrogen peroxide	None	Discolored	None	Surface dulled	Delaminated	None	Cloudy	None	None	None	None	None	None	Swollen; rubbery
Distilled water	None	None	None	None	None	None	Cloudy	None	None	None	None	None	None	Swollen; rubbery
50% Ethyl alcohol	None	None	None	None	None	None	Swollen; rubbery	Slightly swollen	None	None	Partly dissolved	Swollen; cracked	None	Swollen; rubbery
95% Ethyl alcohol	None	None	None	None	None	None	Dissolved	Surface attacked	None	Dissolved	Partly dissolved	Dissolved	None	None
Acetone	None	Softened	Blistered	None	None	Dissolved	Swollen; opaque	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	None	None
Ethyl acetate	None	None	None	None	None	Decomposed	Decomposed	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	None	None
Ethylene chloride	None	None	None	None	None	Dissolved	Decomposed	Dissolved	Dissolved	Partly dissolved	Soft; swollen	Dissolved	None	None
Carbon tetrachloride	None	None	None	None	None	None	Swollen; rubbery	Surface attacked	Dissolved	None	None	Dissolved	None	None
Toluene	None	None	None	None	None	Soft; rubbery	Swollen; rubbery	Dissolved	Dissolved	Partly dissolved	None	Dissolved	None	None
Gasoline	None	None	None	None	None	None	None	None	Partly dissolved	None	None	Swollen; cracked	None	None

From a paper, Resistance of Plastics to Chemical Reagents, by G. M. Kline, R. C. Rinker and H. F. Meindl presented before Chicago meeting of A.S.T.M. June 24, 1941.

Types, Trade Names and Manufacturers of Principal Plastics*

Types	Trade Names	Manufacturers
Polyethylene	Polyethylene	Carbide & Carbon Chemicals Corp., N. Y.
	Polythene	E. I. du Pont de Nemours & Co., Wilmington, Del.
Organo-Silicon	Silicone	Dow Chemical Co., Midland, Mich.
Phenolic materials	Bakelite	Bakelite Corp., New York, N. Y.
	Cardolite	Irvington Varnish & Ins. Co., Irvington, N. J.
	Celeron	Continental Diamond Fibre Co., Newark, Del.
	Coltrock	Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
	Durez	Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
	Durite	Durite Plastics, Philadelphia, Pa.
	Haveg	Haveg Corp., E. Newark, Del.
	Heresite	Heresite & Chemical Co., Manitowoc, Wis.
	Indur	Reilly Tar & Chemical Corp., Indianapolis, Ind.
	Insurok	Richardson Co., Melrose Park, Ill.
	Makalot	Makalot Corp., Boston, Mass.
	Resinox	Monsanto Chemical Co., E. Springfield, Mass.
	Templus	Bryant Electric Co., Bridgeport, Conn.
	Textolite	General Electric Co., Pittsfield, Mass.
Phenolic, cast	Bakelite	Bakelite Corp., New York, N. Y.
	Catalin	Catalin Corp., New York, N. Y.
	Gemstone	A. Knoedler Co., Lancaster, Pa.
	Marblette	Marblette's Corp., L. I. City, N. Y.
	Opalon	Monsanto Chemical Co., E. Springfield, Mass.
	Prystal	Catalin Corp., N. Y.
Urea	Bakelite	Bakelite Corp., N. Y.
	Beetle	American Cyanamid Co., N. Y.
	Cibanoid	Ciba Corp., N. Y.
	Plaskon	Plaskon Co., Toledo, Ohio
	Uformite	Resinous Products & Chemicals Co., Phila., Pa.
Melamines	Melamac	American Cyanamid Co., N. Y.
	Malamine	Plaskon Co., Toledo, Ohio
Acrylics	Crystalite	Rohm & Haas, Phila., Pa.
	Lucite	E. I. duPont de Nemours Co., Arlington, N. J.
	Plexiglas	Rohm & Haas, Phila., Pa.
Vinyls	Alvar	Shawinigan Prod. Corp., N. Y.
	Butacite	E. I. duPont de Nemours Co., Wilmington, Del.
	Butvar	Shawinigan Prod. Corp., N. Y.
	Formvar	Shawinigan Prod. Corp., N. Y.
	Gelva	Shawinigan Prod. Corp., N. Y.
	Koroseal	B. F. Goodrich Co., Akron, Ohio
	Resistoflex	Resistoflex Corp., Belleville, N. J.
	Tygon	U. S. Stoneware Co., Akron, Ohio
	Vinylite	Carbide & Carbon Chemicals Corp., N. Y.
Vinylidene Chloride	Saran	Dow Chemical Co., Midland, Mich.
Polystyrene	Bakelite	Bakelite Corp., N. Y.
	Loalin	Catalin Corp., N. Y.
	Lustron	Monsanto Chemical Co., E. Springfield, Mass.
	Styron	Dow Chemical Co., Midland, Mich.

Types, Trade Names and Manufacturers of Principal Plastics (Continued)

Types	Trade Names	Manufacturers
Cellulose Acetate	Bakelite	Bakelite Corp., N. Y.
	Cellulate	National Plastics Co., Detroit, Mich.
	Fibestes	Monsanto Chemical Co., E. Springfield, Mass.
	Gemloid	Gemloid Corp., N. Y.
	Lumarith	Celanese Celluloid Corp., N. Y.
	Macite	Manufacturers Chemical Corp., Jersey City, N. J.
	Nixonite	Nixon Nitration Works, Nixon, N. J.
	Plastacele	E. I. du Pont de Nemours & Co., Arlington, N. J.
	Tenite I	Tennessee Eastman Corp., Kingsport, Tenn.
Cellulose Acetate Butyrate	Tenite II	Tennessee Eastman Corp., Kingsport, Tenn.
Ethyl Cellulose	Ethocel	Dow Chemical Co., Midland, Mich.
	Hercules	Hercules Powder Co., Wilmington, Del.
Laminated Materials	Aqualite	National Vulcanized Fibre Co., Wilmington, Del.
	Cellanite	Continental Diamond Fibre Co., Newark, Del.
	Celeron	Continental Diamond Fibre Co., Newark, Del.
	Coffite	Formica Insulation Co., Cincinnati, Ohio
Laminated Materials.	Corresite	S. Blickman, Inc., Weehawken, N. J.
	Dilecto	Continental Diamond Fibre Co., Newark, Del.
	Dilectene	Continental Diamond Fibre Co., Newark, Del.
	Duraloy	Detroit Paper Products Co., Detroit, Mich.
	Formica	Formica Insulation Co., Cincinnati, Ohio
	Insurok	Richardson Co., Melrose Park, Ill.
	Lamicoid	Mica Insulation Co., N. Y.
	Lamitex	Franklin Fibre-Lamitex Corp., Wilmington, Del.
	Micarta	Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
	Panelyte	Panelyte Corp., N. Y.
	Ohmoid	Wilmington Fibro Specialty Co., Wilmington, Del.
	Phenolite	National Vulcanized Fibre Co., Wilmington, Del.
	Spauldite	Spaulding Fibre Co., Tonawanda, N. Y.
	Synthane	Synthane Corp., Oaks, Pa.
	Taylor	Taylor Fibre Co., Norristown, Pa.
	Textolite	General Electric Co., Pittsfield, Mass.
	Ucinite	Ucinite Co., Newtonville, Mass.
	Vulcoid	Continental Diamond Fibre Co., Newark, Del.

* In this table only the more usual engineering plastics materials are listed by trade name and manufacturers. No attempt has been made to include all types of plastics materials, as that is beyond the scope of this issue of *Chem. & Met.*, which is concerned primarily with materials of construction for chemical engineering equipment. The engineer may find listings of molders and extruders as well as other valuable data in the book by John Sasso. "Plastics for Industrial Use," McGraw-Hill Co., (1942), from which this list was largely compiled.

RUBBER AND LIKE PRODUCTS

Physical Properties of Synthetic and Natural Rubbers

Material	Specific Gravity of Base Material	Tensile Strength, lb./sq. in.	Hardness, Shore Durometer	Maximum Temp. for Use, °F.[2]	Dielectric Strength, v./mm.	Effect of Heat	Abrasion Resistance	Effect of Sunlight[3]	Effect of Aging	Machining Qualities
Chemigum, oil resistant	1.0–1.5	800–4,000	30–90	300	....	Stiffens	Excellent	Equal to rubber	Stiffens	Can be ground
Chemigum, tire	1.0–1.15	1,000–4,000	50–65	450	....	Stiffens	Good	None	Better than rubber	....
GR-I (Butyl)	0.91	500–3,000	15–90	250–300	25,000	Stiffens slightly	Excellent	None	Highly resistant	Can be ground
GR-M (Neoprene)	1.25–1.30	1,000–4,500	10–95	300	....	Stiffens slightly	Excellent	None	Highly resistant	Can be ground
GR-N (Perbunan)	0.96	500–5,000	30–90	300	....	Stiffens	Excellent	Slight	Highly resistant	Can be ground
GR-P (Thiokol FA)	1.34	1,400	25–90	200	....	Hardness slightly	Fairly good	None	None	Excellent
GR-P (Thiokol ST)	1.27	500–2,000	30–90	250–300	....	Hardens slightly	Good	None	None	Excellent
GR-S (Buna S), hard	0.94	4,000–11,000	70–95[1]	220	....	....	....	....	Highly resistant	Excellent
GR-S (Buna S), soft	0.94	500–3,000	25–95	300	....	Stiffens	Excellent	Deteriorates	Highly resistant	Can be ground
Hycar OR-15, soft	1.00	500–4,000	20–95	300	....	Stiffens	Excellent	Slightly better than natural rubber	Highly resistant	Can be ground
Hy OR-25, soft	0.99	500–3,000	20–95	300	....	Stiffens	Excellent	Slightly better than natural rubber	Highly resistant	Can be ground
Hycar OR-15, hard	1.00	4,000–11,000	70–95	275	....	....	....	....	Highly resistant	Excellent
Hycar OS-10, soft	0.98	500–3,500	20–95	300	....	Stiffens	Excellent	Deteriorates	Highly resistant	Can be ground
Koroseal, soft	1.40	500–2,500	30–80	190	15,000–30,000	Softens	Good	None	Highly resistant	Can be ground
Koroseal, hard	1.40	2,000–9,000	80–100	212	30,000–50,000	Softens	Excellent	None	Highly resistant	Good
Pliolite, No. 40	1.06	4,000–5,000	....	160–248	....	Softens	....	None	None	....
Resistoflex	1.26	2,000–5,000	55–95	250	6,000–10,000	Softens	Good	None	None	....
Tygon T	1.33–1.36	9,000	....	175	35,000–50,000	Softens	Good	None	....	Excellent
Vistanex, medium	0.9	200	....	....	....	....	....	None	Better than rubber	Cannot be machined
Vistanex, high	0.9	550	....	....	....	....	....	None	Better than rubber	Cannot be machined
Natural rubber, hard	0.93	4,000–11,000	70–95[1]	220	....	....	....	....	Highly resistant	Excellent
Natural rubber, soft	0.93	500–5,000	20–95	300	....	Softens	Excellent	Deteriorates	Moderately resistant	Can be ground

[1] Type "D". [2] Maximum temperature suitable for service depends greatly upon the exact service conditions. Maximum temperature for use as a packing can be much higher than the maximum temperature suitable for tank lining. Individual cases should be referred to the supplier for recommendations. [3] Effect of exposure to sunlight under tension.

Representative Makers of Industrial Rubber Products and Rubber-Like Materials

Manufacturers (Name and Address)	Products
American Hard Rubber Co., New York, N. Y.	Hard and soft rubber, neoprene and Thiokol linings, pipe, fittings, shapes, pails, pumps, rubber paint, anode process, etc.
American Wringer Co., Woonsocket, R. I.	Tensilgrip natural and synthetic rubber lined tanks, vats, pipe, buckets, propellers, shafts, stacks, flues, pumps, impellers, filter press frames, etc.
Atlas Mineral Products Co. of Pa., Mertztown, Pa	Rewbon seamless rubber linings, Neobon and Zerok synthetic resin linings
Boston Woven Hose & Rubber Co., Boston, Mass	Conveyor and transmission belts, hose, mechanical rubber goods
Crane Packing Co., Chicago, Ill.	Rubber and synthetic rubber packings and mechanical seals
Custodis Construction Co., New York, N. Y.	Custoplast soft rubber and neoprene tank linings
Dayton Rubber Mfg. Co., Dayton, Ohio	Oilproof rubber belts, transmission belting, synthetic rubber products
E. I. du Pont de Nemours & Co., Neoprene Div., Wilmington, Del	Neoprene polymerized chloroprene rubber
Firestone Tire & Rubber Co., Akron, Ohio	Molded and extruded rubber, synthetic and plastic products, rubber to metal bonded products, vibration dampeners, adhesives, sheet stock, friction tape, hose, V-belting, Velon woven fabric, plastic moisture-vapor proof film
Garlock Packing Co., Palmyra, N. Y.	Rubber and synthetic rubber packings, gaskets, Klozure oil seals and molded goods
Gates Rubber Co., Denver, Colo	V-belts, molded rubber goods, hose
L. H. Gilmer Co., Tacony, Philadelphia, Pa.	Transmission belting and special molded parts
B. F. Goodrich Co., Akron, Ohio	Acid and abrasion-resistant linings, hose, conveyor and transmission belting, packing and gaskets, hard rubber pipe and molded goods, vibration insulators and dampeners, adhesives, corrosion resisting paints, Koroseal, anode process products, Ameripol products
Goodyear Tire & Rubber Co., Akron, Ohio	Hose, conveyor and transmission belting, packings, linings, Plioweld rubber lined tanks, pipe, etc., mechanical rubber goods, molded goods, Pliolite modified rubber plastic, Chemigum
Greene, Tweed & Co., New York, N. Y.	Rubber packings, gaskets and sheet.
Hewitt Rubber Corp., Buffalo, N. Y.	Hose, transmission, conveyor and elevator belting, packings, molded goods, extruded items
Hodgman Rubber Co., Framingham, Mass.	Rubber mechanical rolls and rubber lined tanks
Hycar Chemical Co., Akron, Ohio	Synthetic rubbers (Hycar)
Jenkins Bros. Rubber Div., Bridgeport, Conn	Mechanical rubber goods, rubber and synthetic rubber packings, valve discs, molded and extruded products, friction and rubber insulating tapes and tire valves
The Osborn Mfg. Co., Johns Conveyor Div., Cleveland, Ohio	Johns rubber and synthetic rubber "moving pipe-line" conveyors
Maurice A. Knight, Akron, Ohio	All-rubber acid shipping drums. Pyroflex resin-base tank linings
Linear Packing & Rubber Co., Philadelphia, Pa	Rubber and synthetic rubber packings
Luzerne Rubber Co., Trenton, N. J.	Hard rubber pipe, fittings, valves, shapes, tanks, rayon apparatus and other equipment
Manhattan Rubber Mfg. Div., Passaic, N. J.	Transmission and conveyor belting, blocks, hose, piping, rolls, brake lining, bearings
Miller Rubber Industrial Prod. Div., B. F. Goodrich Co., Akron, Ohio	Rubber and synthetic rubber hydraulic oil packings and seals
Paramount Rubber Co., Detroit, Mich	Neoprene tank linings and rack coatings; masking stop-off parts, plastic laminate products
Resistoflex Corp., Belleville, N. J.	Rubber-like oil-resisting resin — tubing, hose, sheets, molded shapes, gloves, aprons, solutions, gaskets,
Self-Vulcanizing Rubber Co., Chicago, Ill.	Liquid and plastic rubber self-vulcanizing coatings and lining materials
Standard Oil Development Co., Elizabeth, N. J.	Perbunan synthetic rubber
Jos. Stokes Rubber Co., Trenton, N. J.	Hard rubber and synthetic, molded and extruded products, hard rubber pipes, valves, fittings, buckets, funnels and dippers
Thermoid Rubber Div., Thermoid Co., Trenton, N. J.	Transmission belting, F.H.P. and multiple V-belts and drives, conveyor and elevator belting, wrapped and molded hose, packings, industrial brake linings and friction products
Thiokol Corp., Trenton, N. J.	Thiokol olefine polysulphide synthetic rubber — crude sheet, molding powder and liquid dispersions
U. S. Rubber Co., New York, N. Y.	Hose: conveyor, elevator and power transmission belting; packings; molded and extruded rubber; rubber bonded to metal: rubber linings (hard, semi-hard, soft for tanks, pipe, fittings, chutes and valves)
U. S. Stoneware Co., Akron, Ohio	Tygon synthetic resin products: tank linings, gaskets, tubing, acid-proof paints, cements, molded or extruded goods. Molded or extruded mechanical rubber goods, rubber linings
Union Bay State Co., Cambridge, Mass.	Gacco (neoprene base) compounds for tank surfacing and similar corrosion proofing purposes
Vulcanized Rubber Co., New York, N. Y.	Hard and semi-hard rubber molded products

WOOD FOR CHEMICAL EQUIPMENT

Manufacturers of Wooden Tanks, Towers and Pipes

Manufacturers (Name and Address)	Products
Acme Tank Co., Jersey City, N. J.	Tanks and stave pipe
Acme Tank Mfg. Co., Los Angeles, Calif.	Tanks and stave pipe
American Wood Pipe Co., Tacoma, Wash.	Pipe
Armco Drainage Products Association, Middletown, Ohio	Pipe
Arrow Tank Co., Buffalo, N. Y.	Tanks and stave pipe
Atlantic Tank Corp., North Bergen, N. J.	Tanks and stave pipe
Axtell Co., Fort Worth, Tex.	Tanks and pipe
Baltimore Cooperage Tank and Tower Co., Baltimore, Md.	Tanks and stave pipe
M. C. Bascom and Co., Bolivar, N. Y.	Tanks and pipe
Batavia Metal Products Co., Batavia, Ill.	Tanks and stave pipe
Beall Pipe and Tank Corp., Portland, Ore.	Tanks and pipe
Beaver Silo and Box Mfg. Co., Beaver Dam, Wis.	Tanks and pipe
Beckman Bros., Des Moines, Iowa	Tanks and pipe
Beloit Iron Wks., Beloit, Wis.	Tanks and pipe
Black-Clawson Co., Hamilton, Ohio	Tanks and pipe
Black, Sivalls and Bryson, Inc., Oklahoma City, Okla.	Tanks
Breyer Bros., Waupan, Wis.	Tanks
Brooks Lumber Co., Bellingham, Wash.	Tanks and pipe
Brown Lumber Co., Massilon, Ohio	Pickling tanks

Manufacturers of Wooden Tanks, Towers and Pipes (Continued)

Manufacturers (Name and Address)	Products
W. E. Caldwell Co., Inc., Louisville, Ky.	Tanks and stave pipe
California Redwood Dist., Chicago, Ill.	Redwood pipe
Carley Heater Co., Inc., Olean, N. Y.	Tanks and stave pipe
Carlton Lumber Co., Portland, Ore.	Towers
Cascade Pipe and Flume Co., Seattle, Wash.	Pipe
Challenge Co., Batavia, Ill.	Tanks and stave pipe
Chicago Wooden Tank Co., Chicago, Ill.	Tanks and stave pipe
A. J. Corcoran Inc., Jersey City, N. J.	Tanks and stave pipe
Cottage Grove Lumber Co., Cottage Grove, Ore.	Tanks and pipe
G. M. Davis and Sons, Palatka, Fla.	Cypress tanks
Drane Tank Co., Ft. Worth, Tex.	Oil tanks
Dunck Tank Wks., Inc., Milwaukee, Wis.	Tanks and stave pipe
Eagle Tank Co., Chicago, Ill.	Tanks and stave pipe
Eastern Wood Products Co., Williamsport, Pa.	Wrapped, continuous stave and solid bored pipe
Economy Silo and Mfg. Co., Frederick, Md.	Tanks
John Eppler Co., Baltimore, Md.	Tanks and towers
Everett Forest Products Co., Everett, Pa.	Wrapped pipe and continuous stave pipe
Federal Tank Co., Houston, Tex.	Tanks and pipe
Federal Pipe and Tank Co., Seattle, Wash.	Tanks, and wrapped and continuous stave pipe
Fleming Tank Co., Pittsburgh, Pa.	Tanks and stave pipe
Fluor Corp., Los Angeles, Calif.	Cooling towers
Fleischel Lumber Co., St. Louis, Mo.	Red cypress equipment
Fordyce-Crossett Sales Co., Fordyce, Ark.	Towers
Forest Products Treating Co., Portland, Ore.	Towers
Foster Wheeler Corp., New York. N. Y.	Cooling towers
General Tank Corp., Kearny, N. J.	Tanks and stave pipe
Amos H. Hall and Sons, Philadelphia, Pa.	Tanks and stave pipe
Hanson-Van Winkle-Munning Co., Matawan, N. J.	Platers tanks
Harder Silo, Inc., Cobleskill, N. Y.	Tanks
Hauser-Stander Tank Co., Cincinnati, Ohio.	Tanks and stave pipe
Haywood Tank Co., Greggton, Tex.	Tanks and pipe
Henry Mill and Timber Co., Tacoma, Wash.	Towers
J. Holland and Sons, Brooklyn, N. Y.	Plating tanks
Horizontal Stave Tank Co., Seattle, Wash.	Tanks and pipe
Howard Wood Tank Co., Brooklyn, N. Y.	Tanks and pipe
F. E. Hudson and Sons, Buffalo, N. Y.	Tanks and pipe
Rodney Hunt Machine Co., Orange, Mass.	Dye tubs
James Hunter Machine Co., North Adams, Mass.	Dye tubs
Hydro and Chemical Tank Co., New York, N. Y.	Tanks and pipe
Improved Paper Machinery Corp., Nashua, N. H.	Tanks and pipe
Iowa Wind Mill and Pump Co., Cedar Rapids, Iowa	Tanks and pipe
Isseks Bros., New York, N. Y.	Tanks and pipe
David Isseks and Sons, Brooklyn, N. Y.	Tanks and stave pipe
C. Jacobsen and Co., Chicago, Ill.	Tanks and pipe
Johnson and Carlson, Chicago, Ill.	Tanks and stave pipe
E. D. Jones and Sons Co., Pittsfield, Mass.	Tanks and pipe
Kalamazoo Tank and Silo Co., Kalamazoo, Mich.	Tanks and stave pipe
Kretchmer Mfg. Co., Council Bluffs, Iowa.	Tanks and pipe
Leird Lumber Co., Little Rock, Ark.	Towers
Lincoln Tank Co., Shreveport, La.	Oil tanks
Harvey Loehr Lumber Co., Canton, Ohio.	Pickling tanks
Lord and Bushnell Lumber Co., Chicago, Ill.	Pipe
M. and V. Tank Co., Witchita Falls, Tex.	Oil tanks
Mangold Stave and Cooperage Co., St. Louis, Mo.	Tanks and stave pipe
G. H. Manville Pattern and Model Co., Waterbury, Conn.	Tanks and pipe
Market Mfg. Co., Syracuse, N. Y.	Tanks and pipe
Marley Co., Kansas City, Kan.	Cooling towers
Martin Tank Co., Corsicana, Tex.	Tanks and pipe
Mayer Tank Mfg. Co., Inc., Brooklyn, N. Y.	Tanks and stave pipe
McGarr-Turner Co., Cordele, Ga.	Tanks and pipe
McGuffin Tank Co., Shreveport, La.	Tanks and pipe
McKeown Bros. Co., Chicago, Ill.	Towers
Michigan Pipe Co., Bay City, Mich.	Toncan clad, wrapped, solid bored and continuous stave pipe
Modolow Lumber and Building Co., Seattle, Wash.	Towers
Morse Bros. Machinery Co., Denver, Colo.	Tanks
Moran Tank Co., Shreveport, La.	Tanks and pipe
Nashua Milling Corp., Nashua, N. H.	Towers
National Tank Co., Tulsa, Okla.	Oil tanks
National Tank and Pipe Co., Portland, Ore.	Tanks, and wrapped pipe and continuous stave pipe
Nebraska Bridge Supply and Lumber Co., Omaha, Neb.	Pipe
New England Tank and Tower Co., Everett, Mass.	Tanks, stave pipe, agitators and agitator equipment
Pacific Tank and Pipe Co., Oakland, Calif.	Tanks and wrapped, continuous stave and solid bored pipe
Pacific Wood Tank Corp., San Francisco Calif.	Tanks and stave pipe
Parkersburg Rig and Reel Co., Parkersburg, West Va.	Oil tanks
Peerless Tank and Tower Co., New York, N. Y.	Tanks and pipe
Perdue Tank Co., Witchita, Kan.	Tanks and pipe
Plattner Co., Denver, Colo.	Tanks
Plymold Corp., Lawrence, Mass.	Tanks and pipe
Pope and Talbot, Inc., Portland, and San Francisco	Towers and pipe
Prefabricated Products Co., Seattle, Wash.	Towers
Producers Tank Co., Seminole, Okla.	Tanks and pipe
J. F. Prichard & Co., Kansas City, Mo.	Tanks
Redwood Mfg. Co., San Francisco, Calif.	Redwood tanks; wrapped, continuous stave and solid bored pipe
Riggs and Lombard, Inc., Lowell, Mass.	Dye tubs and paper mill equipment
Rilco Laminated Products, St. Paul, Minn., Wilkes-Barre, Pa.	Towers
Roof Structures, Inc., Webster Groves, Mo., New York, N. Y.	Towers
J. C. Roy Lumber Co., Chicopee, Mass.	Tanks and pipe
San Mateo Planing Mill, San Francisco, Calif.	Tanks and pipe
James E. Stark Co., Memphis, Tenn.	Tanks and pipe
E. F. Schlichter Co., Philadelphia, Pa.	Tanks and stave pipe
E. W. Schmeling and Sons, Rockford, Ill.	Tanks and pipe
Alexander Schroeder Co., Houston, Tex.	Tanks and pipe
A. F. Schwerd Mfg. Co., Pittsburgh, Pa.	Wrapped pipe
Harry J. Simons Lumber and Mfg. Co., St. Paul, Minn.	Tanks
Smith Fabricating Shop, Hot Springs Nat'l Park, Ark.	Towers
Souder Tank Co., Madison, Kan.	Tanks and pipe
James E. Stark Co., Memphis, Tenn.	Tanks and pipe
Charles H. S ehling Co., Milwaukee, Wis.	Tannery drums and paddles
Stearns Tanks, Boston, Mass.	Tanks and stave pipe
Stevens Tank Co., Wichita, Kan.	Tanks and pipe
Stevens Tank and Tower Co., Auburn, Me.	Tanks and stave pipe
Summerbell Roof Structures, Springfield, Ore.	Towers
Terminal Mfg. Co., St. Paul, Minn.	Tanks
Tex Well Equipment Mfg. Co., Ft. Worth, Tex.	Oil tanks
Timber Fabrications, Miami, Fla., Houston, Tex.	Towers
Timber Structures, New York, N. Y.	Towers
Twin City Tank, Silo and Specialty Co., Minneapolis, Minn.	Tanks
Union Lumber Co., San Francisco, Calif.	Redwood tanks and stave pipe
Unit Structures, Inc., Peshtigo, Wis.	Towers
U. S. Plywood Corp., New York, N. Y.	Plywood pipe
Valley Iron Works, Appleton, Wis.	Tanks and pipe
Wauna Lumber Co., Wauna, Ore.	Towers
Well Machinery and Supply Co., Ft. Worth, Tex.	Oil tanks
Wendnagel Co., Chicago, Ill.	Tanks and stave pipe
Wenneis Tank Co., New York, N. Y.	Tanks and stave pipe
Weyerhaeuser Sales Co., Newark, N. J., Baltimore, Md., Tacoma, Wash.	Towers
Whatcom Falls Mill Co., Bellingham, Wash.	Tanks and pipe
Wheeler Lumber, Bridge and Supply Co., Des Moines, Iowa	Pipes
Wilborne Bros. Co., Amarillo, Tex.	Tanks and pipe
Wilcox-Johnson Tank Co., Victor, N. Y.	Tanks and stave pipe
George Windeler Co., Ltd., San Francisco, Calif.	Tanks and stave pipe
Woolford Wood Tanks, Darby, Pa.	Tanks and stave pipe
A. Wyckoff and Son Co., Elmira, N. Y.	Wrapped, and solid bored pipe

$50 WAR BOND FOR A GOOD IDEA!

Until further notice the editors of *Chem. & Met.* will award a $50 Series E War Bond each month to the author of the best short article received during the *preceding* month and accepted for publication in the "*Chem. & Met.* Plant Notebook." Articles will be judged during the month following receipt, and the award announced in the issue of that month. The judges will be the editors of *Chem. & Met.* Non-winning articles submitted for this contest may be published if acceptable, and if published will be paid for at space rates applying to this department.

Any reader of *Chem. & Met.*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible. Neither finished drawings nor polished writing are necessary, since only appropriateness, novelty and usefulness of the ideas presented are criteria of the judging.

Articles may deal with any sort of plant or production "kink" or shortcut that will be of interest to chemical engineers in the process industries. In addition, novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address entries to Plant Notebook Editor, *Chem. & Met.*, 330 West 42nd St., New York 18, N. Y.

AUGUST WINNER!

A $50 Series E War Bond will be issued in the name of

L. D. ANDERSON

Consulting Engineer
Potash Co. of America
Carlsbad, N. M.

For an article dealing with a new method of using wood flooring for corrosion prevention, which has been adjudged the winner of our August contest.

This article will appear in our October issue. Watch for it!

July Contest Prize Winner

SLIDE RULE NOMOGRAPH USEFUL FOR CALCULATIONS BY UNTRAINED OPERATING PERSONNEL

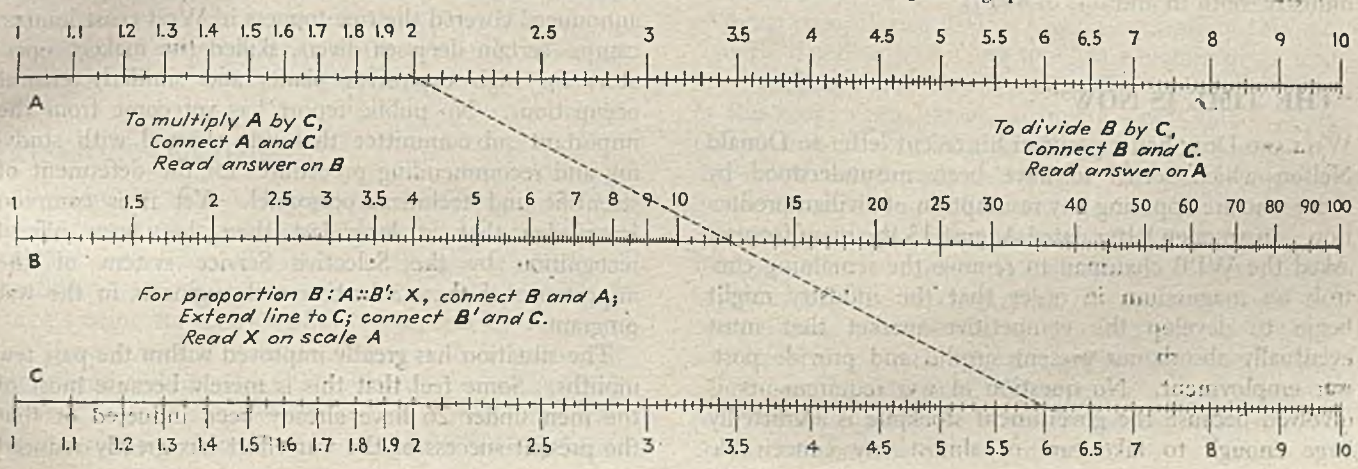
J. A. MAY
Technical Foreman
Styrene Div., The Dow Chemical Co.
Lake Jackson, Texas

Below is a chart which I have termed a slide rule nomograph, since it performs the same sort of calculations as can be handled with a slide rule. It is handy when a slide rule is not available, and particularly useful for operating personnel in making routine control calculations and in establishing rates involving ratios. At the loss of some accuracy and convenience in operation as compared with a slide rule in the hands of someone who has used it for years, the slide rule nomograph can be mastered much more quickly than the slide rule itself. Furthermore, it can readily be constructed to any size and fineness of division desired, simply by plotting logarithms to any desired scale. If for any reason it is desired to do so, additional scales of more than two cycles can be added for higher roots.

As will readily be seen the nomograph consists of three logarithmic scales, the upper and lower being single-cycle and the middle, a two-cycle scale. To multiply, the multiplicand is set on the "A" scale and the multiplier on the "C" scale, or vice-versa, and the two connected with a straightedge, giving the answer on the "B" scale at the point cut. Division is accomplished by setting the dividend on the "B" scale and the divisor on the "A" or "C" scale, and reading the quotient on the other of these last two. For proportion $B : A :: B' : X$, with X the unknown, connect the "B" scale (for B) to the "A" scale, noting the resulting ratio on the "C" scale. Then connect the "B" scale (for B') to the "C" scale, reading the value of X on the "A" scale. For squares and square roots, it is obvious that the results are indicated by vertical lines.

The principle of the nomograph is simple. Since the two-cycle "B" scale is midway between the "A" and "C" scales, then a line joining points on "A" and "C" determines the average value on the "B" scale. That is, the length along the "B" scale equals the length along "A" plus that along "C", divided by 2. Mathematically, the point on "B" is (log "A" + log "C") ÷ 2, but since "B" is two cycle, this multiplies the result by 2, giving on "B" the result which is log "A" + log "C".

Slide rule nomograph simplifies calculations for untrained operating personnel



FROM THE VIEWPOINT OF THE EDITORS—

S. D. KIRKPATRICK, Editor • JAMES A. LEE, Managing Editor • THEODORE R. OLIVE, Associate Editor • HENRY M. BATTERS, Market Editor
J. R. CALLAHAM, Assistant Editor • L. B. POPE, Assistant Editor • R. S. McBRIDE, Consulting Editor

POSTWAR MODELS *vs.* PILOT PLANTS

UNDER certain fairly restrictive limitations, any manufacturer is now permitted by WPB to produce a "postwar model" of whatever he intends to make when peace-time production can be resumed. The restriction we hear most about is one to prevent the diversion of essential manpower but an existing order also puts a practical ban on any new building or plant construction. The latter is not a serious handicap in the automobile and most metal-working industries but it is proving an almost insurmountable obstacle in the path of certain chemical and process industries.

Suppose your postwar planning calls for the production of a new plastic. You have completed the small-scale research and have been able to turn out a few pounds of the product in laboratory glassware. Does such a sample constitute a "postwar model"? Actually, of course, it is not at all comparable with the hand-made automobile, electrical refrigerator or washing machine which the WPB order seems to have been designed to cover. In most chemical industries the pilot plant comes the nearest to being the "model" for postwar production. Most processes must be developed at least that far before one can know whether or not large-scale manufacture is technically feasible and economically practicable. Hence if the process industries are to receive equitable treatment by WPB and not be further handicapped in their reconversion programs, they should be permitted to build pilot plants large enough to demonstrate their manufacturing procedures but not of sufficient size to produce on a commercial scale. This means that the WPB order will have to be modified or its official interpretation broadened to permit granting of the priorities required to complete such small-scale construction. It seems a simple and logical move but because of the highly charged political atmosphere surrounding the entire reconversion program, we are sure that it is going to require a lot of education and persuasion on the part of spokesmen for chemical industry, both in and out of WPB.

"THE TIME IS NOW"

WILLARD Dow had a point in his recent letter to Donald Nelson which seems to have been misunderstood by those who are opposing any resumption of civilian production. In an open letter dated August 13 the manufacturer asked the WPB chairman to remove the remaining controls on magnesium in order that the industry might begin to develop the competitive market that must eventually absorb our present surplus and provide postwar employment. No question of war requirements is involved because the government stockpile is admittedly large enough to take care of almost any conceivable needs. But Dr. Dow's critics implied that he was merely trying to get a head start on his competition and to recapture his company's prewar position in the magnesium industry. Actually something much more fundamental was involved.

Magnesium, in its present proportions, is one of our great war-born, or war-proven, industries. The nation looks to it as a postwar promise of new things to come. Those of us in the process industries know, however, that these new applications cannot possibly be developed without months of research and experimentation. Much of this can be done only in the plants of the users, working with their engineers and designers on their peculiar problems of application and fabrication. Then come long periods of trial and testing, followed finally by the approval or disapproval of the ultimate consumer. All this takes time. It is a slow process and the sooner it is started and the more thorough the testing, the surer we can be about the future of this industry and the jobs that will depend upon it.

By this time we should all know that mere capacity to produce a hundred times our prewar consumption does not mean that we have created a magnesium industry of that proportion. Since the very beginning, the technique of application has always lagged behind production. No useful purpose can be served by continuing to pile up surplus stocks and at the same time insisting on keeping magnesium ingots under allocation. Ultimately the industry must be allowed to stand on its own feet. The man who has most reason to know says: "The time, I submit, is now!"

RECOGNITION AT LAST

RECENTLY the Iron and Steel Division of the WPB announced that the Inter-Agency Committee on Occupational Deferments had approved a quota of 500 key workers under 26 years of age who were sorely needed to maintain steel production. Other quotas previously announced covered the tree toppers in West coast lumber camps, certain deep-sea divers, skilled tire makers, operators for high explosives plants and similarly critical occupations. No public report has yet come from the important sub-committee that was charged with studying and recommending procedures for the deferment of scientific and technical personnel. Yet it is common knowledge that at long last there has been official recognition by the Selective Service system of the importance of these scientists and engineers in the war program.

The situation has greatly improved within the past few months. Some feel that this is merely because most of the men under 26 have already been inducted or that the present success of the war effort has greatly reduced the quotas sought by the local boards. To some extent, both have been factors but those who have been closest to the technical manpower problem also realize that there has been a decided change in attitude on the part of top officialdom in Washington. High-grade scientific and engineering personnel, in increasing numbers, have received stays of induction. More recently it has come to be known that the Armed Services, the commodity divisions of WPB, Petroleum Administration for War, OPRD, OSRD, War Food Administration and Maritime Commission have been authorized to endorse the deferment claims of technical personnel in war industries, always with the provision, however, that there are no comparable personnel now engaged on postwar projects who might be substituted for the registrants. Employers in war work wishing to claim deferment for technical employees under 26 who meet these requirements of essentiality must submit their cases on Form 42-a, refer them in the usual way to the claimant agency for which the work is being done. In the chemical process industries this is usually the appropriate commodity division of WPB, the Army, Navy or PAW. If and when that endorsement has been obtained, the case is submitted to the State Director and appropriate action will be taken. At least that seems to be the procedure and it is getting results.

A MATTER OF TIMING

Rubber Reserve, which since the inception of the government's synthetic-rubber program, has had actual charge of plant operations, is now faced with some difficult problems of control and correlation. One of the most serious of these is the further adjustment of butadiene supply. If the program is to be administered most economically, we must gradually transfer the responsibility for making this basic component of GR-S from the alcohol processors to the petroleum refiners. This should be done in the public interest because butadiene from petroleum is substantially cheaper. But hasty or ill-considered action could dangerously affect the war effort.

Butylenes and other petroleum hydrocarbons needed for butadiene are also the basis for aviation gasoline and are used for other war purposes. These needs will not end with the German collapse. Some of them will continue at high levels until the last of the Pacific air fighting is finished. Thus it will require highly skilled technical guidance on the part of Rubber Reserve to make sure that the change-over occurs at exactly the right time. If it is made too soon, it will hamper the air program. If made too late it delays the lowering of costs that are essential if synthetic rubber is to stand on its own feet.

CONSERVE CHROME

Elsewhere in this issue are many references to the valuable role that chromium and its alloys are playing and must continue to play in the battle against corrosion. Occasional reference is made to chrome plate as a protective coating for many surfaces. Yet just as we go to press there comes a bulletin from the Navy Bureau of Aeronautics and its Operating Committee on Aircraft Materials Conservation warning us that the immediate requirements for chromic acid and sodium dichromate are such as to make a supply of these basic chemicals extremely critical at this time. Furthermore, there is little hope for an immediate increase in their production and there are no large stockpiles to meet mounting demands. Fortunately, some alternative treatments are available for the aircraft industry and all who are concerned with this problem would benefit by securing from the Aircraft Production Board of WPB its Conservation Bulletin No. 16 that outlines these in some detail.

THE MIRAGE OF LOWER TAXES

From now until election time there will be much loose talk about lower taxes. Each of us by wishful thinking can see a beautiful mirage. Each of us will hopefully picture certain hypothetical cases where it would seem logical to expect relief, either individually or in a corporate sense, from the heavy tax burdens of wartime.

Postwar tax collections by Uncle Sam will not be as great as are current levies. That is both politically and socially necessary. Postwar industry will not be able to pay Uncle Sam between $40 and $50 billion per year.

But the more conservative students of the tax problem, such as the Research Committee of the Committee for Economic Development, believe that $20 billion must be collected annually by the Federal Government in early postwar years to meet the costs of the readjustment period. Such a levy, which is more than twice that of 1939, cannot be achieved unless high rates are imposed on the then lower taxable incomes.

Regardless of the occupant of the White House during the next four years, our chemical engineering cost calculations must assume high taxes on both corporate and personal incomes. It is to be hoped, however, that the next Congress can work out some measure of relief to provide an urgently needed incentive for venture capital. Ultimately this must be followed by a conservative reduction in corporate taxes, thus providing relief from the double taxation of corporation income, now taxed both at the corporation and at the stockholder levels. But the important point now is that despite the campaign promises, no big cuts in these taxes can be expected for several years after the war. Our forecasts of postwar costs for the products of the chemical process industries must be calculated on that basis.

THE COST THAT COUNTS

Comparing the usefulness of two materials of construction requires more than a comparison of the primary cost of the parts or device itself. A good example of this was recently described as a "sore spot" in a certain dryer feed line handling a hard abrasive ore. The wear at an elbow in the spout caused steel castings to wear out in from two to four weeks. A high chromium iron casting for this elbow lasted from six to eight months, or eight to twelve times as long as ordinary steel.

Suppose this particular part cost five dollars in plain steel or ten to twenty dollars in alloy steel. But in estimating the relative merit of various materials of construction, it is the relative cost of the parts in place and ready to go, including the loss through shut-downs, which must be compared. Many times a more expensive part will prove much the more economical in place when comparison is made on the proper basis.

PROCESS EQUIPMENT NEWS

THEODORE R. OLIVE, Associate Editor

JET AGITATOR

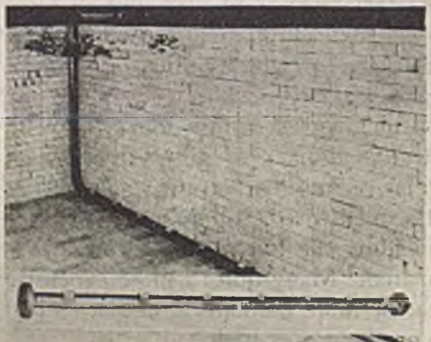
Developed for the heating of liquids in tanks, a new type steam-jet heater has been announced by the Heil Engineering Co., 12901 Elmwood Ave., Cleveland, Ohio. The jet is furnished in flanged sections which can be coupled together to provide any desired length and to extend the agitating and heating effect to any part of a tank. The jet can be adapted to square, rectangular or round tanks. The sections are usually made in lengths of about 10 ft. and are coupled with lead bolts, with blind flanges to close the open ends. Nozzles are spaced along the tank bottom on 15-in. centers unless otherwise specified. A series of such nozzles along the entire length of a long tank, such as a pickling tank, creates a rolling, agitating effect, causing the liquid to circulate above and around the parts immersed. The effect is increased, according to the manufacturer, by placing jets on either side or all around the bottom of the tank, with nozzles set at angles to produce the maximum rolling effect. The nozzle is constructed of graphitic carbon to resist the corrosive attack of most chemical solutions. Several modifications of this type jet are available. Jets are furnished with a steam flange and bolts to connect to a standard 6-in. O.D. flange reduced from a 1-in. steam supply line. Recommended steam pressure is 80 lb., although a maximum pressure of 125 lb. can be used.

NEW ROTAMETERS

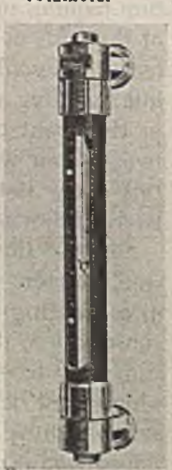
Several important features which are claimed to be exclusive are mentioned by the Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia 32, Pa., in announcing the company's new line of Series R-100 rotameters. These rotameters which are of the indicating area meter type, are available in sizes from ⅛ to 3 in., with both free and guided floats. The floats may be compensated for viscosity or density variations. The metering tubes are of extra-heavy-walled Pyrex glass, formed on mandrels, annealed, polariscope-inspected and check-gaged by precision ball testing.

Among the features may be mentioned spring-stop floats to prevent damage to the float by sudden surges of the liquid; high-pressure stuffing boxes permitting use of corrosive liquids under high operating pressures; a single external adjustment of the stuffing boxes by wrench, instead of by taking up successively a number of bolts or screws; a white-backed metering tube for easy reading; interchangeable calibration scales for quick and inexpensive change from one service to another; and special features in the design of the guide rod to insure accurate centering and uniform tension regardless of repeated stuffing box adjustment. The new line includes such types of rotameters as portable types, types for pulsating flows and opaque liquids, remote indicators, recorders, integrators, automatic controllers and automatic proportioners.

Jet agitator for acid tanks



New Type R-100 rotameter



FILTER UNIT

Development of a line of factory-assembled vacuum filter units has been announced by the Eimco Corp., Salt Lake City 8, Utah. The feature of this equipment is that it is completely assembled during manufacture, mounted on a steel base, and provided with all necessary pipe and fittings in place, as well as with electric wiring and the starter panel connection. Hence the filter is ready to go to work immediately upon arrival at the point of use. It is claimed that these self-contained units, such as the 4x4 ft. unit shown in the accompanying view, are designed to withstand severe corrosive properties of materials filtered; and that they are compact but with all parts readily accessible. The equipment shown includes the filter, vacuum pump, weak liquor pump, strong liquor pump, blower, agitator, cleaners, mufflers, variable speed drive, receivers and control panel. Specific details, however, are of course varied to meet the requirements of particular installations.

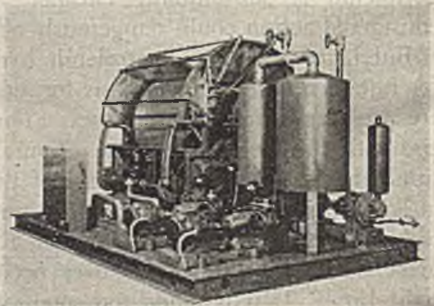
LARGE DIESEL

What is believed to be the largest single-acting diesel engine so far built in the United States, a 6,000-hp. design, has recently been tested successfully by Nordberg Mfg. Co., Milwaukee 7, Wis. Although it was built for ship propulsion, the manufacturer states that the same design is equally applicable for stationary service. The engine will be available in sizes for stationary applications from 3,000 to 6,000 kw. in 6- to 12-cylinder models. The engine is of the two-cycle single-acting, crosshead type, having 29x 40-in. cylinders.

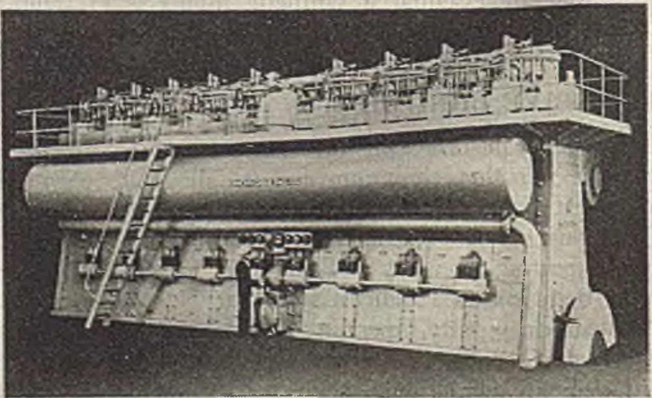
In general the design follows the lines of other two-cycle diesels built in recent years by this company, except in the camshaft drive and reversing mechanism which have been located overhead because of the much greater physical dimensions of the engine. Simplicity of design, rugged construction, streamlined appearance and accessibility of all working parts are important characteristics. Large oil-tight, light-weight covers which are easily han-

(*Continued on page 149*)

Factory-assembled filter unit



New 6,000-hp. two-cycle diesel engine



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CONTINUOUS PROCESSES

INCLUDE

STRAIGHT LINE FLOW Valve Advantages

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVES

Streamlined flow of steam, air, oil, etc., around the inner valve is an immediate solution to the important need of dependable control under varying loads.

Continuous processes can be dependably protected against slow downs, failures, and maintenance ordinarily due to valve inefficiencies. The STREAMLINED "1000" Valve with ample capacity, tight closing characteristics, close delivery pressure control, and with a wide range of adjustment makes possible speedier production, smooth operation and no spoilage.

You get straight line flow which eliminates turbulence so that at all times you are easily able to meet peak demand and yet hold the reduced pressure constant at the same time. For the complete facts write for Bulletin "1000."

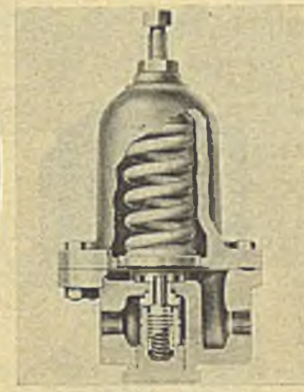
Left — Type 1000-HP normal size diaphragm. Made for delivery pressures over 30 lbs.

Right — Type 1000-LP has large diaphragm. Made for delivery pressures under 30 lbs.

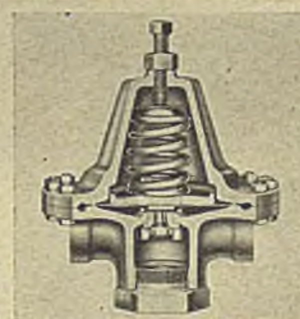
CASH STANDARD CONTROLS.. VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

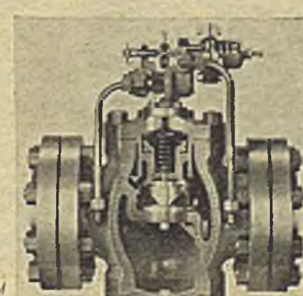
OTHER VALVES *from the* CASH STANDARD LINE



High Pressure Reducing Valve Type H-P; extra heavy for use with initial pressures up to 5000 lbs.; and for reduced pressures up to 650 lbs. Good for most fluids. Sizes: 3/8" to 2"; bronze body; nitralloy trim. Get Bulletin 931.



Type 8871 Pressure Regulator for dirty liquids (like Bunker C fuel oil). Inner valve is bolted to diaphragm for positive movement. Sizes 1/2" to 10". Bodies; iron, bronze, or steel. Seat ring and inner valve; stainless steel. Bulletin 972.



Cash Standard Type 10 Pressure Regulating Valve, pilot operated. (Pilot operating fluid discharges to outlet pipe; not wasted). Sizes: 2" to 12". Highest pressures; inlet 600 lbs.; reduced 250 lbs. Iron, bronze, or steel bodies; standard trims. For water, air, non-corrosive gases and oils. Get interesting Bulletin 966.

A
Chem & Met
FLOW
SHEET

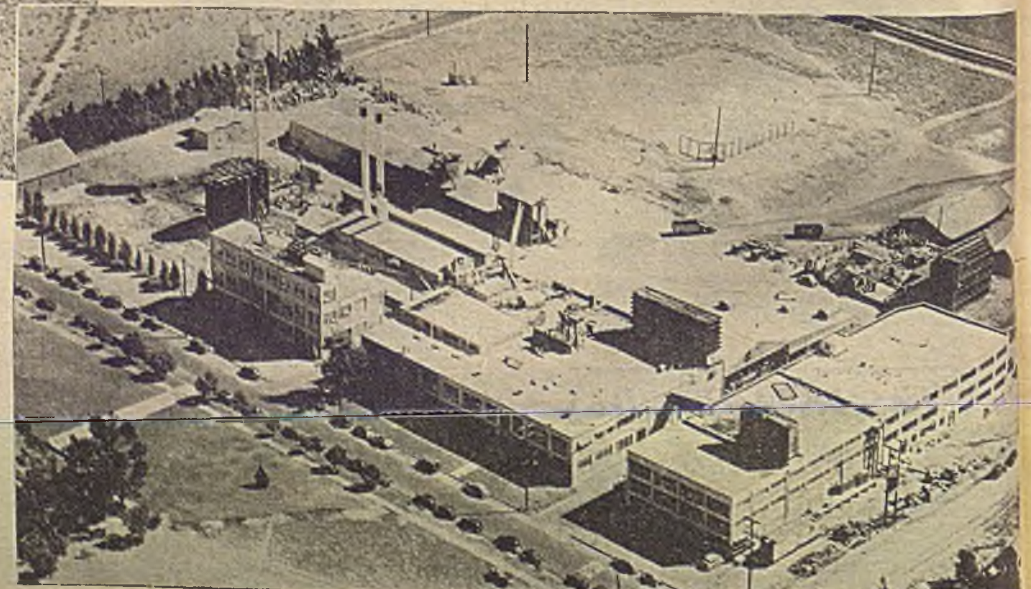
Orange Products

UTILIZATION of surplus fruit in the orange industry has created an interesting array of products with expanding commercial uses, possibly of great importance in the future; products such as oil well drilling compounds, synthetic rubber antistick agents, and concentrates of vitamins found in citrus fruits. Continued research portends further interesting developments in this branch of the field of chemurgy.

Processing has greatly increased in volume in the last few years due to the demands for concentrated fruit juices. The former yearly average of 50,000 tons of fruit processed has increased to 100,000. This has required expansion of plant facilities at Exchange Orange Products Co., Ontario, Calif., affiliate of the California Fruit Growers Exchange. The fruit is first washed and then reamed or pressed to yield juice and pulp. Part of the latter is subjected to steam distillation for recovery of orange oil. Formerly a waste product, the pulp remaining after juice, oil and pectin are removed is shredded and passed through a gas-fired rotary kiln. Fine particles are collected by means of a cyclone and bagged as such, or portions may be mixed with the coarser dried pulp. The coarse material passes through storage bins and weighing hoppers for bagging as feeds.

In order to obtain pectin the pulp is treated with a solution of hydrochloric acid. The mass is conveyed to a hydraulic press from which the fiber residue goes to the gas-fired rotary dryer and later is bagged as fine or coarse orange pulp for feed. The liquid from the press is passed through a filter press. The filtrate is concentrated and treated with alcohol to yield a jelly-like precipitate. After separation of the alcohol by means of a drain tank, the precipitate goes to a screw press in which the mass is broken up. The pieces are then hardened by action of isopropyl alcohol in a tank. These pieces go to a hydraulic press. The pressed cakes are ground in a cake grinder, dried in a tunnel dryer, again ground and finally bagged for shipment.

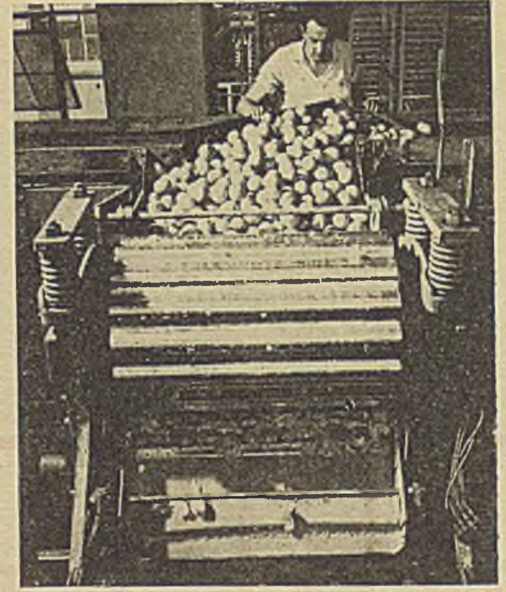
Treatment of the juice consists first in centrifuging for separation of the cold-pressed orange oil which is further clarified before barreling by means of separators. Orange juice passes to vacuum concentrators for preparation into a food product. Chemicals which today have no commercial usage are existent in citrus fruits. Science creates many changes however and possibly the processing of citrus products may lead rather than follow the citrus industry of the future.



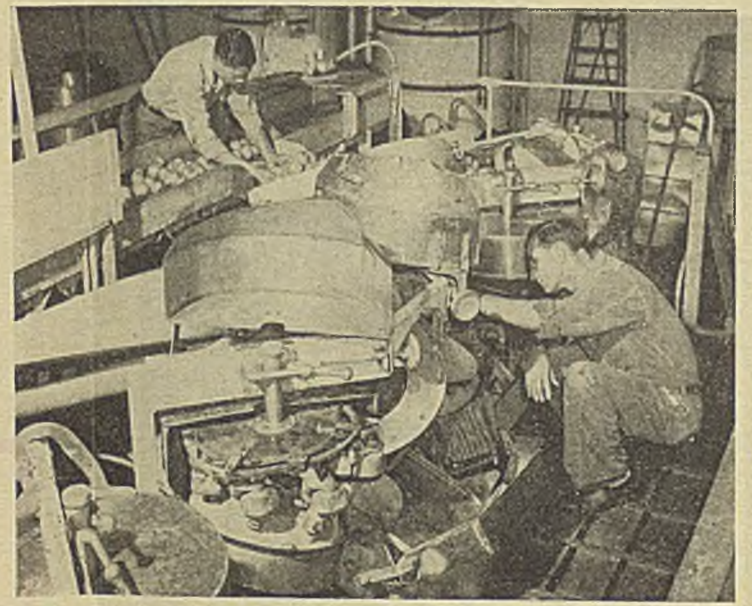
Oranges below fresh fruit standards are used in making pectin, oil and concentrates at the plant of Exchange Orange Products Co., Ontario, Calif. Processing of fruits has reached 100,000 tons a year due to demand for juices

CHEMICAL & METALLURGICAL ENGINEERING
September, 1944
PAGES 142 to 145

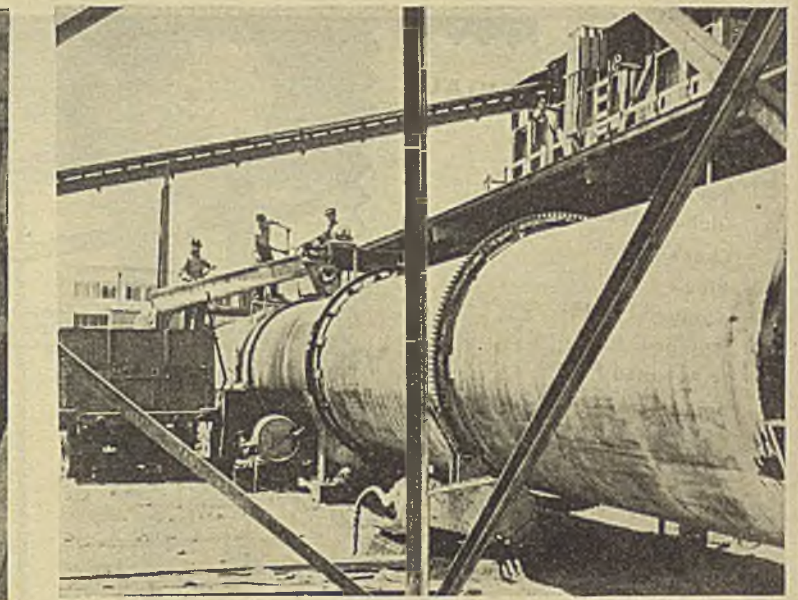
1 Surplus oranges delivered to the Ontario plant are inspected, soaked in a soapy solution, scrubbed and rinsed before processing.



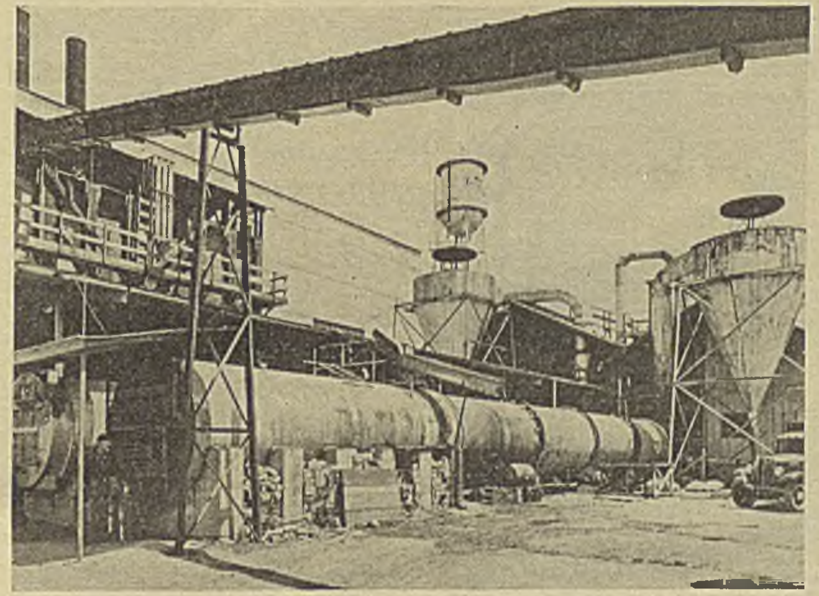
2 Fruit can be pressed between heavy corrugated rollers shown here



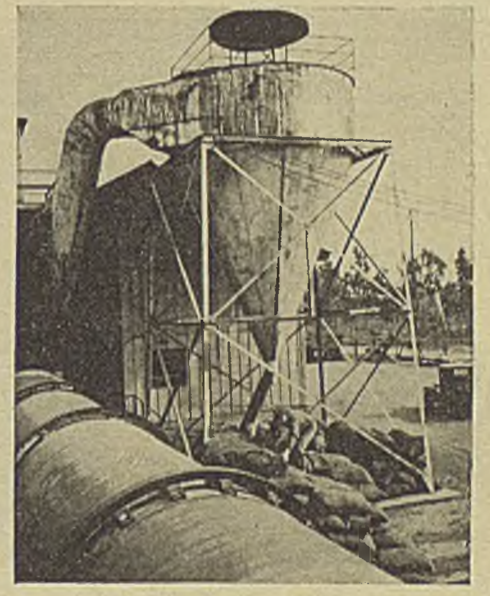
3 Reamers are also used to separate juice and pulp. Rubber cups press orange halves down over revolving reamers



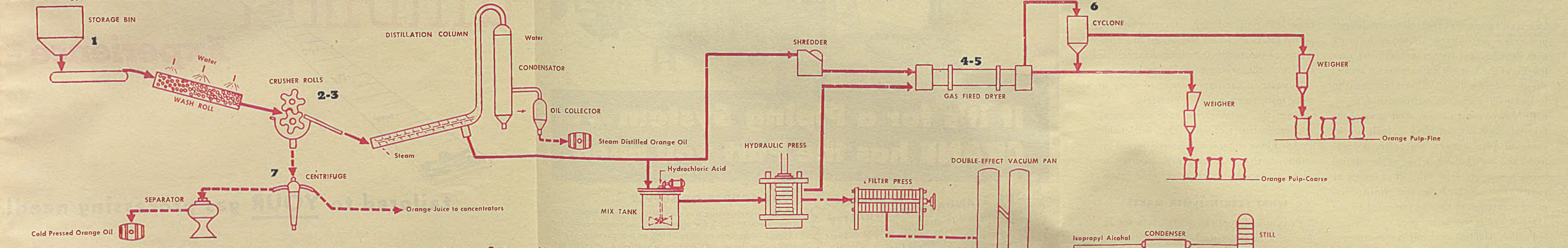
4 Halves are ground and the oil extracted. The pulp then goes to the pectin plant or to the dehydrator shown

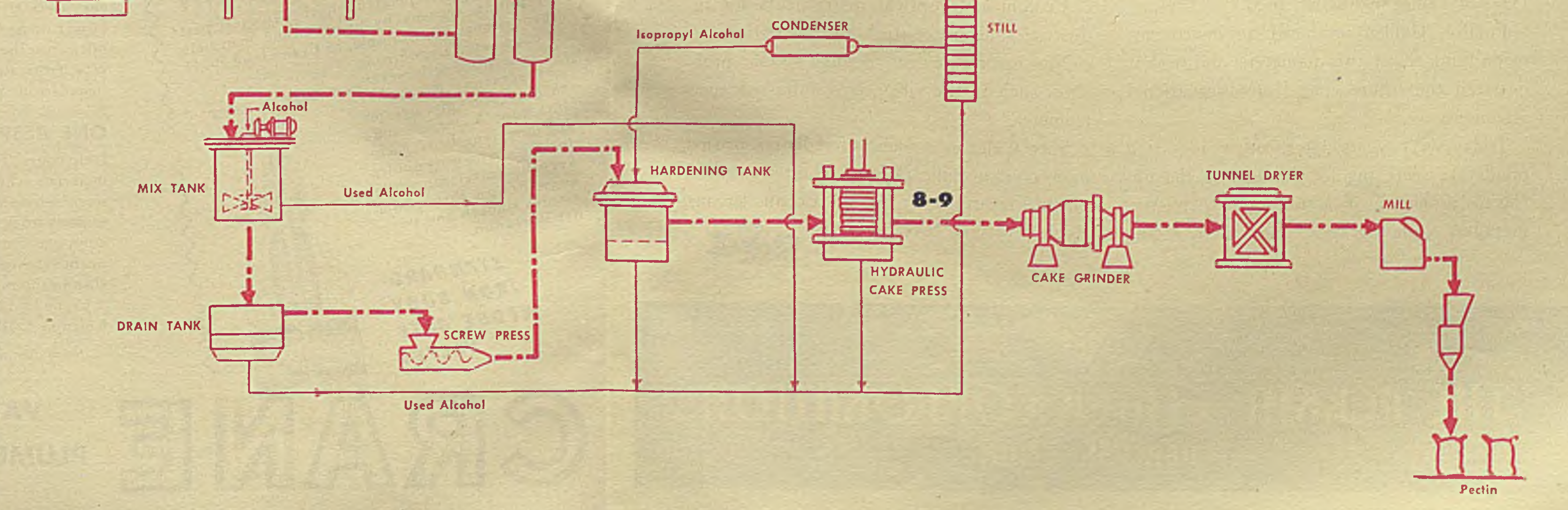


5 Gas-fired kilns 70 ft. long and 7 ft. in diameter rotate slowly at 5 r.p.m. About 12 min. are required for drying pulp



6 Cyclone dust collectors catch fine pulp which is later bagged for feed





7 Separating orange oil (2 lb. from a ton of fruit) and juice

8 Hydraulic press in the pectin plant

9 The material leaving the hydraulic press goes into a chute

GALILEO GALILEI

ASTRONOMY'S *poor vision was corrected by his* TELESCOPE

GALILEO's genius for rapid solution of difficult problems is perfectly exemplified by his work with the telescope. Within several hours after hearing of the first telescope, he had mastered the principles involved. Within several months, he had made a scientific instrument of it.

In May of 1609, the day after news of the first telescope reached him, he built a telescope of plano-convex and plano-concave lenses and later, having arrived at the relation between magnification and foci of lenses, he constructed another telescope which magnified eight times. This he presented to the Doge of Venice in August, 1609.

Finally, Galileo produced an instrument magnifying thirty-two diameters, and with it initiated the future course of observational astronomy.

Today, 335 years later, other inquiring minds are searching for answers to the unsolved problems of astronomy, chemistry, metallurgy, photography, and vision. Aiding these leaders in industry, education and the armed forces are lenses and prisms in instruments of constantly increasing accuracy. It has been the privilege of Perkin-Elmer to collaborate in the improvement of many of those instruments and their elements.

From this collaboration have come ideas and production techniques that will enable Perkin-Elmer to provide post-war optical instruments that will bring new accuracy to analysis, control, inspection and observation.

WHAT PERKIN-ELMER MAKES

Custom-built optical instruments for industrial analysis, control, and inspection.

New optical devices to solve specific problems, such as the all-purpose infra-red spectrometer.

Special elements such as fine lenses, prisms, flats, photographic objectives, interferometer plates, retardation plates, Cornu prisms, Rochon prisms, Nicol prisms.

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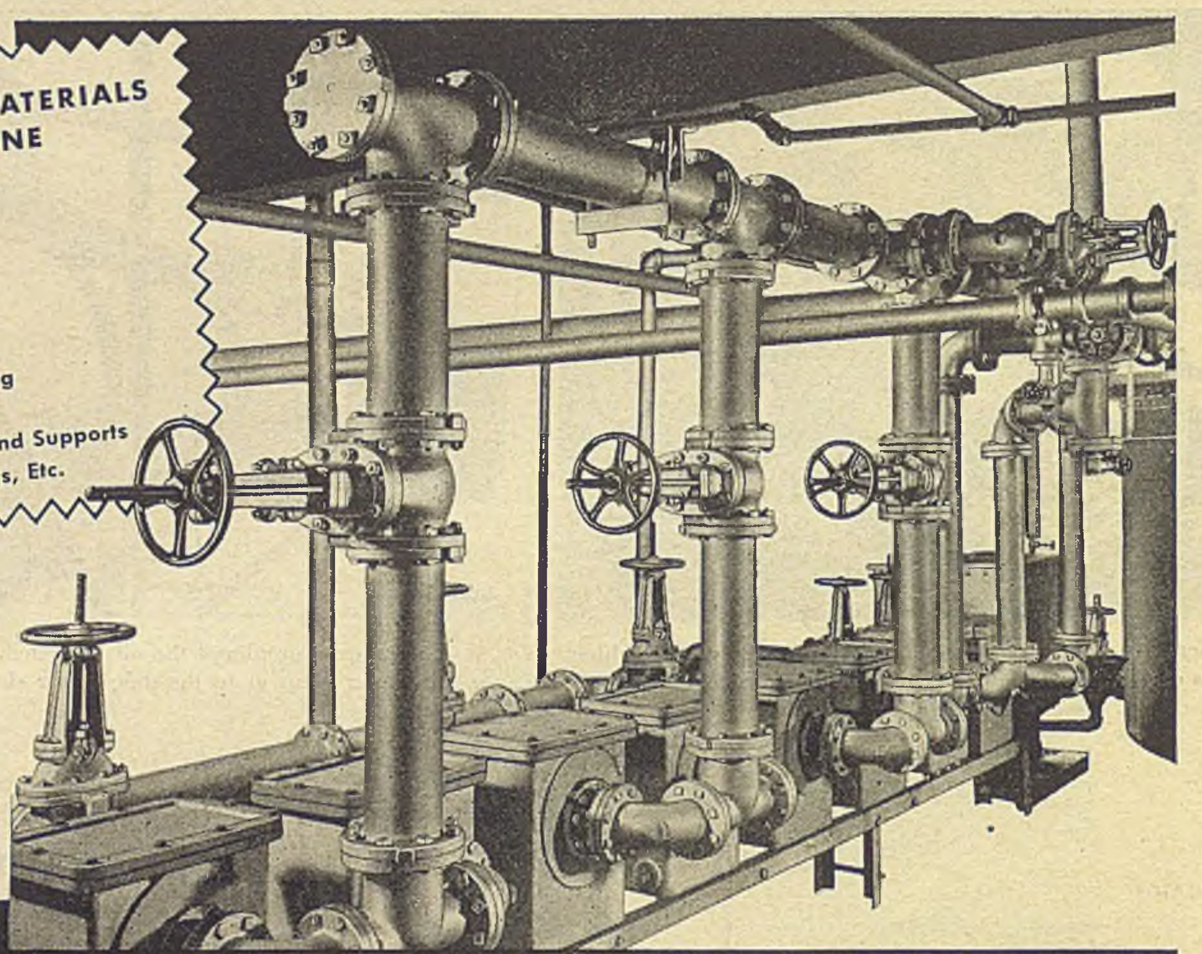
- Globe Valves
- Check Valves
- Pipe
- Flanged Fittings
- Flanges
- Fabricated Piping
- Bolts and Studs
- Pipe Hangers and Supports
- Screwed Fittings, Etc.



Installation in Chemical Processing Plant.

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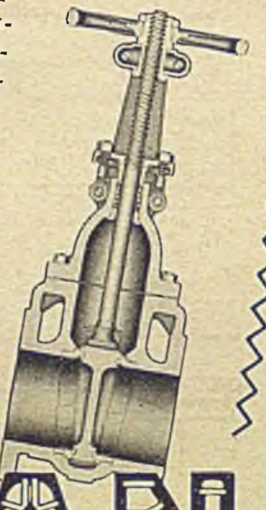
Insure equally dependable quality in every part of piping systems by using Crane materials throughout. For example, in Crane Iron Body Wedge Gate Valves: Strong body sections resist severest strains. Straight-through ports give stream-line flow. A deeper stuffing box lengthens packing life. Extra long guides keep disc travel true, while finest design throughout assures smooth and positive operation.



STANDARD IRON BODY WEDGE GATE VALVES

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From a single fitting to a complete system—Crane is your *one source of supply* for all piping equipment needs. For power or processing lines—high or low pressure—Crane offers you the world's greatest selection of valves, fittings, pipe, fabricated assemblies, and all accessory parts for any installation. You need merely name the service.

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Help yourself to better piping installations by starting with materials whose quality and craftsmanship are backed by *single responsibility.* Ordering, maintenance work, keeping of parts stocks—all such operations are simplified by Crane complete materials service. And you're sure of getting all the benefits of Crane Co.'s 89 years' experience and leadership in the piping equipment field.

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Originators of the Girbotol Process

On any gas processing problem, however difficult it may seem, we urge you to take advantage of Girdler's long and successful engineering and technical experience and unexcelled laboratory facilities. If you are concerned with the manufacture or purification of gaseous mixtures or liquid hydrocarbons – consult Girdler without delay.

The GIRDLER CORPORATION

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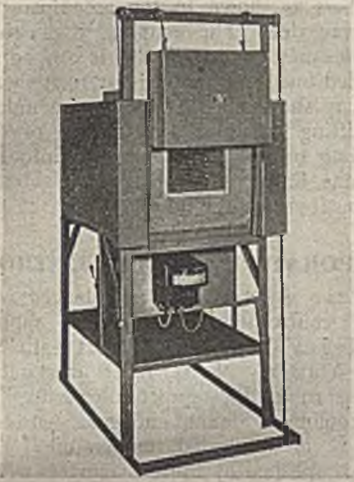


Series 16 electric furnace

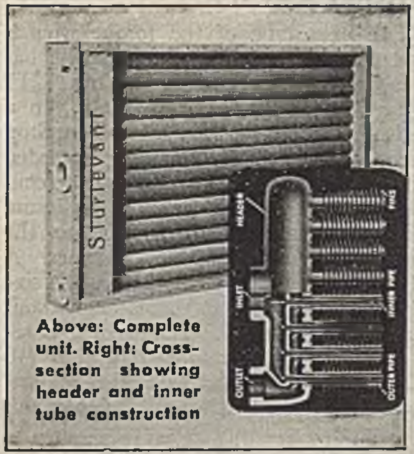
dled by one man are used to inclose the spaces between the A-frames on both sides of the engine. When these are removed they admit men into the crankcase from either side of the engine for inspection and maintenance. The overhead location of the camshaft greatly enhances accessibility to the crankcase. Fuel pumps, governor and control shaft are readily accessible from the engine platform. The fuel system, which is of the mechanical injection type, is designed for the application of this company's system of gas injection, if desired, to permit burning natural or manufactured gas with the thermal efficiency of the diesel cycle.

ELECTRIC FURNACE

An entire new series of floor-model electric furnaces, available in five basic designs, each of which is produced in five variations dealing particularly with the inside depth of the furnace, has been announced by K. H. Huppert Co., 6830 Cottage Grove Ave., Chicago 37, Ill. These furnaces are intended primarily for heat treatment of metals but are also suitable for other purposes. The furnace body is constructed of 14-ga. steel reinforced on all corners. The heating elements have totally inclosed contacts and connecting wiring is brought through the back of the furnace into a special compartment. This company's principle of "multi-insulation" is used on all furnaces of the line. All types can be operated on 220-volt, single- or three-phase lines. Standard equipment on all types includes the necessary controls, fuses and switch box.

GOGGLE LENS CLEANER

A system for the cleaning of goggle lenses recently announced by the Brite-Ize Co., 1218 Pratt Boulevard, Chicago 26, Ill., includes a special concentrated detergent for cleaning, and a system of dispensing. The detergent concentrate is supplied in hermetically sealed ampoules, each of which when mixed with distilled



Above: Complete unit. Right: Cross-section showing header and inner tube construction

New heavy duty steel heater

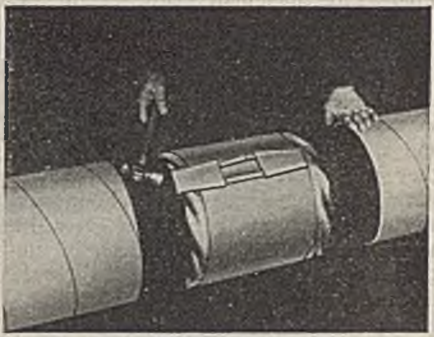
Goggle cleaning equipment

water, makes a full gallon of lens cleaner capable, according to the manufacturer, of cleaning 250 goggles every day for one month. The diluted solution can be sprayed on the lens by means of one of the company's pressure type dispensers shown in the accompanying illustration. The smaller one, having a capacity of ½ pint, and the larger, of 1 quart, are charged with air either with a small hand pump or from any standard 50-lb. air line. At a touch of the lever they release the solution as a fine mist spray. Since they are entirely self-contained they can be set on any shelf or attached to any pillar convenient to the point of work, thus saving time expended in going to washrooms to clean goggles with soap and water.

SIMPLIFIED COUPLER

To facilitate making the final field connections on prefabricated insulated pipe conduit of its manufacture, the Ric-wiL Co., 1572 Union Commerce Bldg., Cleveland, Ohio, has developed a new drive coupling which is said to eliminate the need for skilled workmen and materially to reduce installation time. The coupling is adaptable to either mechanical or welded closures, the operations in either case being much simpler than former methods.

This company's insulated conduit is shipped to the job site in 21-ft. sections, prefabricated with pipe or pipes, insulation and aligning pipe supports. The ends of the helical corrugated conduit are expanded smooth at the factory, removing corrugations for a distance of 3 in. The bare pipe within the conduit extends beyond the ends of the conduit for 3 in.



Simplified closure for prefabricated conduit

more. After the pipe has been coupled or welded and insulation applied over the exposed portions, the smoothed ends of the conduit are coated with a waterproof sealing cement. A heavy-gage split connector sleeve is then slipped over the opening. As in the accompanying illustration, clamps are driven on to wedge-shaped channels over the lapped joint, quickly making a strong, watertight mechanical coupling. When a welded closure is required, the cement is omitted, the ends of the sleeves are lap welded to the conduit after the clamps have been applied, and the clamps are then removed and the longitudinal seam is lap-welded. For extra strength the clamps may again be driven on to the channels after the weld is made. When the conduit coupling is completed, an asphalt blanket, applied with heat over the entire closure area, fuses with the factory-applied asphalt on the conduit cover proper, providing protection at all points.

HEAVY-DUTY HEATER

Heavy-duty heating applications in air conditioning, vapor absorption, drying and other processing work is the function of a new steel heater, announced by B. F. Sturtevant Co., Hyde Park, Boston, Mass. The new heater is said to possess the advantages from a maintenance and repair standpoint of the old pipe-coil heater but, at the same time, to give performance equal to modern heating surfaces which have increased heat capacity of about ten times, owing to the addition of fins to the heater pipes. These heaters are constructed of 1-in. standard steel pipe threaded into cast-iron headers. Inside these pipes are ⅜ in. steel pipes which carry the steam from the header, distributing it uniformly to all heater pipes, preventing air binding and providing non-freeze characteristics. Wound around the heater pipes are spiral fins of soft carbon steel strips, 9/32 in. wide and tapered from 0.035 in. thickness at the edge attached to the pipe to 0.012 in. at the outside edge. The tapered construction is said to provide greater heat transfer than with the usual fin of uniform thickness. Absence of crimping is said to effect marked reduction in resistance to air flow. After assembling, fins and pipe are passed through a metallic bath to assure a permanent bond between pipes and fins and to protect against corrosion.

Each finned pipe is anchored at one end only, permitting the pipes to expand and contract freely, independently of each

NEW PRODUCTS AND MATERIALS

JAMES A. LEE, Managing Editor

ALIPHATIC DERIVATIVES

ALIPHATIC compounds consisting of the even-numbered normal hydrocarbons from C_8 through C_{18} and the corresponding olefins, alcohols, ethers, mercaptans, thioethers, disulphides and sulphonic acids have been developed by the chemical division of the Connecticut Hard Rubber Co., New Haven. Most of these chemicals are available in commercial quantities and are supplied in various grades from technical to "fine chemical."

The saturated n-alkanes are suggested for use as organic intermediates, laboratory solvents and as standard hydrocarbons. The olefins, with the double bond at the first carbon, are interesting in organic synthesis, particularly as a starting material for dispersing agents, resins, oil additives, pharmaceuticals and insecticides. Certain branch chain olefins, isomeric with the n-compounds of this series are available for laboratory research. The alcohols are also suggested as intermediates for chemical synthesis and for use in cosmetic preparations.

The aliphatic ethers, according to the company, can be used as plasticizers, impregnating agents, solvents, heat transfer liquids, as well as in the cosmetic field. The high-purity aliphatic mercaptans present possibilities as polymerization conditioners, intermediates for synthesis, corrosion inhibitors, oil additives, insecticides, flotation agents and alarm odorants. The thioethers and disulphides are suggested for uses along the same lines while the aliphatic sulphonic acids, available only in experimental quantities, are of interest as hydrogen soaps and the salts as stabilizers, dispersing agents, wetting agents and oil additives. The corresponding sulphones are obtainable in limited amounts for experimental work.

CONTENTS

LATEX INSULATION

SYNTHETIC rubber of the standard GR-S composition does not ordinarily lend itself to the coating of wire and cable by the latex continuous dip method nor are its electrical and physical properties entirely satisfactory for use as insulation. Recognizing these limitations, the United States Rubber Co. initiated research several years ago which has resulted in a new synthetic rubber latex insulation called Nubun, which permits the design of new types of power, lighting and communication cables.

As announced in New York Aug. 3, by C. W. Higbee, manager of the Wire and Cable Department, the new insulation is produced by modifying the composition and process of polymerizing the basic buna S before it is applied in latex form. "The standard GR-S rubber found most advantageous for the greater part of the Government's program and for most military applications is based on a 75 percent butadiene and 25 percent styrene composition." Mr. Higbee then explained that "The modified polymer has a special styrene ratio and is prepared by a modified reaction technique which gives it improved processing and insulating properties." As will be noted from the following tabulation, the special synthetic rubber compound is low in specific conductive capacity, has good aging qualities because of the presence of special anti-oxidants, and since it can be applied by the latex process, the rubber particles are not distorted or broken down by milling.

Physical and Electric Characteristics of Nubun Latex

Physical tests	Before aging	After 96 hr. aging in oxygen bomb
Tensile strength, lb.........	2,500	2,000
Elongation, in................	2 to 13	2 to 11
Set, in......................	5/16	
Electrical tests		
Voltage breakdown after submersion in water at room temperature, volts per mil.	650	
Insulation resistance constant K after submersion in water at room temperature......	54,000	
Specific inductive capacity at 70 deg. C.		
After one day in water....	3.0	
After three days in water..	3.2	

COPPER COATING

TO BE USED in coating copper alloys, a process has been announced by the Enthone Co., New Haven, Conn. The Ebonol "C" process is said to produce a stable, adherent, nonreactive cupric oxide coating which gives high adhesion of lacquers, paints and enamels under severe weathering conditions. Its inert nature prevents reaction between it and the organic finish. The finish obtained is nap-like, presenting a relatively absorbent base to which the paint may be anchored. The process is suitable for treating alloys containing from 60 to 100 percent copper. The lower copper alloys are colored a mahogany brown and alloys containing more than 65 percent copper are blackened. The Ebonol "C" finish, therefore. is not appropriate as a base for clear lacquers or for one coating of white pigmented lacquer due to its dark color. The finish is applied by immersion of the work in a dilute solution of the salts operated near 210 deg. F. The treating time is approximately 10 min.

DEGREASER COMPOUND

DEVELOPMENT of an emulsifying degreaser, characterized by the fact that it gains in strength with dilution, has been announced by Gaybex Corp., Nutley, N. J. G-Bex 45-A has a fresh, clean odor and despite its detergent action, it will not corrode metals nor harm the skin. The alkaline factor of this compound is pH-7 (neutral) and its flash point 150 deg. F.

To be used for the cleaning, degreasing and dewaxing of machinery, motors, equipment, floors and parts which are being processed—prior to finishing or assembling, this product can be applied with a brush or a spray gun. It may also be used in standard emulsion degreasing tanks either cold or heated. When the dirt, oil and grease are thoroughly saturated they are removed by flushing or hosing with water. A trace of the residual compound minimizes rusting after the washing process.

SELF-SEALING PLASTIC

SHATTER-RESISTANT plastic which self-seals bullets and flak holes and makes possible the installation of pressure cabins where crews can function without oxygen masks, has been developed by E. I. du Pont de Nemours and Co., Wilmington, Del. The three-ply plastic, used in the B-29 Superfortress, is a "sandwich" of laminated lucite-butacite. Army and Navy tests showed that under some circumstances bullet holes close almost completely because of the rubber-like nature of the plastic.

PROTECTIVE CREAM

WATER-RESISTING hand protective cream for workers whose jobs bring them into contact with water-soluble cutting oils, dilute acids. alkalis and other water-chemical

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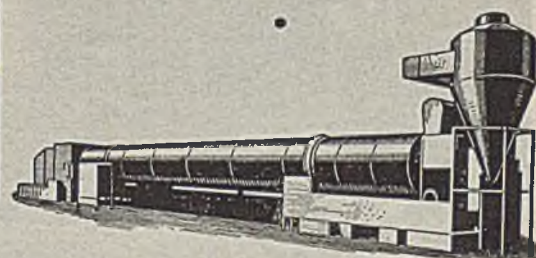
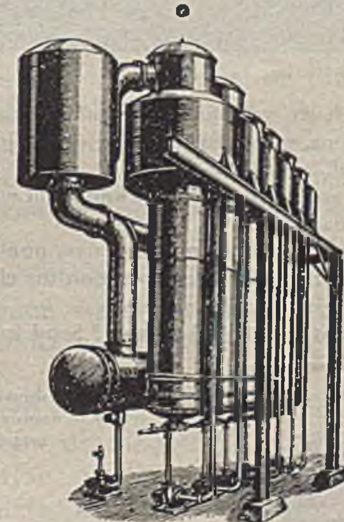
TANKS AND PRESSURE VESSELS

CONKEY VACUUM AND PRESSURE FILTERS



LOUISVILLE DRYERS, COOLERS, KILNS



CONKEY VACUUM EVAPORATORS

AMERICAN DRUM DRYERS AND FLAKERS

mixtures has been announced by the Finishes Division of E. I. du Pont de Nemours and Co., Wilmington, Del. Known as Pro-Tek No. 2 it is a companion to Pro-Tek and intended for operations where water is present and the standard water-soluble Pro-Tek is unsuitable. Pro-Tek No. 2 is applied to the hands and arms before starting work and forms a flexible, slightly greasy film which acts like an invisible glove. One application lasts from 3 to 4 hr. and may be removed by using an industrial hand cleaner or washing in hot water with a mild soap. It contains a high percentage of lanolin and is neutral in reaction and non-irritating.

SYNTHETIC RUBBER TACKIFIER

To be used in softening and tackifying synthetic rubbers, especially GR-S, Pentacizer 344 has been developed by the Heyden Chemical Corp., New York, N. Y. A brown, resinous, friable solid, the new product is soluble in ketones, aromatic hydrocarbons, vegetable and mineral oils, and synthetic rubbers. When up to 40 percent of Pentacizer 344 is employed, the tack will remain to a considerable extent after vulcanization. When less than 25 percent is used the uncured stock will possess ample tack but the cured rubber will not be sticky and will maintain a good nerve.

PLASTIC DYE

The development of Kriegr-O-Dip-V, a new addition to their line of plastic dyes, is announced by the Krieger Color and Chemical Co., Hollywood, Calif. The dye is for the purpose of coloring Vinylite plastic sheet stock by the dipping method. Absolute cleanliness of the plastic is essential before dipping it into the dye. The length of time for immersion depends on the condition of the plastic; five to ten seconds for pastel shades; 20 to 30 seconds for medium shades and 30 seconds to one minute for heavy shades. Kriegr-O-Dip-V is commercially available in four colors; yellow, orange, green and rose.

WETTING AGENT AND DETERGENT

Designed primarily for use in the textile trade as a powerful wetting agent and detergent, Triton N-100 developed by Rohm & Haas Co., Philadelphia, Pa., is now finding vital wartime uses as an industrial cleaner, in priming compounds, electroplating and pickling baths, in the manufacture of rubber life rafts and mine trap covers. N-100 is soluble in most organic compounds excepting aliphatic hydrocarbons. It is sold as a concentrated material, containing less than 0.5 percent water. It has a specific gravity approximately that of water and is an aryl alkyl polyether alcohol, soluble in all proportions in cold water but only slightly soluble in hot water. It is miscible with alcohol in all proportions and readily soluble in 50 percent glycerine.

SYNTHETIC CEMENTS

Generally speaking, synthetic cements will not satisfactorily bond to rubber. The B. F. Goodrich Co., Akron, Ohio, is at the present time developing new cements of this type. Cement A-75-B is tan color, GR-M synthetic base, for adhering neoprene to neoprene, fabric to neoprene, or fabric to fabric. It is an air drying cement with a strong bond. Cement A-68-B-A-53-B is air curing, 2-part, black cement of GR-M synthetic base, used for neoprene barrage balloons. It is useful for any neoprene to neoprene adhesion. It is a good leather adhesive and should have potential uses in a large number of fields, according to the company.

VULCANIZING CEMENT

When equal portions of C-80-S and C-81-S, produced by the B. F. Goodrich Co., Akron, Ohio, are mixed, they form a true air-curing or self-vulcanizing cement. They are mixed just prior to use as vulcanizing sets in immediately and renders the product unfit for use within about six hours after mixing. In cool weather the mixed cement requires about seven days to become fully vulcanized, but the process is greatly accelerated as temperature increases. At the temperature of boiling water, complete cure is obtained within 25 min. The mixed cement is of brushing consistency. B. F. Goodrich R-464-T and R-465-T are the same as C-80-S and C-81-S, except they are in less toxic petroleum solvent.

PLYWOOD TUBING

Plywood tubing fabricated from thin veneers and urea-formaldehyde resin by Plymold Corp., Lawrence, Mass., is known as Plytube. Because of the resin bonding agent, it is rendered waterproof, flameproof, splinterproof and rotproof. It has been used, according to the manufacturers, to convey chemicals, as well as gasoline and oil. This tubing can be threaded on the job with ordinary pipe dies. It may be cut with regular woodmarking machinery. The strength and weight characteristics of the tubing render it especially adapted to the replacement of war materials wherever weight is a factor. This is true in aircraft.

SYNTHETIC INSULATING RESINS

For 20 years the electrical industry has talked about the ideal impregnating material for insulation in coils and apparatus. It is quite evident that solvent type varnishes which are 50 percent solvent cannot give more than 50 percent fill. The two most desirable but elusive properties of such materials are (1) usability without a solvent and (2) a 100 percent filling of all space within the insulation. It is said that these properties have now been obtained in a new resin, Fosterite, developed by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. During the impregnation of a coil or device, Fosterite is in a liquid state but the solvent reacts with another resin dissolved in it, and the whole mass turns to a tough solid. It is solventless in that the whole of the liquid resin reacts under heat to form the infusible solid. There are no byproducts of the reaction that must escape as in most resin reactions. The additional problem of keeping the resin from running out while it is being polymerized to a solid has also been solved and there is now a satisfactory material and a satisfactory processing method. Actually, this resin transported by air.

is not just one resin, but a family which makes it possible to obtain a wide range of properties by suitable modifications.

This family of resins is giving some very interesting results in application, both for the filling and coating of insulation. The complete filling allows much higher voltage gradients to be used than for normal materials. On one small radio transformer, for example, Fosterite is said to provide 4 to 5 times the dielectric strength that was obtained with former materials. This permits a radical reduction in size and weight.

SYNTHETIC RUBBER ADHESIVES

The "100" series of Plastilock adhesives developed by B. F. Goodrich Co., Akron, Ohio, was designed primarily as an aromatic, oil-resistant adhesive for bonding cured or uncured Ameripol to itself, metal, wood, plastics, etc. It has also been found useful in bonding cured natural or other synthetic rubbers. This series does not require heat to establish a bond, although elevated temperatures cause the bond to form more quickly. With proper heat treatment, a non-thermoplastic bond is formed permitting service temperatures up to 200 deg. F.

The "500" Plastilock series was designed primarily as a non-thermoplastic, water and aromatic oil-resistant adhesive for bonding metals, wood, plastics, and ceramic materials to themselves or to each other. Heating alone will give some degree of adhesion. However, heat with pressure is recommended for best results. The purpose of pressure is to get a good surface contact.

THIALDINE

Thialdine, a heterocyclic intermediate containing both sulphur and nitrogen in the ring, has recently been developed by Carbide and Carbon Chemicals Corp., New York, N. Y., and is currently available in commercial quantities. It is a colorless, crystalline solid that is soluble in alcohol, ether, and hydrocarbons, but relatively insoluble in water. It exhibits reactions typical of secondary amines. Thialdine has a powerful odor resembling ammonium sulphide, but readily forms salts that are comparatively odorless. This amine has possible application as an intermediate for dyestuffs, insecticides, rubber chemicals, pharmaceuticals, and ore-flotation operations. Thialdine has interesting insecticidal properties even when used in aqueous solutions in concentrations as low as one part by weight to about 7,000 parts of water.

SYNTHETIC ADHESIVE

A low-temperature-curing adhesive of the phenol-formaldehyde type for bonding a wide variety of heavy lumber and timber constructions, is made by the Resinous Products & Chemical Co., Philadelphia, Pa. Known as Amberlite PR-75-B, this new resin is useful in the manufacture of oak ship keels and laminated structural members for columns, timbers, arches and trusses.

This new Amberlite is supplied as a viscous reddish-brown solution, which is infinitely dilutable with alcohol, and can also be diluted with water to any practical spreading consistency needed. Amberlite PR-75-B has a storage life of a year at room temperature. It is used with Catalyst P-79 which is added at the time of use to effect proper cure. The cured glue line exhibits a pH in the range 6–7 and meets the strength and durability requirements of Army-Navy Specification AN-NN-P-511b (Plywood, Aircraft, Flat Panel) as well as the strength, durability and acidity requirements of Bureau of Ships Specification 52-G-12 (Interim) (Glue, Phenol-Formaldehyde, Low Temperature Setting) and the new Army Air Force Specification 14124 (Glue; Low Temperature Setting).

Preparation of the glue is a relatively simple operation, requiring no special equipment nor unusual techniques. The resin solution is first weighed into a suitable container, the catalyst is then added, and the mixture is stirred until the catalyst is uniformly dispersed. Water at normal room temperature is added to the mixture, and after brief stirring the glue is ready for use.

GENERAL PURPOSE PHENOLIC

A REFORMATION of its general purpose material, brought about through the use of a newly developed phenolic resin, has been effected by Durez Plastics and Chemicals Inc., North Tonawanda, N. Y. 791 Black General Purpose Durez has long flow properties, and yet a fast cure, making it widely adaptable, especially in drilling and tapping.

Specifications

Powder properties	
Bulk factor	2.7
Apparent density	50–54
Screening USS mesh	16
Form of material	Granular
Pourability	13
Preforming	Good
Plasticity	6–14
Recommended mold temperature deg. F	280–360
Recommended mold pressure PSI	2000–6000
Mechanical properties	
Specific gravity	1.32–1.34
Molding shrinkage in/in	.006–.009
Water absorption, %	0.7
Flexural strength PSI	9000–11,000
Impact strength:	
Energy to break FP	.15–.18
Per in. of notch FP	.30–.36
Tensile strength PSI	7000–8000
Compressive strength PSI	25,000
Mod. of elasticity $\times 10^6$	1
Heat resistance deg. F.	
Hot oil 1 hr	340
Electrical properties	
Dielectric strength V/M-S/T R.T.	300–400
Dielectric fatigue V/M-S/S	250–300
Vol. resistance meg. cm	2×10^5
Insulation resistance meg. R.T.	3×10^3
Power factor R.T. 1000 KC	.05
Dielectric constant R.T. 1000 KC	5–6

MOLDING COMPOUND

A SERIES of new molding compounds derived from farm waste, called Noreplast, has been developed in the U. S. Dept. of Agriculture's Northern Regional Research Laboratory, Peoria, Ill. Most significant is the fact that Noreplase can be made with one-half the phenol-formaldehyde resin commonly required in the manufacture of this type of plastic. All formulas contain 50 percent or more ground agricultural residues, such as wheat straw, flax shives, cornstalks, peanut shells, and some are mixtures of these. The formulas differ specially in the amount of phenol-formaldehyde resin, either liquid or dry form, and in the percent of a speical plasticizer designed specifically to produce rapid flow during the molding operation. The percent of phenolic resin varies from 47 to 25 and the plasticizer from zero to 15 percent.

Any of these Noroplast formulas will mold in the regular commercial molding cycle and will produce articles having strength and finish characteristics approximately equal to general purpose phenolic resins containing approximately 50 percent phenol-formaldehyde and 50 percent wood flour.

To prepare Noreplast, finely-ground agricultural residue is mixed with the dry or liquid phenolic resin, the powdered plasticizer, catalyst, lubricant, and coloring agents in a dough mixer or other machine capable of producing a uniform mixture. The mixture is then rolled between heated differential rolls to obtain the desired characteristics of density, flow and setting time. The rolled sheets are then ground and screened to produce the molding compound ready for use. In experimental molding tests to ascertain the molding speed of the new plastic, it took about 2½ min. to mold a pencil tray, pin tray or a cup; about 23 sec. for a bottle cap, 2⅓ min. for a safety razor and 3 to 4 min. for the distributor head for an automobile.

The natural color of the plastic ranges from light brown to black, but products ranging from ivory or very light tan through light blues, greens, reds, browns, blacks or mixtures of these colors can be made by the use of appropriate dyes and pigments. Flax shives, wheat straw cornstalks, tobacco stalks, tobacco stems, peanut shells and soybean hulls are the agricultural residues which have been compounded and examined. The particular residue to be used depends upon which one is the most economically available to the producer.

HOT FORMING MICARTA

Laminated phenolic was for many years believed to be virtually inert at temperatures below decomposition. Recently Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has developed a hot forming laminated plastic which when heated rapidly to a temperature of about 275 deg. F. passes through a stage of considerable flexibility and when cooled to ordinary temperatures recovers its average physical properties. This hot forming material is known as Micarta 444. It has a tensile strength of 13,000 psi., a flexural strength of 19,000 psi. and a compressive strength of 30,000 psi. It has a density of about one-half that of aluminum, and a thermal conductivity of 6x10^{-4}. Unlike most of the thermoplastics, it does not become as brittle as glass at temperatures below zero. It maintains 85 percent of its impact strength and gains 25 percent in ultimate strength at −4 deg. F. It does not wilt at elevated temperatures, but maintains 60 percent of its tensile and gains 50 percent in impact at 170 deg. F. which is about the softening point of the average thermosplastic.

Drawing and shaping of this new plastic without a draw ring is possible, indicating its formability. A mold for this type of work may be set for a draw of 10 percent in either grain direction of the cloth and as much as 40 percent on the diagonal. The inside radius of a bend may be as little as 1/32 in. for 1/32-in. thickness or 3/32 in. for 1/16-in. thickness. The clearance between the sides of the pressing block, and the sides of the forming block should be 0.010 in. greater than the maximum thickness of the Micarta. Both blocks are greased before using, unless hot oil has been used as the source of heat.

Unlike the thermoplastics, it is highly significant that after cooling to room temperature this hot formed plastic retains the strength characteristics of the flat laminate. Furthermore, the general appearance of the material does not change.

SEALING COMPOUND

After several months of laboratory research and development work, Presstite Engineering Co., St. Louis, Mo., announces the production of sealing compound known as Galco. This material is a thiokol compound of the latex type, designed for spray, brush, or slush application. It has a low diffusion rate, low solubility in aromatic fuel and water, and very high adhesion to aluminum, steel, wood and other surfaces. Galco will maintain a tight seal at high and low temperatures, it is claimed.

RESIN

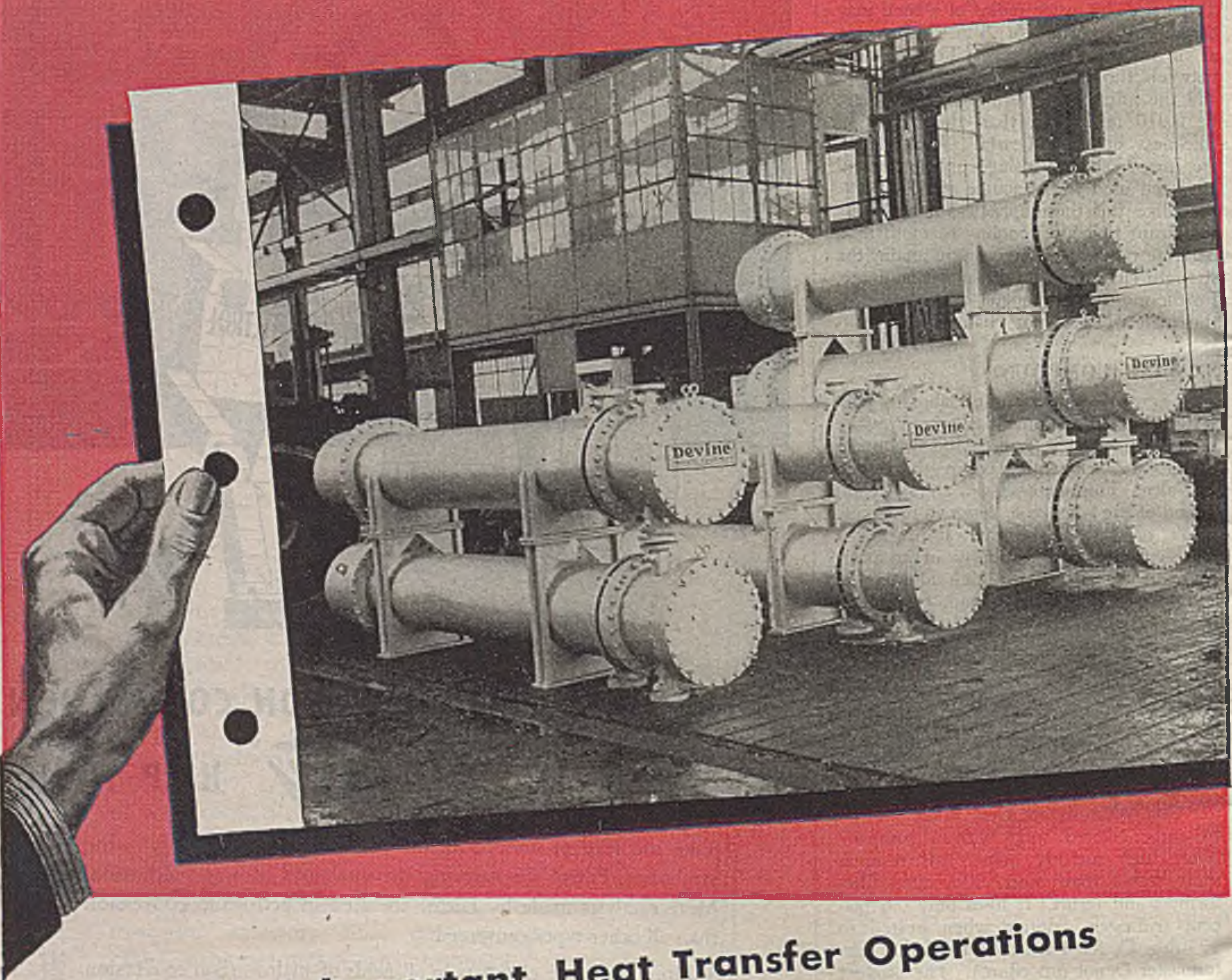
Used in the formulation of flameproof and waterproof coatings for textiles and flameproof paints and adhesives, Clorafin 70 has been developed by Hercules Powder Co., Wilmington, Del. A light-yellow to amber-colored solid with a comparatively high melting point, this resin is more stable than most chlorinated film-formers and resins. It loses only 0.6 percent hydrogen chloride when heated to 175 deg. C. for 4 hr. (Jeffersonville Quartermaster Depot procedure). The product is soluble in aromatic hydrocarbons, chlorinated hydrocarbons, esters and ketones and terpene solvents, and is insoluble in alcohols, aliphatic hydrocarbons and ethers. Clorafin 70 is compatible with all types of plasticizers with the exception of those made of mineral oil, with all types of resins and chlorinated products and with many waxes. It shows limited compatibility with high polymers such as cellulose derivatives, vinyl compounds and synthetic rubbers.

Specific Properties

Chlorine content, %	69–72
Color,[1]	Yellow to amber
Specific gravity	1.60 to 1.65
Stability,[2]	Approx. 0.6
Iron content, ppm.	10–20
Physical form	Pulverized
Softening point, deg. 2.[3]	90–100

[1] The color is based on the solid material. When pulverized it has a cream color. [2] Max. percent HC1 liberated. Determined by measuring the percent of HC1 freed on bubbling air through a 20-g. sample contained in a 22-mm. by 175-mm. test tube while being heated for 4 hr. at 175 deg. C. in conformity with the method of the Jeffersonville Quartermaster Depot. [3] Ball and ring method, deg. C.

Devine
HEAT EXCHANGERS



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Thoroughly experienced in the problems of heat transfer in the chemical industry, Devine Engineers are prepared to design units specifically engineered for any particular heat-exchanging operation. Built in an up-to-date plant by expert workmen with every modern facility at their disposal, Devine Heat Exchangers achieve an unusually high degree of efficiency and mechanical simplicity. Low initial investment and minimum maintenance costs are characteristic of Devine Equipment. If you have a heat transfer problem, Devine Engineers will help you solve it.

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JOINT LUNCHEON WILL OPEN CHICAGO CHEMICAL SHOW

THE Third National Chemical Exposition which will be held in the Coliseum, Chicago, Nov. 15-19, will be opened with a joint luncheon at noon on Nov. 15. The luncheon will be held at the Palmer House and will be a joint gathering of The Chicago Chamber of Commerce and the Chicago Section of the American Chemical Society. Three prominent directors of research from the Chicago area will talk on current research achievements.

The Industrial Chemical Conference will be devoted to a discussion of the manifold research contributions by chemists and chemical engineers. On the evening of Nov. 15, metals will be discussed with P. V. Faragher, Aluminum Co. of America talking about aluminum; L. B. Grant, Dow Chemical Co., about magnesium; and John Mitchell, Carnegie Illinois Steel Co., about steel and its alloys. On the next afternoon, pharmaceuticals will be the main topic of discussion with C. R. Addinall, Merck & Co., presenting a paper on the synthesis and production of vitamins. Other speakers will tell of the development of penicillin and sulfa-drugs.

The evening program for Nov. 16 will be given over to addresses on the role of the chemical engineer in industry highlighted by a talk on the work of the chemical engineer in petroleum refining by George Granger Brown, president of the American Institute of Chemical Engineers and on chemical engineering in the synthetic rubber industry by a speaker not yet selected. The dinner meeting on Nov. 17 will be the occasion of the November meeting of the Chicago Section of the American Chemical Society and the principal speaker will be C. F. Kettering, General Motors Corp.

On Saturday morning high school students and their teachers are invited to a session at which a talk will be given defining the work of the chemist and the chemical engineer. Later they will be taken on a personally conducted tour of the Exposition.

PORTABLE PLANT FOR CARBON DIOXIDE AND HYDROGEN

A PORTABLE hydrogen-carbon dioxide generating plant, mounted on a 16-ton Army trailer, has passed acceptance tests and will soon be exported to battle areas. It was designed last December for the U. S. Engineers Corps by the Gas Processes Division of The Girdler Corp., Louisville. Two of the twenty-seven units in production will be kept in this country for training purposes.

This mobile plant has all the component controls and essential operating features to be found in permanent installations, despite the limitations on weight and dimensions. Each trailer carries the following equipment: three heaters, fired with oil; a high temperature catalytic conversion chamber in which hydrogen and carbon dioxide are formed by reaction of water and alcohol; four pumps; three air blower fans; and a high pressure compressor—all powered by a 50-hp. gasoline engine by a compact system of belt drives.

Completed plants, mounted on 12-wheel trailers, are approximately 23 ft. long, 8½ ft. wide, and 11 ft. high and weigh about 36,000 lb. They will be employed to generate hydrogen for barrage balloons, used to discourage low-level bombing attacks. The carbon dioxide produced, compressed into cylinders at about 1,000 lb. pressure, will be available for fire fighting, medicinal purposes, and for making carbonated water or beverages.

PLASTICS SOCIETY WILL MEET IN NOVEMBER

THE annual fall meeting of The Society of the Plastics Industry will be held Nov. 13-14 at the Waldorf-Astoria Hotel, New York. As has been the case with all national meetings of the Society since the war, the major objective of the gathering is to promote the interchange of information among industry members and others interested in war and civilian uses of plastics.

Many new plastic materials and manufacturing technique have been developed to meet war-time demands and these will be discussed in papers delivered before the meeting by outstanding authorities. The speaking programs and other arrangements are being handled by a committee headed by C. S. Shoemaker, Dow Chemical Co. Truman Handy, Celanese-Celluloid Corp., is arranging the various group meetings which incluide injection molders, machinery manufacturers, button manufacturers, merchandising, fabricators, extruders and compression molders.

One of the features of the conference is to be a large exhibit which will include hundreds of plastics, items which have contributed toward the superiority of allied arms and equipment. Manufacturers will find special interest in that section of the exhibit which is to provide a view of plastics in the postwar period.

FERRO ENAMEL WILL BUILD PLANT ON WEST COAST

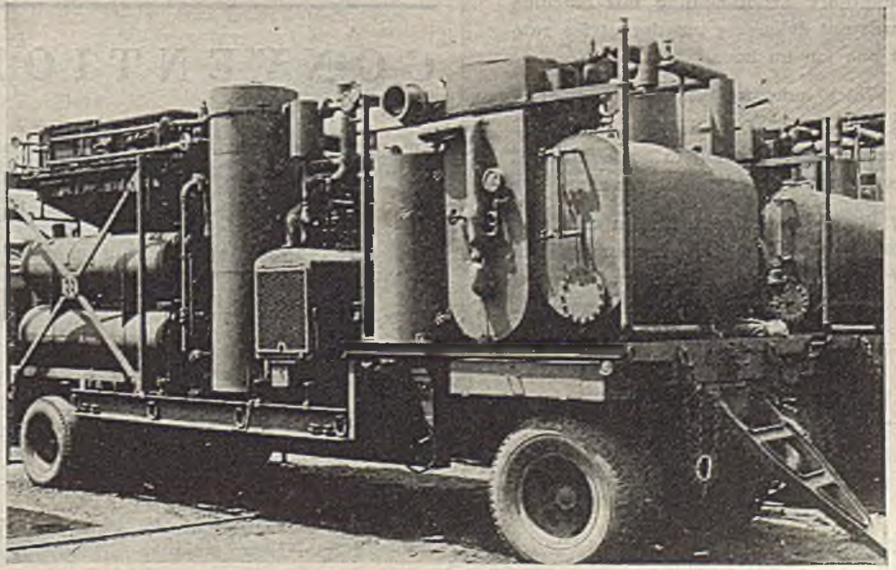
PLANS for a new manufacturing plant to be located in the Los Angeles area were announced last month by Robert A. Weaver, president of Ferro Enamel Corp. The new plant will produce enamel frit and synthetic-enamel industrial paints. In addition warehouse facilities will be provided for all other products made by the company in its other plants, for distribution throughout the western states and for export. John A. Rumer, who has been representing the company on the West Coast, is in charge of the new development.

For the past two years, the company has operated a small plant at Modesto, Calif., to provide vital war materials for the Chemical Warfare Service but no decision has been reached regarding postwar operation of this plant.

STANDARD CHEMICAL WILL REBUILD ACID PLANT

LAST spring the sulphuric acid plant of the Standard Chemical Co., Inc., of Troy, Ala., was largely destroyed by a tornado. Plans have now been made for rebuilding the plant. Andrew M. Fairlie, consulting chemical engineer of Atlanta, Ga., is in charge of the design. Mills-Packard water-cooled chambers embodying the latest patented features and capable of operating at from 2.5 to 3 cu. ft. of chamber space per lb. of sulphur burned per day, will be one of the main features of the new plant.

Compact new mobile hydrogen-carbon dioxide generating plant



CHARCOAL-IRON PLANT FOR TEXAS

A phosphorus blast furnace and an old wood chemical plant from Michigan are being moved to Rusk, Texas, to be used in a new charcoal-iron plant which will have a rated daily capacity of 100 tons of pig iron. The plants being dismantled for the new establishment are the Delta Chemical & Iron Co. of Wells, Mich., long a producer of wood chemicals and charcoal iron, and the blast furnace-phosphorus plant at Pembroke, Fla., which has been idle since 1931. The latter blast furnace was built to make elemental phosphorus by fuel-fired furnacing of Florida phosphate rock.

The new plant in Texas will smelt limonite ore which is available from deposits in East Texas. The charcoal used as furnace fuel will be obtained, with methanol and acetic acid, as byproducts of the distillation of hardwood from nearby forests. The new undertaking is being organized by Col. E. F. McCrossin of the McCrossin Engineering Co. of New York, and Ralph H. Sweetser, also of New York, is serving as its consulting engineer. The plant, which is reported to cost about $2,500,000 will be leased to McCrossin Engineering Co. by the Defense Plant Corp.

MONTANA PHOSPHATE MINE IN OPERATION

Under the direction of E. C. Anderson, chief engineer, the International Minerals & Chemical Corp. of Chicago, has placed in commercial operation, the phosphate mine south of Hall, Mont. The corporation had constructed a pilot plant there and found results so promising that it was decided to establish full-scale operations as a permanent development. The new plant has a 24-hr. capacity of 450 tons.

I. M. LeBaron, chemical engineer, who designed the pilot plant, is in charge of research and the company has established offices at Drummond and at the mill site. The Northern Pacific Railroad has run a spur line from the Church siding and the Montana Power Co. has built a two and one-half mile transmission line to serve the mill. The company itself is building seven miles of road to connect with the main highway.

OAKLAND PLANT TO PRODUCE TARTARIC ACID

What is described as the largest tartrate and tartaric acid plant in the United States is expected to be in operation at Oakland, Calif., by next October. The Alloychemical Corp. is converting a steam-electric generator plant into a manufacturing establishment. About $750,000 is the amount reported as being spent by the corporation to convert and equip the plant. Production schedules call for the processing of 45,000 tons of grape pomace under normal conditions in a 10-month period of operation. The returns are estimated at about 3,000,000 lb. of pure tartaric acid, 500,000 wi. gal. of potable alcohol, 4,000 tons of grape seeds, 3,600 tons of stock feed, and fusel oil.

ANNUAL BOSTON CONFERENCE ON DISTRIBUTION

The sixteenth annual Boston Conference on Distribution will be held at the Hotel Statler, Boston, Mass., Oct. 16-17. The Conference will deal with vital problems in the field of distribution of immediate concern to business and government in handling the period of transition from war to peace. Leading government and industrial authorities are scheduled to address the gathering.

IMPROVED TECHNOLOGY FOR SYNTHETIC RUBBER

The General Tire & Rubber Co. has developed a process which permits the addition of carbon black to the rubber latex in the manufacture of synthetic rubber. This is said to cut milling time by 35 percent, reduce power consumption by 20 percent, and result in a material reduction in production costs. Another report from Akron states that rubber technologists have reduced the Banbury mill cycle by 20 percent or more by the addition of such plasticizing materials as naphthol and naphthylene sulphides.

CONVENTION CALENDAR

American Association of Textile Chemists and Colorists, annual meeting, Claridge Hotel, Atlantic City, N. J., Oct. 12–14.

Electrochemical Society, Inc., fall meeting, Hotel Statler, Buffalo, N. Y., Oct. 12–14.

Boston Conference on Distribution, annual conference, Hotel Statler, Boston, Mass., Oct. 16–17.

American Oil Chemists' Society, annual meeting, Hotel LaSalle, Chicago, Ill., Oct. 25–27.

The Society of the Plastics Industry, fall meeting, Waldorf-Astoria Hotel, New York, N. Y., Nov. 13–14.

Third National Chemical Exposition, Chicago Coliseum, Chicago, Ill., Nov. 15–19.

American Institute of Chemical Engineers, fall meeting, St. Louis, Mo., Nov. 19–21.

Technical Association of the Pulp and Paper Industry, annual meeting, New York, N. Y., Feb. 1945. Regular fall meeting will not be held this year.

PRODUCTION OF SULPHUR AND PYRITES IN 1943

Domestic production of sulphur dropped sharply last year according to the annual report of the Bureau of Mines. The output of crude sulphur is given at 2,538,786 long tons. In addition to this production of relatively pure sulphur, a small amount of sulphur ore containing from 10 percent to 50 percent sulphur, was mined in Texas and Colorado and sold for agricultural purposes. The equivalent of 270,000 long tons of sulphur was recovered at smelters, 5,101 long tons from gases, and hydrogen sulphite recovered contained 17,591 long tons.

Shipments of sulphur reached a total of 3,460,686 long tons and domestic consumption made a new record, the apparent total being 2,525,237 long tons as compared with 2,472,396 long tons in 1942. The greater part of domestic consumption goes into the manufacture of sulphuric acid and acid production last year is estimated to have increased about 11 percent over that for 1942.

Producer-owned stocks declined 13 percent to 4,462,000 long tons.

Domestic production of pyrites last year amounted to 802,384 long tons valued at $2,844,000. The average sulphur content was 40.9 percent. In 1942, production was 720,363 long tons with an average sulphur content of 42.6 percent.

POWER SHOW WILL BE HELD IN MADISON SQUARE GARDEN

Problems uppermost in times of industrial change involve primarily those concerned with the supply and distribution of power and those involving tools, especially the more mobile types of machine tools for production in volume. The industrial change which lies ahead as a result of the conversion of plants from wartime work to their regular lines of manufacture, has increased interest in the 16th National Exposition of Power and Mechanical Engineering which will be held in Madison Square Garden, New York, Nov. 27-Dec. 2.

Power plant equipment, well represented on the exhibitors' list, includes the many lines of materials, supplies, equipment and instruments which afford the means for converting existing plants to serve new and larger demands. Machine tools, instruments and tool room equipment constitute another group of exhibits that is well filled already and promises many innovations based on experience growing out of world war production.

OKLAHOMA STARTS RESEARCH ON DRYING OF GASES

The University of Oklahoma is undertaking a research project on the drying of gases by activated alumina, from a chemical engineering point of view. The investigation, which is financially supported by the Aluminum Co. of America, is under the direction of Dr. R. L. Huntington, chairman of the School of Chemical Engineering. He will have the part-time assistance of Professors G. F. Russell and F. F. Blankenship.

HELSER SELECTED TO DIRECT MAGNESIUM ASSOCIATION

The recently-formed Magnesium Association has completed its organization by the selection of Perry D. Helser as secretary-director. Mr. Helser had been serving as chief of the Magnesium Branch of WPB in Washington. Membership in the Association takes in a substantial part of the industry including producers, fabricators, smelters, and consumers. Its purpose is to develop and increase the use of magnesium and its products and to correlate technological progress in the industry. Officers are E. S. Christiansen, vice president, Apex Smelting Co., Chicago, president; C. C. Loomis, president, New England Lime Co., Canaan, Conn., vice president; and C. E. Larson, manager of operations, White Metal Rolling & Stamping Co., Brooklyn, treasurer. Headquarters are at 30 Rockefeller Plaza, New York.

The Association already has arranged to hold its first annual meeting at the Waldorf-Astoria Hotel, New York, Oct. 3-4. The morning session on Oct. 3 will be addressed by leading members of the industry and in the afternoon a business meeting will be held. The Sand Cast Division is working on a program for the entire day of Oct. 4.

LENINGRAD LIBRARY ASKS FOR TECHNICAL JOURNALS

The Committee on Aid to Libraries in War Areas has received a request for assistance on behalf of the library of the Leningrad Scientific and Design Metallurgical Institute. This library was bombed twice in the same day, and nearly all its books and periodicals were lost. A letter from P. L. Litvin, formerly connected with the library says they are interested in metallurgical periodicals which are being published in the United States, preferably for the last ten years, but those for the last four or five years would be a fair start for rehabilitation of the library.

The Committee has agreed to furnish storage space for such periodicals until they can be sent to Russia. The Committee can pay transportation costs. If you have material to donate, write to Miss Dorothy J. Comins, executive assistant to the Committee on Aid to Libraries in War Areas, Library of Congress Annex, Study 251, Washington 25, D. C.

RESEARCH ON INSECTICIDES TO CONTINUE AT DELAWARE

Continuation of the fellowship in the Department of Entomology at the University of Delaware has been announced by G. L. Schuster, director of the Agricultural Experiment Station. The fellowship carries a grant of $10,000 this year. Work on the fellowship, which is sponsored by Hercules Powder Co., will be under the direction of Dr. Paul L. Rice, acting head of the entomology department and will be concerned primarily with screening tests on new compounds developed at Hercules Experiment Station. Arnold Mallis, Hercules Fellow, and his associates will handle the research work.

SOURCES OF ENZYMES FOR HYDROLYZING STARCHES

Basic information on the use of enzymes from sources other than barley malt for the hydrolysis of starches has been made available by recent work of Dr. W. W. Pigman at the National Bureau of Standards. At the request of the Wheat-Alcohol Committee of the War Production Board, Dr. Pigman undertook a study of various types of enzyme preparations that might be used to convert starches into substances fermentable by yeasts.

As a result of the Bureau's studies it has been found that enzymes prepared from certain molds are able to break down starches completely to fermentable sugars in the presence of yeasts. On the other hand, enzyme preparations made from some bacteria and from pancreases do not break down starches completely to fermentable sugars, even if yeasts are present. The enzymes found particularly in wheat and soy beans, also do not bring about complete saccharification. For certain of these enzyme types, complete hydrolysis to fermentable sugars probably does not take place because certain unfermentable materials are formed from the products of hydrolysis. The synthesis of such substances by the action of the enzyme preparations on maltose, for instance, has been demonstrated. The nature of the actions of the various types of enzymes that hydrolyze starch has been considered in relation to the structures of the various starch substances, and procedure for liquefying starch suspensions without the intermediate formation of gels has been developed.

HIGH ALUMINA IRON ORE FOUND IN OREGON

Sizable deposits of high alumina iron ore and high iron bauxite in northern Washington Co., Ore., have been confirmed by investigations of the Oregon State Department of Geology, with chemical analysis revealing the ore averages 20 to 25 percent iron, 25 to 35 percent alumina, 6 to 12 percent silica and 0.15 percent phosphorus. Though there are no commercial operations treating this type of ore in the United States at present, a department report indicated similar ore found in Norway has been reduced in electric furnaces, producing high grade pig iron and calcium aluminate slag, on a commercial scale.

ORONITE CHEMICAL TO MAKE PHTHALIC ANHYDRIDE

According to a recent announcement by R. G. Follis, chairman of the board of the Oronite Chemical Co., a plant to manufacture phthalic anhydride will be built by his company at Richmond, Calif. Construction on the plant is expected to start by Oct. 1 and the cost is estimated at a million dollars. When completed this will be the first phathalic anhydride plant west of St. Louis and the output will go to other manufacturers who use phthalic anhydride as a raw material, since present plans do not call for use of this product within the Oronite company.

RAW MATERIAL SUPPLIES OFFER PROBLEM IN BRITISH CHEMICAL POSTWAR PLANNING

Special Correspondence

NEXT TO THE enforced neglect of plant repair and overhaul, the exhaustion of raw material stocks in private hands is probably the most serious obstacle to a prompt resumption of civilian production lines after the war. This at least is a view widely held in British industrial circles and has had the result of focusing considerable attention on raw material supply problems. As far as import commodities are concerned, the Board of Trade has from time to time made estimates of the requirements of different industries for the main raw materials. These estimates were based on various assumptions regarding the date of termination of the war and are subject to constant revision in the light of new knowledge and information on conditions likely to prevail in future periods. Every effort is being made, so the president of the Board of Trade assured the House of Commons, to ensure sufficient supplies of materials, but this will not everywhere be possible, and where there is not a sufficiency of supplies to go round, the intention is to distribute the available quantities in accordance with essential needs. In other words, control will stay in these fields until supplies are sufficiently large.

From the point of view of the British chemical industry, availability of raw materials is not enough. They must be obtainable at a sufficiently low cost to allow the industry to compete effectively in contested markets. In general economic debates the argument has lately often been put forward that Great Britain, through war expenditures transformed into a debtor country, will not be able to afford importing all the commodities she used to buy abroad and that the anticipated unfavorable balance of payments will force the country to develop its domestic raw material sources to the best of its abilities, even if such a policy is not in accordance with ordinary economic considerations. Evidence of such ideas is provided, for instance, by suggestions for the utilization of Scottish raw materials, such as seaweed, peat, clays, shales, dolomite, felspar, and diatomite, possibly with power generated in the proposed hydroelectric stations.

Neither the government nor the manufacturing industries seem to be greatly impressed by these arguments, and while the research organizations have gone into the question of the utilization of domestic raw materials, the majority view still remains

that Britain, thanks to her industrial experience, commercial tradition, geographical position, and advantages in the field of shipping and international finance, will fare better by a policy of widest possible participation in world trade. Yet, opportunities for development of new raw materials in the British Isles are not neglected, and the immense demands likely to be made by the building trades after the war makes reliance on unorthodox construction materials imperative. Slag from iron furnames is now "foamed" at two works, and it is intended to install more plants of a similar type at other blast furnaces where suitable slag will be available. These new plants are to be ready for operation by the time the housing program can be started. Considerable experience in the use of substitutes, some supplied by chemical producers, for building has been gained during wartime, and this knowledge will be put to good advantage.

Home-produced tar has replaced imported bitumen for many building purposes. Two simple black tar paints have been standarized for iron and steel protection, and refined tar can be used for coating ground pipes. Incorporation of fillers and vegetable plasticizing oils, reported G. H. Fuidge to the Association of Coke Oven Managers, results in improved paints. Progress has also been made with tar-impregnated roofing felts, and laminated pitch felt has been used for static water tanks built of bricks. Pitch mastics for flooring made under a wartime standard specification have been very successful, and experiments are now in progress with a view to the development of a pitch mastic for roofing. Tar products have also been used for impregnating the wrappings of electric cables. Special refined tars and soft pitches prepared from washed oils very low in content of phenols and tar bases have been found quite suitable by cable makers. All these new developments are due to wartime conditions and may find less favor under peacetime conditions, but since there is normally a surplus of pitch and certain other coal-tar products, the efforts for their utilization for building purposes will certainly be continued.

As another example, though of an entirely different kind, of wartime developments in the utilization of domestic raw materials in the British Isles mention may be made of the plastics industry. As far as phenol, cresol, benzene, etc., and methanol, formaldehyde, urea, and nitric acid are concerned, adequate quantities at competitive prices can be obtained by tar distillation and nitrogen synthesis, according to a survey by Dr. W. J. Worboys to the Institute of the Plastic Industry. Acetylene for the vinyl group is now available from carbide made in two British plants of doubtful profitability, while alcohol for ethylene required for polythene and styrene can be made from various raw materials. Without going into details of wartime progress, it can be said that considerable progress in the utilization of these various materials for the manufacture of plastics has been made and that there are no insuperable technical or operational difficulties provided the primary raw material can be made available at a sufficiently low cost and manufacture of the materials which the plastics industry requires can be fitted in economically with other productions.

While not all observers agree that petroleum refining is the most valuable source for the organic chemicals required, all seem to agree that in the case of Britain an efficient and competitive organic chemical industry must be based primarily on coal. And further that it is not even so much the producing cost of the coal as the way in which it is used for chemical purposes, what importance is attached to byproducts, and what allowance is made for the needs of the chemical trades in comparison with those of other customers of an expanded postwar coal processing industry, which will determine the progress of this side of chemical production. At present public discussion cannot be taken further than to indicate the great possibilities open for processing and manufacturing industries based on domestic coal. A case of careful investigations has certainly been made out, and the authorities actively support the research work now going on. Even the research workers, however, seem at present to concentrate on a few widely separated individual problems and for the rest content themselves with defining and delineating the potential field of development. Economic considerations must be postponed until more is known of the basic facts of the industrial application of wartime research and of the conditions under which production will have to be carried on after the war.

Nevertheless it seems certain that, while the chemical industries in the British Isles, especially the organic section, will to an even greater extent than in the past rely on domestic coal and coal derivatives for its raw material supply, narrow self-sufficiency arguments will not be allowed to affect their raw material policy. On the other hand, it is clear that where domestic resources are available, where, e.g., limestone is found near coal deposits, more use will be made of the potentialities of such combinations than in the past. But this will not affect Britain's absorptive capacity for overseas raw materials. The investigations of the Board of Trade show quite clearly that these facts are fully appreciated in official quarters.

HYDROELECTRIC PROJECT UNDER WAY IN PERU

Several chemical and metallurgical projects are reported to be considering use of 2-mill electric power that will be available within 18 months from a hydroelectric development now under construction some 85 miles inland from Chimbote, Peru, the best port on the west coast of South America. The $5,000,000 required for the development is being provided by the Peruvian government. A government organization has been established specially to handle this and other power and irrigation projects. Two other large hydroelectric projects, for which preliminary surveys have been made, are planned to be undertaken after the one near Chimbote is more nearly completed.

Remarkably favorable local conditions permit the development of power at the site near Chimbote at very low cost. After the preliminary construction, engineers estimate that energy may be generated at less than a mill per kilowatt hour, including all charges. Early shipment from the United States of the construction machinery and equipment required to complete the project, is assured. With a full crew of experienced workmen already on the project, the estimated time for completion within 18 months is considered conservative.

Originally started to supply power for a projected steel mill at Chimbote, the low-cost electric energy has attracted several other industrial projects. Among these are a cement mill, at least one electric-smelting undertaking and a chemical plant utilizing nearby raw materials.

Barton M. Jones, an American engineer with wide experience in the control and development of stream flow, is engineer-manager of the hydroelectric development. David Dasso, a Peruvian engineer who was educated in the United States, heads the government organization.

NEW ZEALAND INCREASES AGAR PRODUCTION

A plant for the production of agar was established in New Zealand in 1943 and the rate of production has been steadily increasing. At present the output is sufficient to take care of all home requirements and, as production is still growing, it is expected that considerable quantities will be available for the export market.

AUSTRALIA PRODUCES AND CONSUMES MORE TALC

Prior to the war, consuming requirements for talc in Australia were relatively light and production was held down accordingly with the total output for 1910-1943 amounting to about 41,012 tons. In 1943 production was reported at 4,933 tons with consumption close to that figure. Most of the Australian talc goes in lump form from the mines and quarries to processing firms in Sydney and Melbourne where it is ground to about 200 or 250 mesh.

GOOD PROSPECTS FOR TUNG PRODUCTION IN BRAZIL

Prospects for a good yield of tung nuts for the 1945 season are reported in Brazil with the trees in good condition so far. No estimate for possible production can be made before the September flowering. Last September while the trees were in flower, a freeze was experienced and the crop of nuts failed to come up to earlier expectations. The crop was estimated at 500,000 kg. from which 75 tons of good quality tung oil may be obtained. A carryover of about 30 tons of oil from the 1943 crop is said to be available for shipment but scarcity of drums is restricting trading.

TANNING OPERATIONS IN SOUTHERN RHODESIA

A new tannery has been established at Gwelo, Southern Rhodesia, and it is expected to produce enough leather to meet not only the major part of the colony's requirements but allow an exportable surplus of certain items. Another tannery in Salisbury plans to produce high-grade leathers for all purposes as well as finished leather products. The Industrial Development Advisory Committee is favoring a movement to establish wattle growing and the manufacture of wattle extract in the eastern districts of Southern Rhodesia.

JAPAN TO BUILD PAPER MILLS IN INDOCHINA

According to the Department of Commerce, German and Scandinavian newspapers have carried stories to the effect that the Japanese Government plans to build two large paper mills in French Indochina. One will use timber as its primary raw material and the other will make use of such native materials as rushes and bamboo. At present there is only one paper mill in the entire area and it supplies about one-ninth of the country's normal requirements.

SWEDEN PRODUCES MORE PAINT MATERIALS

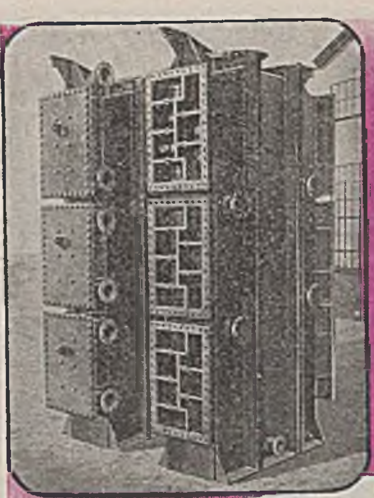
With the spread of the war area, Sweden has found difficulty in maintaining imports of many materials used in the manufacture of paints. As a result domestic production has been extended to many of these materials. Dry colors are not produced in any large way but new solvents have been turned out to take the place of those formerly brought in from Germany and the United States and their quality is said to be high. Manufacture of synthetic paint materials has made progress and this is expected to reduce import competition in the paint and varnish field in the postwar period.

NEW INSECTICIDE TURNED OUT IN PERU

Use of calcium arsenate for dusting the cotton plant is being superseded in Peru. A new company, Insecticida Babbini, S. A., is producing an insecticide powder known as Babbini at an annual rate of 1,000,000 lb. with plans to step this up to 4,000,000 lb. a year. It is intended for use against pests attacking the cotton plant. It is composed of chili pepper, sabadilla, arsenic, and quicklime. Sabadilla is imported while the other materials are found in Peru. It is offered to replace calcium arsenate and calcium arsenate-paris green mixtures.

MEXICO INCREASES EXPORTS OF OILCAKE AND MEAL

Production of oilcake and meal in Mexico is expected to reach 156,194 metric tons this year, nearly one-half of which is from cottonseed. Production has increased nearly 100 percent since 1938. A drop in output is anticipated for next year owing to the cut in acreage sown to peanuts and sesame. Exports of these products from Jan. 1 to June 1 this year amounted to about 30,000 metric tons or about one-half of what is expected to be shipped out of the country for the full calendar year.



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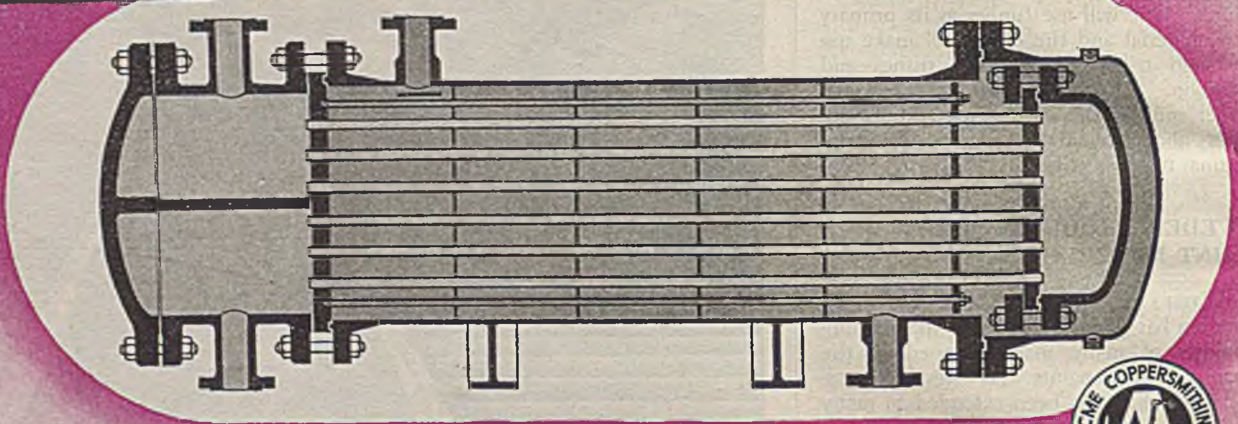

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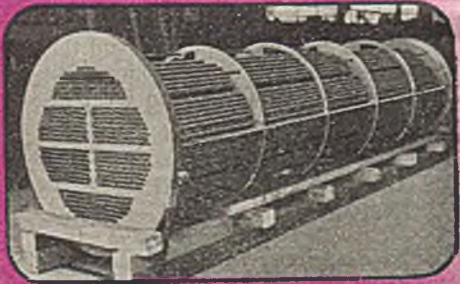
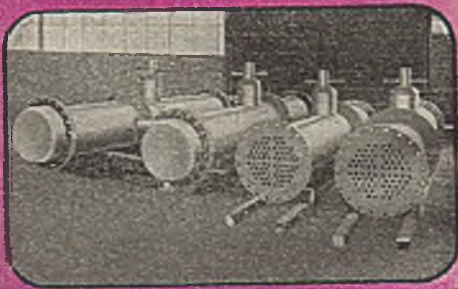
Acme Heat Exchangers are designed and constructed to meet specific problems, and to operate most efficiently under given working temperatures and pressures. Acme Heat Exchangers are engineered to minimize and, in many instances, to eliminate fouling and clogging, thus reducing maintenance costs. Sturdy construction and precise machining prevent leakage and contamination. Good workmanship and proper selection of materials insure consistent performance and long life. Acme engineers are ready to co-operate in the designing and planning necessary to solve your heat exchange problems—no matter how difficult!

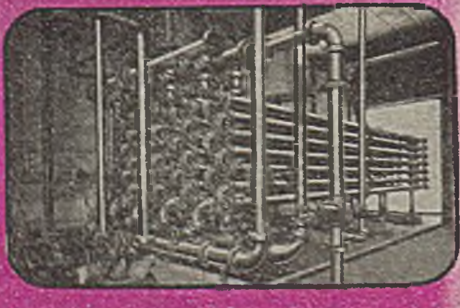




TYPES: *Tubular, or Plate, with either removable or fixed bundle; U-Bend, Multi-Pass, Coil, Fin Tube, Drip, Baudelot, and Forced Circulation, in either ferrous or non-ferrous metals.*

MECHANICAL STANDARDS: *Acme Heat Exchangers are fabricated in accordance with A.S.M.E. Code, A.P.I.-A.S.M.E. Code, or T.E.M.A. Standards.*

ACME *Processing Equipment*



ACME COPPERSMITHING & MACHINE CO., ORELAND, PA.

FROM THE LOG OF EXPERIENCE

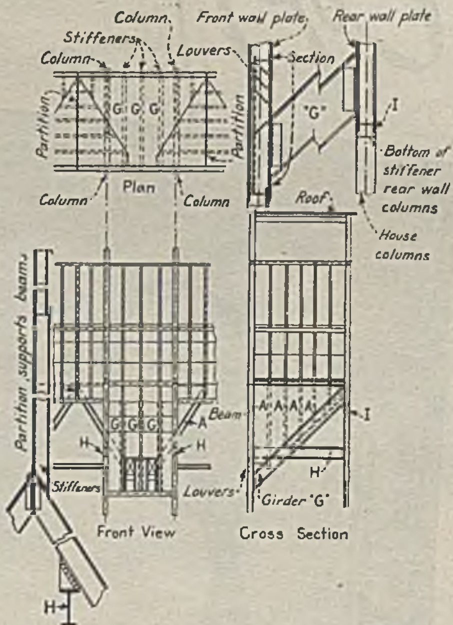
DAN GUTLEBEN, Engineer

BINS DISPOSED strategically promote continuity of operation. They function for dry materials as tanks do for liquids. In the case of finished sugar they allow 24-hr. production while packing and shipping is accomplished during the day-shift when delivery can be made direct to waiting trucks without intermediate storage. There is some choice of shape and position. The shape should achieve complete discharge, especially in the case of high-volatile coal subject to spontaneous combustion. Besides having a bottom slope slightly in excess of the angle of repose of the material, the hopper bottom should have one or two vertical sides to facilitate flow to the outlet. A conical or pyramidal hopper with the apex in the center exhibits greater tendency to form a bridge above the outlet than a hopper with at least one vertical side. Louvres should be arranged just above the outlet gate to admit a poker in case of need. It is usually preferable to locate the bins above the equipment that they supply.

In some refineries the raw sugar bin is located on the dock floor. Thus the continuity of operation of the minglers, necessarily located on an upper floor above the centrifugals, is dependent upon the elevators. The high position allows uniform feed to the minglers through the gates and furthermore tides over a temporary breakdown of the elevator. The 1,000-ton steel bin built above the melter house roof in 1926 cost $30,000. Its position added $23,000 for reinforcement of the columns and foundations plus two months of vigorous effort against an uncomfortable job of underpinning. On the other hand, in return for this short period of discomfort, the operating department has for 18 years since then enjoyed the convenience that the high position affords. The difference between a satisfactory installation and a makeshift is extra personal effort. There is of course another bulk bin of large capacity on the ground floor to supplement the live storage operating bin. The structural design of the supports presents no problem that arithmetic cannot solve, being limited only by the cost that the job warrants.

The design of bins built in existing buildings is modified to some extent by the building structure. An economical device is to make the steel plates as wide as possible and long enough to reach in horizontal courses from column to column. The plates are then riveted or welded to the columns and stiffened with vertical girts which project below the side walls to carry the floor beams. The bin walls, acting like plate girders, then deliver the load of the bottom directly to the columns.

Plate thickness is arrived at more or less by the snap of the fingers. For the bottom of the coal-bin, having a load of 1.15 tons per sq.ft. and a beam spacing (wide flange beams) of 4 ft. 8¼ in., a thickness of ⅜ in. was selected for structural sufficiency and to this was added ⅛ in. to anticipate weakening through corrosion—that is, to satisfy the old master mechanic's facetious formula "to make it last as long as we're here!" The bottom of the raw sugar bin with a load of 1.35 tons per sq.ft. and a beam spacing of 2 ft. 10½ in. is made of ½-in. steel plates. There is no tendency to corrode with sugar. In both cases the maximum deflection at full load is from ⅛ in. to ¼ in. For some refined



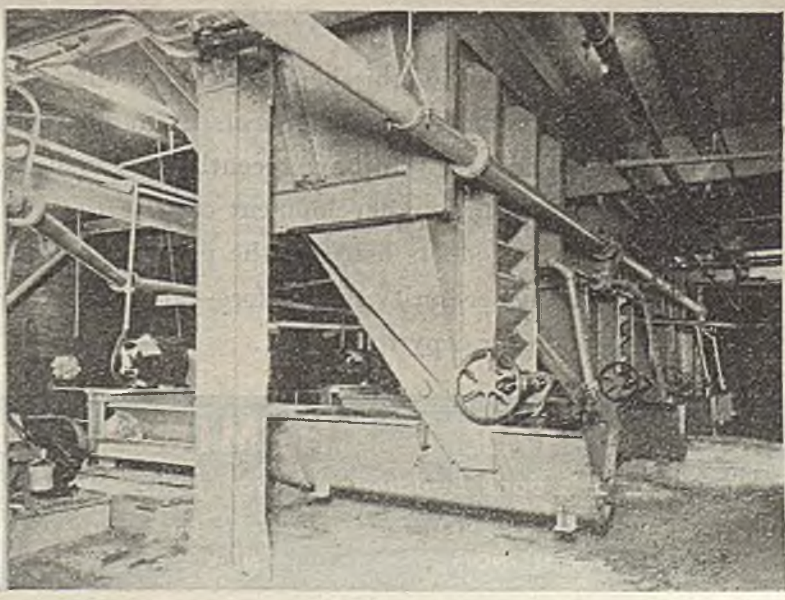
Stiffened bin walls support bottom and carry load to columns

sugar bins No. 10 galvanized sheets are used stiffened with 4-in. I's using a factor of safety of a "good big one," although for the girders that support these, the conventional 4 is applied. These plates and small I's deflect as much as ⅜ in. which shows that they are earning interest on their cost. The deflected plate approaches in action the effect of a catenary suspension cable in which the entire cross section of the steel is effectively used in tension.

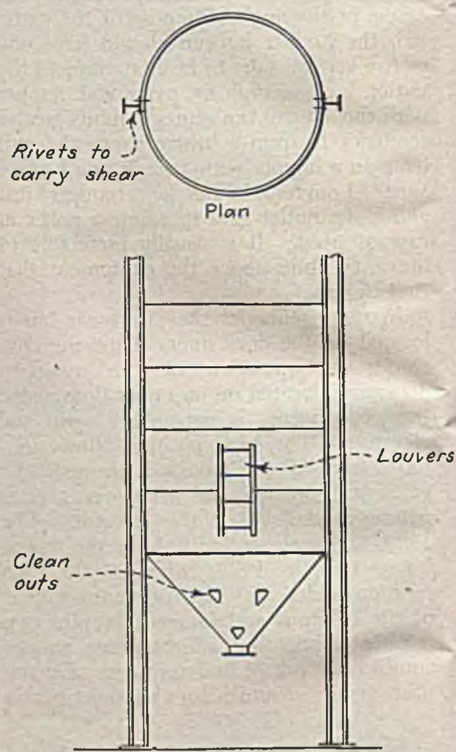
Circular bins have been built 13 ft. in

Raw sugar storage bins located on dock floor

Discharge hoppers and minglers on 5th floor of melter house



diameter to fit in between 12 in. H house columns spaced 14 ft. center to center. The plates were of No. 10 galvanized steel at the bottoms and No. 14 in the upper portion. These bins were riveted to two columns respectively at the ends of the diameter and had no other support. When the Old Man contemplated the thin plates, he became jittery. The drafting room then made a 1-in. scale model of the bin of heavy drawing paper with two 1 in. square wooden posts glued on to represent the columns. This model was filled with sand, covered with a steel disk and set up on its columns on a platform scale. A screw jack was placed on the disk on top of the sand and a load pressed down into the bin. When the scale beam indicated one ton, one of the wooden posts failed and wrecked the bin but reassured the Old Man. When the bins in the plant were eventually loaded with 180,000 lb. of sugar, no deflection or signs of distress could be detected.



Circular bin suspended from columns

Tanks for hot liquids are frequently hung in the same manner to save floor beams. In this case the bottoms are made conical or dished. In the construction of the circular shell of the bins, the plate thickness and vertical joints were designed for a liquid load equal to the weight of the sugar and sufficient rivets driven through the columns to take the shear. As the depth of the bin was greater than the diameter, no thought was given to the possibility of collapse, especially as the sugar would tend to maintain the circular shape.

The Old Man, possessing outstanding skill not only in attaining happiness for the stockholders but also in fostering originality and initiative in his men, did not possess the patience to visualize the complex drawing of the new raw sugar bin and the equipment re-arrangement accompanying it. The drafting room, therefore.

made a scale model of drawing paper and thereby provided perspicuity in the presensation of the proposition.

Tight bins for food products improve sanitary conditions and impart to the food a more palatable prospect. The famous old advertising slogan, "untouched by human hands," has been obsolete for many years. For a small plant to produce 4,000,000 lb. daily of any chemically pure food product at a nickel a pound where the raw material costs 4c., would leave little margin for manual touching at the price of $1 per hr. per pair of hands. The old family sauerkraut barrel in Lancaster County around 1865 may not have been touched by human hands but the feet were discretely unmentioned.

IN HIS PROGRESS towards the goal of eminence in steam plant engineering, "J. P." served a wearisome period as a draftsman. It was drudgery to him. He hated the job and he hated the boss. His work reflected his feelings and thus he merited and received his discharge. As he left the drafting room, his parting shot was to express his appreciation. He thanked the boss for firing him as he feared that prolonged association with such a boss might develop in himself the same hateful characteristics that the boss exhibited.

FAITHFUL OLD MICHEL was mustered out of the Polish army at the conclusion of the last war with a strong desire to emmigrate to the land of milk and honey. In the course of time he drifted to our corner and was assigned to the good old repititious job of operating the granulators. The job required little activity either physical or mental. On occasion Michel could even stroll away to other stations if the foreman chanced to be out of sight. For some strange reason, Michel with all his good qualities developed an irresistable kleptomaniacal tendency. The watchman, following a scent, found a large quantity of tools bearing assorted names cached in his cellar. Michel returned the tools and got himself a job in another plant where lack of acquaintance avoided prejudice. In some other respects Michel exhibited practicality of unusual quality. In the fatherland his religious persuasion followed the ritual of the Catholic community. In Philadelphia he observed that the nearest church of his own faith and language was ten blocks away while there was a Baptist church, where the Polish language was used, a half block distant from his house. He thereupon betook himself to the near-by house of worship and accomplished his purpose to his satisfaction.

PAN HOUSE FOREMAN Jake Sondheimer routed the chronicler out of bed at low twelve to impart the important intelligence that it was raining down at the refinery. In fact it was a gully washer and the water was coming through the monitor over the pan house roof to the discomfort of the sugar boilers. In the traditional engineering department spirit of helpfulness we promised to take the matter up with the weather bureau at once but suggested that in the meantime Jake try closing the windows!

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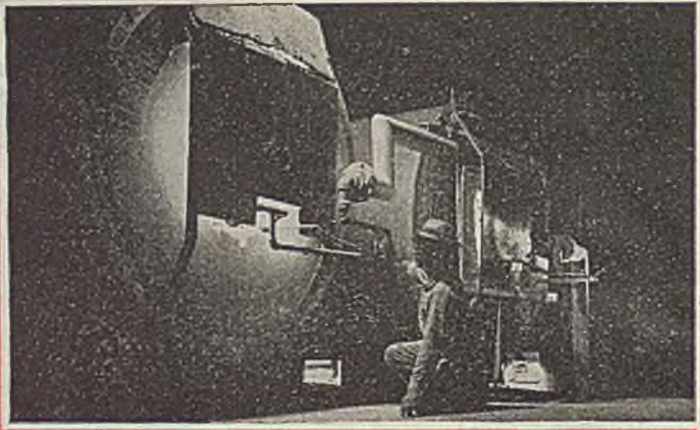

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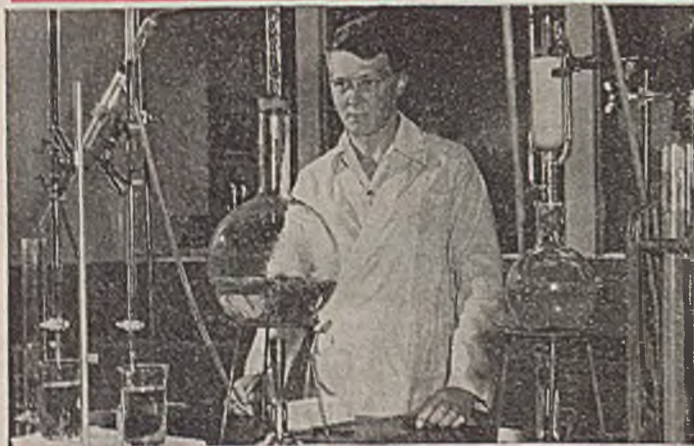

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NAMES IN THE NEWS

Lauren B. Hitchcock

E. E. LeVan

Frank E. Bell

Lauren B. Hitchcock has been named manager of the newly formed Chemicals Department of the Quaker Oats Co. Dr. Hitchcock will be located in the company's general offices in Chicago. He was formerly with Hooker Electrochemical Co.

C. F. Cummins, formerly of the Chicago office of Dow Chemical Co., has been transferred to Midland where he has charge of plastic engineering activities in molding powders. **P. W. Simmons**, transferred from the New York office, will handle protective coating materials.

H. W. Christoffers, L. T. Dupree and **R. B. Schneider** have joined the staff of Arthur D. Little, Inc., in Cambridge.

William A, LaLande, Jr., formerly director of research of Attapulgus Clay Co., has joined the Research and Development Department of Pennsylvania Salt Manufacturing Co. as director of research.

Orlan McGrew Arnold, formerly a professor of chemistry at Rensselaer Polytechnic Institute, has been employed by Chrysler Corp.'s Engineering Division to set up a new special laboratory to be devoted to physical-chemistry research.

Maurice L. Macht has been appointed to the technical service group of the Plastics Department of E. I. du Pont de Nemours & Co.

Thomas O. Armstrong, of Westinghouse Electric and Manufacturing Co., East Springfield, Mass., has been reelected president of the National Association of Personnel Directors.

Earl T. Anderson, formerly with Todd & Brown, Inc., La Porte, Ind., has become affiliated with the Kraft Cheese Co. as a chemical engineer in the Development and Research Department.

Carl Christiansen has been appointed to the engineering staff of the John C. Dolph Co., Newark, N. J.

E. E. LeVan has been elected president of Haynes Stellite Co., a unit of Union Carbide and Carbon Corp., to succeed the late Francis P. Gormely.

Almon G. Hovey has been appointed executive in charge of the New Chemicals Development Section of the Research Laboratories of General Mills.

T. L. Nelson has been placed in charge of the reorganized and enlarged Electrode Service Engineering Department of the National Carbon Co., Inc. The enlarged department will consist of two divisions, and **Neal J. Johnson** has been named to head the department's electrolytic service division, while **Charles H. Chappell** is in charge of the electrothermic service division.

August Heuser has retired from his position of control manager of the Electrochemicals Department of E. I. du Pont de Nemours & Co. He has been succeeded by **J. H. Hildreth.**

Charles H. Brooks, formerly with Sun Oil Co., has been promoted from lieutenant (USNR) to lieutenant commander (USNR). He is attached to the Ammunition Section, Production Division, Bureau of Ordnance.

Edward B. Yancey has been elected a vice president and member of the Executive Committee of the E. I. du Pont de Nemours & Co. **William H. Ward** succeeds Mr. Yancey as general manager of the Explosives Department.

Martin B. Williams, who had previously been with Tennessee Copper Co. and the Cullendale, Ark., mill of the International Paper Co., has resigned from the Navy to accept an appointment with the Foreign Economic Administration in Washington.

William Bausch has been elected chairman of the board of Bausch & Lomb, to succeed the late Edward Bausch.

Frank E. Bell has been appointed technical service engineer for Hycar Chemical Co. Mr. Bell, who has had 13 years' experience in the rubber industry, comes to Hycar from the Barrett division of Allied Chemical & Dye Corp.

Paul E. Kuhl, associate manager of the process division of the Standard Oil Development Co.'s Esso Laboratories, has been made assistant manager of the southern refineries and the Baltimore printing plant of the Standard Oil Co. of N. J. **Norval F. Myers**, assistant manager of the process division, will succeed Mr. Kuhl as the new associate manager.

Edward A. Willson has been named resident supervisor of the synthetic rubber laboratories operated by the B. F. Goodrich Co. at Kent State University.

Thomas McLean Jasper has been appointed technical and research director for the General American Transportation Corp. with headquarters in Chicago. Mr. Jasper was previously associated with A. O. Smith Corp. as director of research.

C. Stewart Comeaux has returned to civilian life and again resumed his duties as secretary-treasurer of two trade associations: Institute of Makers of Explosives and Ammunition Manufacturers' Institute. Major Comeaux was in the Office of the Chief of Ordnance.

Henry L. Cox has been appointed general manager of the Chemical Division, Corn Products Refining Co. Dr. Cox was recently assistant to the vice president, Rubber Reserve Co., Washington.

James T. Settlemeyer has been named head of the mechanical engineering division of General Foods Corp.'s Central Laboratories at Hoboken, N. J.

Frank P. Bleier, who has been with Ilg Ventilating Co., Chicago, since 1942, has been named director of the new Ilg Research Laboratory.

Clark B. Kingery

Clark B. Kingery, assistant manager of Hercules Powder Co.'s Parlin chemical plant, has been promoted to manager of the Cellulose Products Department plant just established at Hopewell, Va. Mr. Kingery has been with Hercules for 19 years.

G. F. D'Alelio has been made vice-president of the Pho-phy-lac-tic Brush Co. Since March, 1943, he has been director of chemical research, which position he will continue to hold. Dr. D'Alelio was formerly with General Electric Co. at Pittsfield, Mass.

E. J. Cunningham, assistant controller of the Monsanto Chemical Co., has been elected vice-president of the St. Louis Control of the Controllers Institute of America. M. L. Jarbee, secretary of the Diamond Alkali Co., was similarly honored by the organization's Pittsburg Control, and E. F. Campbell, of The Fyr-Fyter Co., was chosen president of the chapter in Dayton.

Zola G. Deutsch and Alfred C. Loonam have formed a partnership as consulting chemical engineers and metallurgists specializing in the alkali and related industries, and in non-ferrous metal process and product research and development.

Benjamin Levitt has joined the Chemical Manufacturing & Distributing Co., Easton, Pa., in the capacity of consultant and head of research and development.

Fred S. Carpenter, factory manager of the Los Angeles tire plant of United States Rubber Co. was recently appointed manager of the company's synthetic rubber plant in that city.

A. E. Jury, until recently manager of the synthetic rubber plant at Los Angeles of the United States Rubber Co., will return to the textile division of the company as manager of new products. Mr. Jury will establish headquarters in both Winnsboro, S. C., and New York, N. Y.

Walter P. Konrad of the phosphate sales department, Monsanto Chemical Co., has been made branch manager of the phosphate division of the sales department in Chicago.

Lawrence B. Steele, Jr., research chemist in the Acetate Research Section of the Du Pont Co., at Waynesboro, Va., has been named research supervisor in the section. He will supervise work on problems relating to high-tenacity rayon yarn.

Eugene M. Smith, metallurgist, has been appointed to the staff of Battelle Memorial Institute, Columbus, where he will be engaged in research in non-ferrous metallurgy.

M. J. Gavin and **J. G. Detwiler** have been appointed assistant directors of the Foreign Refining Division of the Petroleum Administration for War. Mr. Gavin's duties will relate to the facilities side of the division, while Mr. Detwiler's primary responsibilities will relate to the operations of foreign refineries.

Henry G. Boon has resigned from his position as assistant director of the War Production Board's Paper Division in order to resume his duties with the Kimberly-Clark Corp., of Neenah, Wis..

J. B. Willis has returned to the Technical Laboratories of the Pemco Corp. in Baltimore. Capt. Willis returned to Pemco after nearly four years of active service with the armed forces.

Arthur Crago has been appointed manager of phosphate rock production operations for American Cyanamid Co. He will be in charge of and have full responsibility for all of the company's activities in the Florida phosphate rock field, with headquarters at Brewster, Fla.

Ralph E. Menzel has been promoted from assistant to associate professor of chemistry and **E. R. Epperson** from instructor to assistant research professor of chemical engineering at the Michigan College of Mining and Technology in Houghton, Mich.

C. W. La Pierre, who since 1936 has been in charge of the electro-mechanical sections of the General Electric general engineering laboratory, has been appointed assistant engineer.

Louis G. Gemmell has joined the American Cyanamid & Chemical Corp. as entomologist. Dr. Gemmell was formerly with the Insecticide Division of Sherwin-Williams Co.

John E. McMillan, formerly with the Packard Motor Car Co., Toledo, has been appointed to the technical staff of Battelle Memorial Institute, Columbus, where he will be engaged in research in the field of organic chemistry.

Robert B. Semple, associate director of development, Monsanto Chemical Co., St. Louis, Mo., has been loaned to the Office of Production Research and Development of WPB for special work in connection with the technical manpower problem in the chemical industry.

A. B. Grafius has retired as vice president of the Coronet Phosphate Co. after 27 years of service. He will continue to act as a director of the company.

Leon J. Willien has been appointed associate director of the Institute of Gas Technology at Illinois Institute of Technology. He has been associated with the Public Utility Engineering & Service Corp., Chicago, as a gas engineer.

OBITUARIES

Frederic J. LeMaistre, 75, who was executive secretary of the American Institute of Chemical Engineers 1930-37, died August 25. A native of Quebec and a graduate of McGill University, most of his career was with the Du Pont Co. until 1920 when he became a consulting engineer in Philadelphia.

Frederick Kraissel, 76, chemical adviser to the Corning Glass Co. of Corning, N. Y., died August 4.

Joseph C. W. Frazer, 68, research professor of chemistry at Johns Hopkins University, died in Baltimore July 28.

Harry S. Wherrett, 68, chairman of the board of directors of the Pittsburgh Plate Glass Co., died August 13.

Frank G. Hall, 73, died July 31 at Hanover, N. H. Mr. Hall was president of Stein-Hall & Co., manufacturers of vegetable adhesives.

William S. Stowell, 60, a director of the American Cyanamid Co. and president of the subsidiary unit, the Chemical Construction Corp., died August 6, at his home in New York.

Edward Bausch, 89, chairman of the board of the Bausch & Lomb Optical Co., died in his home in Rochester.

Eugene C. Schwarzenbek, 60, former manager of the Newark district office of the Electrochemicals Department of E. I. du Pont de Nemours & Co., died July 23.

Edmund H. Lunken, 83, chairman of the board of the Lunkenheimer Co., Cincinnati, died July 19 at his summer home in Michigan as the result of a cerebral hemorrhage.

George A. Gahles, assistant control manager of the Grasselli Chemicals Department, E. I. du Pont de Nemours & Co., died July 23 of a heart attack while vacationing at his home town of Beaver Falls, Pa. Mr. Gahles had a record of 45 years service with the Du Pont Co. and the Grasselli Chemical Co.

Edgar H. Bristol, 73, president and one of the founders of the Foxboro Co., died July 24 at his summer home, Falmouth Heights, Mass.

William B. Marvin, 64, secretary of the Farrel-Birmingham Co., died August 13.

Albert H. Killinger, 49, vice president and director of Laclede-Christy Clay Products Co., died in Colorado August 18.

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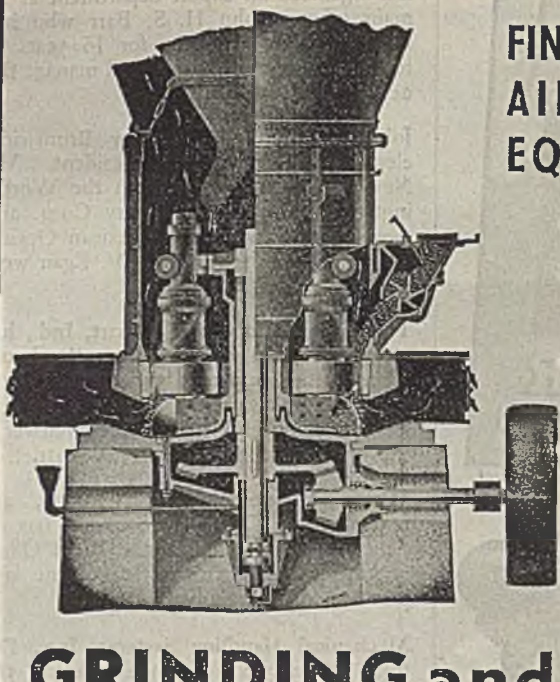

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INDUSTRIAL NOTES

Pennsylvania Salt Mfg. Co., Philadelphia, has organized an export department at its main office. John H. S. Barr who has been with the company for 15 years in technical and sales capacity will manage the new department.

John Waldron Corp., New Brunswick, elected B. R. Newcomb president. Mr. Newcomb formerly was with the Worthington Pump and Machinery Corp. and more recently with the American Optical Co. S. N. Finney and F. W. Egan were elected vice presidents.

The LaBour Co., Inc., Elkhart, Ind., has moved William K. Sims from the home office to the company's branch at 24 Commerce St., Newark, N. J., where he will serve as engineering sales representative in the New York and New Jersey district.

Welco Instrument Co., Chicago, announces that Charles L. Saunders has resigned as branch chief of the WPB Office of Civilian Requirements to become vice president of the company.

Mechanical Handling Systems, Inc., Detroit, has opened a branch office in the Commercial Trust Bldg., Philadelphia, with J. F. O'Hora in charge.

American Machine and Metals, Inc., East Moline, Ill., has appointed Guy E. Heirston manager of its Atlanta district sales territory. The Atlanta office is in the Candler Bldg.

Tube Turns, Louisville, has reopened its Los Angeles office in the Van Nuys Bldg., with James H. Withers in charge. Wilbur E. Geiser, on loan to WPB has returned as manager of the Philadelphia office, located in the Broad Street Station Bldg.

D. D. Foster Co., Peoples Gas Bldg., Pittsburgh, has been formed by D. D. Foster, formerly connected with the Pittsburgh Equitable Meter Co.-Merco Nordstrom Valve Co. The company will handle engineering sales of Hills-McCanna Co.

The Reliance Electric & Engineering Co., Cleveland, has formed a sales promotion department headed by Roscoe H. Smith who also will act as advertising manager assisted by Kenneth F. Ertell.

Geigy Co., Inc., New York, has appointed Charles J. Dumas manager of its insecticide division.

American Chain Ladder Co., Inc., New York, has appointed Eric Morrell assistant to Noel L. Dahlander, president of the company.

Robbins Conveyors, Inc., Passaic, N. J., again has Maurice B. Bradley on its sales staff after serving two years with the anti-aircraft artillery with rank of major.

Pressed Steel Tank Co., Milwaukee, has reopened its branch offices at Chicago and Los Angeles. Kenneth Cole will be in charge at Chicago with headquarters at 208 S. LaSalle St. and James Barr will manage the Los Angeles office at 727 West 7th St.

Jessop Steel Co., Washington, Pa., has appointed G. F. Golby manager of its office and warehouses in Toronto, Canada. W. J. Henderson has been made manager of the warehouse in Montreal.

H. K. Porter Co., Inc., Pittsburgh, has purchased the Fort Pitt Steel Casting Co. of McKeesport, Pa.

The Foxboro Co., Foxboro, Mass., has added Paul Torre to its sales engineering staff covering the New England territory. His headquarters will be at the main office.

The Whitlock Mfg. Co., Hartford, Conn., has appointed Norman W. Stirling, formerly with the M. W. Kellogg Co., manager of sales.

Hercules Filter Corp., Paterson, N. J., has been formed by C. E. Hunziker, R. L. Reardin, C. Stalter, H. T. Jones, Jr., G. Zebora, all of whom had been associated with Republic Filters, Inc.

Manning, Maxwell & Moore, Inc., Bridgeport, Conn., has appointed E. M. Dunlap manager of distributor sales and Rudolf Beck chief engineer of the American instrument division.

L. Sonneborn Sons, Inc., New York, has added J. N. Conover to its staff as assistant to R. W. Bjork, sales manager of the white oil division.

The American Air Filter Co., Inc., Louisville, has made W. G. Frank assistant to the president and has appointed H. C. Murphy, vice president, to serve as general sales director.

United States Rubber Co., New York, announces that Stanley W. MacKenzie has been made director of purchases to succeed George M. Tisdale, recently elected a vice president and member of the executive committee.

American Cyanamid Co., Calco Chemical Division, Bound Brook, N. J., has announced that products for the paper trade made by the pigment department will be sold by the Heller & Merz department, with J. H. Loomis as sales manager.

Olin Corp., East Alton, Ill., has placed Col. Walter F. Siegmund in charge of general sales. Colonel Siegmund formerly was sales manager of its subsidiary, the Western Cartridge Co., and was retired from active duty in the Army Air Corps on Aug. 9.

Allis-Chalmers, Milwaukee, has appointed Frank C. Angle manager of all the company's field sales offices of the general machinery division. He will continue to supervise operations in the Pacific Coast area.

Brown Instrument Co., Philadelphia, has named V. H. Hiermeier to succeed I. K.

Farley as industrial manager of its office in St. Louis. Mr. Hiermeier had been connected with the Chicago office.

Orbis Products Corp., New York, has purchased the plant at Matawan, N. J., formerly operated by the Catalin Corp. of America. The Orbis plant at Newark will be operated as before.

The United States Steel Products Co., Chicago, has acquired the manufacturing assets of Bennett Mfg. Co., makers of steel drums with plants at Chicago and New Orleans. Stevens A. Bennett has been appointed a vice president of the steel company in charge of the Bennett Mfg. division.

Eagle-Picher Sales Co., Cincinnati, has appointed Douglas Via industrial insulation sales manager. Andrew L. Harris has joined the company and is serving as manager of sales promotion.

The Eimco Corp., Salt Lake City, has opened a branch office in the Paul Brown Bldg., St. Louis, with James K. Russell in charge.

The Quaker Oats Co., Chicago, has formed a chemicals department which will take over the functions of sales, research, and production heretofore carried out by several divisions of the company. The furfural and technical divisions become merged in the chemicals department and their former designations discontinued.

Allen-Bradley Co., Milwaukee, has added Frank D. Popowics to the sales engineering staff of its New York office and Charles W. McCoombs to serve in a similar capacity at Boston.

The Warren Refining & Chemical Co., Cleveland, has moved its general offices to 308 Euclid Ave.

The Osborn Mfg. Co., Cleveland, has promoted Ralph W. Hisey to the position of vice president in charge of all manufacturing and engineering of the brush and machine divisions of the company. Hugh M. Little has been appointed works manager for both divisions.

The Ohio Crankshaft Co., Cleveland, has appointed The Anderson Machine Tool Co. of St. Paul as distributor of its induction equipment in the Wisconsin-Minnesota area.

J. O. Ross Engineering Corp., New York, has elected S. W. Fletcher president. For many years Mr. Fletcher had served as executive vice president. A. E. Montgomery continues as vice president with headquarters in the Chicago office.

Stein, Hall & Co., New York, has elected Edwin Stein president to succeed the late Frank G. Hall. M. S. Rosenthal succeeds Mr. Stein as executive vice president.

Schering Corp., Bloomfield, N. J., has appointed Herman W. Leitzow manager of its eastern territory. Carl H. Suding at Chicago is in charge of the central division; James D. Booth at Atlanta, in charge of the southern division; and Franklin K. Johnson at San Francisco, in charge of the western division.

CONTENTS

CHEMICAL ENGINEERS FOR THE SMALLER INDUSTRIES

With the closing of deferments for technical students, civilian chemical engineering instruction has practically ceased. This is the time for taking stock, and schools all over the country are laying plans for a postwar resumption of teaching activities.

There has been a good demand for chemical engineering graduates. In most schools this demand comes chiefly from the large, well-known processing companies. While there has been no lack of opportunity in the larger concerns, there are reasons why the schools should encourage some graduates to go into smaller industries. There are, of course, some disadvantages in entering these industries.

Possibly the most cogent reason for placing more men in the smaller industries in the postwar period is the necessity for broadening the base. An industry or a profession which limits its field of vision is in danger of atrophy through obsolescence. Two dangers appear. The large influx of postwar students may not find sufficient opportunity if all are to enter the large national concerns. The other danger is a corollary. If the schools train only for the large industries and permit accrediting agencies to mold curricula for this purpose, the profession may find itself straightjacketed by its own market.

Happily, large industry has insisted in the past that the chemical engineer be trained in fundamentals. This policy, if adhered to, should allow the utilization of chemical engineers to the fullest extent in the newer industries based on physics and biology.

From the viewpoint of the region, more graduates should be placed in smaller industry. These men, in time, take their places as leaders in local communities. There are compelling forces which make local leaders in industry expand their field of activities. In the case of large companies, because of the presence of a number of co-workers, the interests of the workers tend to look in, not out, of the

company. The policy of transferring men from plant to plant favors this company introspection.

From the viewpoint of the graduate, work in smaller industries often carries a more diversified work program, quick responsibility, and the entry into management at an earlier date. Competition too, is sometimes less strenuous. Disadvantages are usually lower starting salaries, difficulty of seeing the path of advancement, and the absence of clear-cut chemical engineering work.

From another viewpoint, smaller industry has an advantage which is professionally important but less tangible. The engineering graduate in smaller industry is almost always recognized as part of management and the question of unionization is not a personal issue.

Robert M. Boarts, University of Tennessee, before Chemical Engineering Division, S.P.E.E., Cincinnati meeting, June 22-25, 1944.

MOLASSES STILLAGE

In the manufacture of ethyl alcohol from molasses, the stillage in solid content is 3 to 5 Brix. Approximately one-quarter of the non-sugars is ash while the remainder is mostly organic non-sugars. The potash (K_2O) and nitrogen (N) are present in great dilution. Therefore, an economical process for their recovery is very desirable. Low-temperature carbonization yields a carbonaceous nonhygroscopic product with a high K_2O content. Sometimes the K_2O as sulphate is preferable to chloride for fertilizer.

By the use of ammonium sulphate, potassium sulphate and ammonium chloride are obtained which can be separated easily by means of a 60 percent alcohol solution. A stationary retort, while somewhat cumbersome, can be used for the production of a nonhygroscopic product high in K_2O content and consequently desirable for fertilizer purposes.

G. T. Reich, Pennsylvania Sugar Co., before Division of Sugar Chemistry and Technology, American Chemical Society, New York, Sept. 15, 1944.

SAFETY AS A MANAGEMENT RESPONSIBILITY

In looking at safety problems, management must take into consideration its three definite phases. These are education, economics and human relations. Too much stress upon any of the three will render the program ineffective and worthless.

Education in safe practices, education in knowing how to make any operation more safe is expensive and management, almost without exception, is willing to make the investment. Training in safety in the modern industrial set-up has been recognized as having equal importance with all other types of employee training.

Management has learned to count the cost of accidents both direct and indirect. Management has learned the ratio of costs and has found that, indirectly, excessive accidents to men, equipment and materials can ruin an otherwise profitable business venture.

Recognizing safety as an economically sound policy of American business, management must, therefore, look to its third phase, that of human relations, for the success of any safety movement. True it is that the education and economic phases can be effectively sponsored by disinterested management, but certain it is that lack of attention by management to the human relations phase will cause the program to fail.

Management's responsibility seems to lie in an active, sincere and continuing interest in this third phase of the safety problem. Wise management will reinsure its investment in dollars and in training by accepting its full share of responsibilities.

Warren Whitney, manager, National Cast Iron Pipe Div., James B. Clow & Sons, Birmingham, Ala., before 32nd National Safety Congress, National Safety Council, Chicago.

FIBROUS PLASTIC

The molded pulp industry has for many years employed a vacuum process for forming or felting pulp to shape. These shapes, depending on the use to which they are to be put, have been dried by various methods without upsetting the felting structure formed by the vacuum process. There have been some attempts in the past to impregnate such articles after manufacture in an effort to develop a strong, dense product. While this effort has been successful in some cases, it is expensive and slow. Incorporation of synthetic resin into the molded product has been accomplished and a preform produced not unlike the regular molded pulp shapes in appearance, but carrying sufficient resin content so that when this preform is subjected to heat and pressure, the resultant article of this secondary step is a plastic product of unusual strength and excellent appearance.

These resin bearing pulp preforms are made by the mixing of pulp and synthetic resin in regular pulp beating engines similar to those used throughout the pulp and paper industry. The relative amounts of pulp and resin are varied to meet the need of the particular article to be produced. After a uniform mixture has been accomplished in the beater, the stock is pumped to automatic molding machines on which the regular pulp shapes are formed. The resultant preform is then dried on a travelling belt passing through a tunnel dryer. The article is then placed between compression molds and cured in the usual manner.

The fibrous plastic preform is approximately the shape of the finished article, although the bulk is considerably greater. The product after curing retains the preform shape unchanged except for compacting but has the added strength of the interlocking fibers in its structure.

If desired, such articles can be made from layers of material containing varying quantities of resin. The body layers or cores may contain a large percentage of fiber and a low percentage of resin. Likewise, the surface layers may be rich in resin, thereby giving excellent outside appearance and a protective coating of high resistance against wear or anything that may come in contact with it. When the article is finally cured the effect is that of a monolithic piece of material, since the resin content in all layers flows in every direction, completely binding the product into one piece. The result of the combination of these two layers in certain articles gives great impact strength and rigidity to the final product, as well as considerable flexibility without danger of fracture. It can almost be said that the fibrous plastic article which has been produced in this manner is as much a product of the pulp molding technique as it is a product of the plastic industry.

W. E. Parsons Keyes Fibre Co., before 10th Annual Chemurgic Conference, St. Louis, Mar. 29, 1944.

TREATMENT OF INDUSTRIAL WASTES

In some localities the draft on wells is critically taxing these limited water supplies with the alternative of treating river water or purchase from utilities.

A pollution-abatement program should be designed to restore and maintain waterways in that state of purity which may be economically feasible. The demand for varied uses of water courses makes it impossible to maintain all streams in a state of pristine purity, but to permit their indiscriminate use for disposal of wastes is unthinkable.

A comprehensive pollution-abatement program must be practical, formulated on a reasonable and equitable basis, with full advantage taken of natural self-purification processes. A rational classification of all streams, based on their potential use, individually or collectively, should be established and standards of purity set for each classification with sufficient flexibility for proper administration.

Treatment processes should be developed on a watershed basis designed to meet the standards contemplated in the classification. Methods of treatment vary greatly among such wastes as metallurgical, textile, paper, leather, chemical, distillery, etc. Some wastes contain products of value recoverable at a comparatively low cost; others are not amenable to high degrees of purification except at a high cost.

The standard set for each classification should be based on a balance between that which is physically possible of attainment and that which is economically practicable. A pollution-abatement program can be carried out at a cost commensurate with the benefits received, even though these cannot be evaluated on a monetary basis.

W. S. Wise, Connecticut State Water Commission, before Division of Water, Sewage and Sanitation Chemistry, American Chemical Society, New York, Sept. 14, 1944.

GOVERNMENT AND INDUSTRY

Government has long found it desirable to intervene in some phases of our business. For the most part in the past this intervention, while sometimes inconvenient or possibly annoying, has nevertheless been helpful in the long run.

The extent to which Government should invade the fields of private business, or assume direction of it, has been a growing problem for many years. It will never be less of a problem, no matter which political party is in power. The difference will be one of the tempo of invasion. During the past twelve years it might be said that that tempo has been a swift allegro. Many of us hope that in the near future it will slow down to the spirit of a conservative andante.

As far as is necessary, Government should be the source of sound general rules for the conduct of all business but it should leave the actual operation of business to private enterprises under whose direction the most efficient and the most beneficent industrial economy in history has been developed in this country.

It should promote the interests of American agriculture by research, experimentation, education, and demonstration—not by engaging in the business of manufacture and distribution of commodities for farm use.

It should take proper and adequate steps to provide for future national defense needs, keeping war plants in standby condition to whatever extent may be necessary. Competent engineering skill is available in the military staffs to determine what is surplus.

Surplus property, acquired for war purposes but no longer needed for the war emergency, should be disposed of according to law. Great business skill, a deep sense of public responsibility, expert consideration of the true public interest, and a determination to do what, on balance, is best for the public welfare in the long run must govern the officials upon whom Congress imposes the duty of surplus disposal.

Government is in the labor relations field to stay. We should do our part to see that sound policies, fair to all concerned, are worked out and then followed without unfair discrimination. Certainly the future welfare and domestic peace of our country make the finding of right solutions for labor problems imperative. They will call for give and take, forbearance, fairness, frankness, mutually sympathetic understanding, and honesty in all dealings with one another.

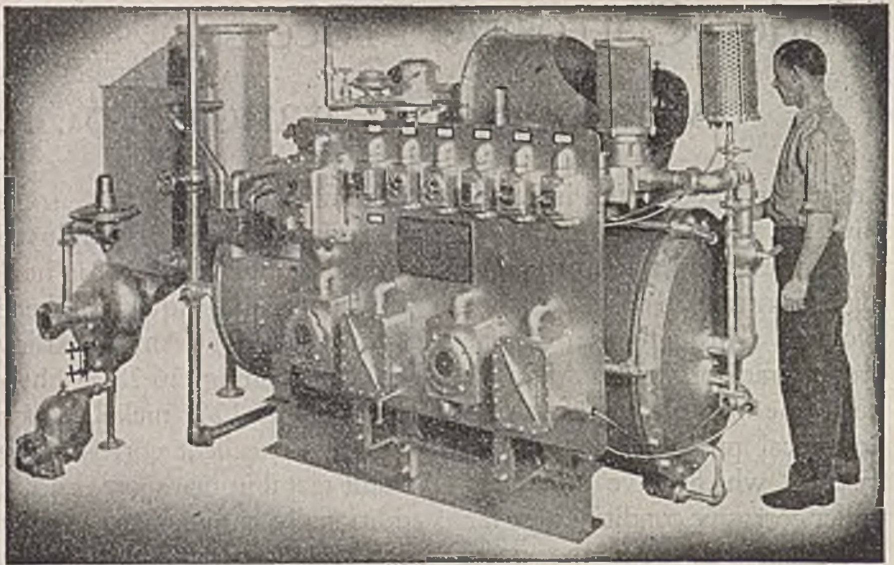
Government must tax. There is no common sense in crying out, wildly and indiscriminately, against taxation. So we should take a citizen's part and responsibility to see that taxes are laid wisely and well, and not discriminatively and destructively. We must also fearlessly do the citizens' part to insist that expenditures of every kind be made prudently and to satisfy real needs where real governmental responsibility exists and not in realms of political, economic, and social reform.

Charles J. Brand, executive secretary and treasurer, before National Fertilizer Association, Atlanta, June 21, 1944.

ARMY FIELD WATER SUPPLY

THERE are few items of Army supply more important than potable water and global mechanized warfare has introduced innumerable water supply and treatment problems heretofore not conceived.

Although basic principles of water purification are well established, their adaptation to field Army requirements presents many problems which do not normally concern water works men. Full cognizance is taken of the fact that proven design factors and operation procedures for water purification in fixed installations may be relied upon to produce a safe treated water. These same principles, however, when applied to portable equipment, frequently



introduce complications. It will be appreciated that the multiplicity of Army field water supply problems invite and occasionally result in deviations from standard water works practice.

Possible denial of field water supplies through their contamination with toxic materials has long been a source of concern to the responsible agencies. That the situation has never really arisen makes the problem only more complex since it must be handled entirely on a speculative basis, theorizing such matters as possible contaminants, amounts expected, and practicality of treatments. Yet insurance measures against this potential danger cannot be neglected.

A vast number of poisonous compounds are known, especially in the organic field, but a critical survey of these substances indicates that most could not be successfully employed as water contaminants.

Much work has been done during the past few years investigating the removal of different toxic materials from water. For Army use a simple universal method is required, it being impractical to adopt several specific treatment processes for use with individual contaminants. Standard water works procedures alone are of value here, and throughout past work, activated carbon has received the preferential consideration for this purpose. Activated carbon will absorb toxic organic contaminants from water although it is not effective in the removal of inorganic cyanides, arsenic, or heavy metals. These, however, were discounted from consideration on other grounds.

The carbon treatment of contaminated water is not ideal, requiring as it does large amounts of carbon. It has, however, the virtues of simplicity, effectiveness with the most probable contaminants, and familiarity to water personnel. Many types of activated carbons are produced commercially for different uses, exhibiting high specificities which cause a wide variance in their removals of different materials. Of these only the finely ground grades are applicable to existing equipment.

H. H. Black, Captain, Corps of Engineers, before Engineering Section, American Public Health Association, New York, Oct. 13, 1943.

CELLULOSE PLASTICS

Cellulose is an alcohol and will react chemically like other alcohols to form esters or ethers. Inorganic esters such as cellulose carbonate, sulphate, nitrate, or phosphate can be made; or organic esters like cellulose formate, acetate, stearate or butyrate; or mixed esters as cellulose nitrate acetate, cellulose acetate butyrate or cellulose acetate phthalate. Any number of ethers can likewise be made, as methyl cellulose, ethyl cellulose, benzyl cellulose. One can even make mixed ether-esters as ethyl cellulose stearate. Of all these possible products only a few are of commercial importance and only four are widely used in plastics. These are cellulose nitrate, cellulose acetate, cellulose acetate butyrate and ethyl cellulose. The use of these materials in plastics developed in the order listed. As each new member of the series was added the total importance of the series increased. Perhaps in time to come new derivatives will be added to the list but there is no such advance to announce today except in-so-far as ethyl cellulose may be considered a recent arrival.

It is not necessary to describe these products individually. They are all characterized by high impact strength, the ability to absorb a sudden shock. They are all true thermoplastics and will soften when heated and harden when cooled through as many cycles as one wants to go. People have talked about some sort of cross* between thermoplastic and thermosetting properties, the object being to have all the advantages of thermoplastic during processing. So far this has not been done commercially with cellulose derivatives.

There are really three types of tests applied to plastics. First, the simple merchandising tests for customer appeal; second, what we choose to call functional tests which determine by trial under adverse conditions whether the finished product will perform as expected; and third, engineering tests to determine fundamental strength characteristics. Considerable advance has been made in determining these engineering properties.

Cellulose plastics in general have very high impact strength. They will absorb a lot of sudden shock without breaking. Under a sustained heavy load, however, they all tend to give some cold flow, particularly if the temperature is a little high. Methods have been sought to reinforce these plastics in some way to reduce cold flow and further improve impact strength if possible. This objective has been accomplished to a considerable extent by laminating with fabric. Laminates made of cotton fabric and cellulose acetate or ethyl cellulose plastic have remarkable shock resistance and hold their shape rather well under fairly adverse conditions. Such laminates can be made and used as flat sheets, they can be made as flat sheets and then subsequently formed and drawn hot, or they can be built up around a form or mandrel.

The fact that flat sheets of thermoplastic laminate can be drawn is of particular interest since it offers a possibility of manufacturing the laminates in a few plants best equipped for the process, and shaping or fabricating them in numerous smaller plants where the finished products are being made. Deep draws and other forming operations can be made with very simple equipment. The plastic when heated forms its own adhesive so that sections can be joined by heat, or if desired a solvent-sealing process may be used. Combinations of plywood with cellulose plastic and fabric can be made and offer some promise.

Ethyl cellulose is the newest of the cellulose plastics. It has been well publicized. However, the effect of ethyl cellulose on the plastics business is just beginning to be felt and the marked increase in its importance during the past year may well be considered a recent advance. Since this has been a wartime development the uses of ethyl cellulose are strictly functional, that is, they depend on the fact that ethyl cellulose has properties which make it the only material which will do certain jobs well.

Fortunately for the country, but unfortunately for purposes of public discussion, most of these new uses of ethyl cellulose are of a military nature. However, the fundamental properties which dictate the use of ethyl cellulose are no secret. One is the wide useful temperature range. Dimensional stability is another feature in which ethyl cellulose is definitely better than either acetate or acetate butyrate. The good properties of ethyl cellulose as an electric insulator recommend it for use in electric equipment.

J. K. Speicher, Hercules Powder Co., before joint Plastics-Douglas Fir Plywood conference, Seattle, July 13, 1944.

TRANSITION PHENOMENA IN HIGH POLYMERS

Organic polymers of high molecular weight exhibit a variety of changes in state which profoundly affect their physical and mechanical properties, and are thus of both theoretical and practical interest. Temperature and external stress are, as expected, the principal determinants of these transitions. Delicate and subtle changes in structure govern the physical behavior of natural and synthetic high polymers.

The most general transition of essentially linear macromolecules is between high elasticity and ordinary elasticity; room temperature is above this transition point for rubber but is below it for polystyrene. These changes in state occur unsharply, as indicated by changes in slope but not discontinuities in the curves of specific heat, coefficient of thermal expansion, dielectric constant, modulus of elasticity, etc. vs. temperature. A great deal of their quantitative interpretation remains to be done.

A great many high polymers possess such geometrical regularity that at least portions of their long chains form ordered, crystal-like arrangements spontaneously above room temperature (polyethylene, polyesters, polyvinylidene chloride), or especially under particular conditions of cooling or annealing (polyamides, cellulose triesters). Others undergo such ordering at lower temperatures (natural rubber). Some polymers "crystallize" under external stress such as stretching, at higher temperatures than those at which they order spontaneously (natural rubber), or only under stress, and not spontaneously at any temperature (polyisobutylene). Many of these transitions, which X-ray and electron diffraction show to involve quite sharp changes in local order, have been lately found to possess high latent heats, or discontinuities in heat content-temperature curve, and are strikingly abrupt considering the great range of molecular weights, and presumably, of overall chain configurations, contained in the polydisperse samples investigated. The low temperature side of these first order transitions is distinguished by the strongest molecular interaction of any state or polymers. Indeed, the molecular packing appears often to be so efficient that characteristic high polymeric strength and toughness are attained at one-tenth the average molecular weight of similar molecular structures which do not show such first order transformations (polyethylene, ordered, compared to polystyrene, disordered.)

Recent studies on simple condensation polymers suggest that either the regular occurrence of points of strong van der

Waals' attraction along a given chain (polyvinyl alcohol, polyamides, polyesters, cellulose triesters, etc.) or such composition that the chain has a sort of rod-like, cylindrical symmetry around its axis (polyethylene, polyvinylidene chloride, polyisobutylene) is necessary for transformation to states of high local order. Attempts at detailed theories do not yet justify review. Evidently, transition temperatures influence greatly the particular utility of high polymers in the form of rubbers, plastics or fibers. Problems like the insolubility at room temperature of simple polymers such as polyethylene and polyvinylidene chloride have been enlightened by evidence that these substances gain sufficient rotational entropy in the solid to make dissolution thermodynamically unattractive. On the other hand, the decrease in entropy caused by orientation (fibering) of an already ordered polymer seems to be too slight to entitle orientation *per se* to classification as a separate state. Perhaps transition phenomena in high polymers are best summarized as being highly probable events for, actually, a given polymer solid usually contains several states of order simultaneously, never being all ordered, nor entirely disordered. These states are likely to be changing more or less continuously, much like the traditional changes in ancient glass.

W. O. Baker, Bell Telephone Laboratories, before Division of High Polymer Plastics, American Physical Society, Rochester, June, 1944.

RESIN ADHESIVES AND THE NEW PLYWOOD PROGRAM

Resin adhesives have become commercially important in the United States during the last decade. Their successful use has been responsible for fundamental changes in the technique of manufacturing plywood as well as in many other problems of wood adhesion. Synthetic resin adhesives have brought about the greatest advances that have occurred in the plywood industry in the last quarter of a century.

The earliest known glue was animal glue made from the bones and hides that eventually became important byproducts of the meat packing industry. Other conventional glues that followed the animal glues were vegetable (cassava flour), silicate of soda, casein, blood albumin, etc., developed progressively since about 1900. There were several rather serious limitations in most of these older glues, among which two of the major handicaps were their lack of endurance under severe weather and moisture exposure and the length of time required under pressure to secure a durable bond.

The durability of the heat-cured resin bond was its first outstanding improvement over the earlier glues. The process of heating a resin adhesive produces an irreversible chemical and physical change which was first recognized in blood albumin glue during the time of the first World War. The older animal and vegetable glues hardened by means of evaporation of the solvent and they were more or less resoluble when exposed to water. In the case of the synthetic resin adhesives the chemical and physical changes produced by heat render them distinctly nonresoluble under exposure to moisture. Resin adhesives, when properly chosen, efficiently applied and cured under heat, will produce a bond that is more durable than the wood layers which are thus joined together. This was an important adhesive development and was found to be of substantial help in the plywood requirements of the second World War.

In addition to the waterproofness of the resin adhesives, experience demonstrated that practically all of these types of resin adhesives are strongly resistant and repellant to mold and fungi growth. The resin adhesives themselves will not support mold or fungi growths, and effectively inoculate the wood for a considerable distance from the glue joints. These parasitic developments had always been found troublesome with the older conventional glues when plywood was exposed in warm, humid climates, such as the tropics, and even casein and blood albumin were seriously weakened under such conditions.

Another of the important factors in establishing the success of the synthetic resin industry was the shortening of clamping time for a satisfactory setting of the adhesive from a matter of hours to a few minutes. And within the last two or three years radio-frequency heating equipment has been developed to apply heat to the cure of resin adhesives. The most useful adhesive application of radio-frequency heat is its ability to heat thick wood assemblies through and through with a reasonable degree of uniformity in the entire assembly and within a surprisingly short interval of time.

There are two major classifications of synthetic resin adhesives, the phenolics and the ureas. The phenol-formaldehyde resin adhesives are the most durable type of synthetic resins for woodwork. They are thermosetting and possess durability superior to those resulting from any of the other resin adhesives. Phenol-formaldehyde resin adhesives are available in film, powder and liquid form. The films and powder have better storage life than the liquid type. From the standpoint of present knowledge, substantial heat seems essential to obtain a satisfactory cure with the phenol-formaldehyde types. However, studies now in progress would indicate that these temperatures can be considerably modified without appreciable sacrifice of durability and it seems reasonable to expect that moderate temperature phenolics, between 175 and 225 F., may soon become commercially important, and possibly supersede the higher temperature types in certain applications.

The other important class of synthetic resin adhesives is that of the urea-formaldehyde type, which is also thermosetting and is available in powder and liquid form, but is not available in film form. The ureas in general require lower temperatures and shorter curing cycles than the phenolics and with certain catalysts can be satisfactorily cured at room temperature of approximately 75 deg. F. The urea resin adhesives differ from the phenolics in their adaptability to the addition of high ratios of low cost extenders, such as wheat flours, while still possessing substantial water resistance. The urea resins are not as durable under moisture and heat exposure as are the phenolics but their durability characteristics are much better than the other conventional glues. This compatibility with extenders makes it possible to secure urea resin bonds in cost ranges that approach those of the early glues but with far better durability.

Cure of urea resin adhesives is usually facilitated by catalysts, commonly acidic in character. There is a considerable range of formula as well as of adjustments in required temperatures and in clamping periods. Urea resins are also available in fortified form. This requires the addition of chemical ingredients with the catalyst that increase the durability of the urea bond so that it approaches more nearly to the durability of phenolics.

There are several other types of resin adhesives, less important at the moment, which are just emerging from the development stage and may become commercially available in the future, although at the present time there seem to be serious limitations of cost which may prevent their economic comparison with the ureas and the phenolics. In the main, these lesser known resins, such as melamine and resorcinol, are used in combination with the ureas and the phenolics, since this affords the advantages while maintaining the cost factors within moderate limits. Whether these resins will be used by themselves remains for the future to determine. The melamine resins are chemically similar to the ureas, while the resorcinol is a particular type of phenol and both are thermosetting.

T. D. Perry, Resinous Products & Chemical Co., Philadelphia, before 10th Annual Chemurgic Conference, St. Louis, March, 1944.

POSTWAR CHINA AND AMERICAN ENGINEERS

You are worrying about postwar unemployment and finding jobs for your boys coming home, while we Chinese with so many industries to be developed will have a hard time finding experienced men to work.

We have a gigantic task to perform. We need outside assistance. You can offer your engineering experience, accomplishment, research facilities. You can furnish your best suitable and yet reasonable equipment to China. You can help to train our young engineers and technicians in your factories, drafting rooms, laboratories and you can help to train them in China.

Engineers utilize their knowledge of nature and experience in handling materials to convert natural resources and energy into products, power, and wealth, for the benefit of all mankind, thereby raising the standard of living of everybody. In China, we have a big job to do; engineers are the key men to do it. In order to carry on our work, we need a total of 2,000,000 more engineers. However, the new graduates cannot shoulder the responsibility of the gigantic job of industrialization. The only possibility of carrying on this work is to invite to China engineers of achievement and of high experience who will design, install, operate, manage and develop our machineries of production.

Training of additional engineers by our guest engineers is one of the prerequisites of this gigantic program. Chinese engineers trained in this country and in Europe are now most influential and many of them are holding important positions in various industries in China. Yet the number available is very limited. Mass production programs of technical training will have to be devised and carried out.

Right after the war, most of the displaced populace will return to their homeland and find that their houses have been demolished or destroyed by the war. They must be sheltered. At first we plan to give them temporary sheds with three rooms each. For this simple project alone, we would need 2,000,000,000 cubic feet of wood and 100,000 tons of hardware. Later on, when living conditions return to normal, more decent and comfortable homes, more public and administrative buildings will be built. Cement factories, brick factories, stone quarries, lumber mills, furniture factories, hardware factories, glass factories, paint factories, etc., are bound to come to exist in order to supply the demand. Household appliances such as refrigerators, vacuum cleaners, washing machines will also come in time. Public utilities such as city transportation, sewerage, water, lighting and gas are industries to be developed parallel with housing. We also must have the all important basic heavy industries such as coal, oil, steel, power, ship building, and basic machinery. China is so big and the industries to be developed are so many that the Central Planning Office will have to study and ascertain what kinds of industries are most suitable to certain localities. We will have to have raw materials, labor, capital and technical skill. We have an abundance of raw materials and man-power. What we are in need of and hope for from our friendly nations are capital and technical skill.

China has enormous resources; if she has sufficient capital, she can develop her industries. At the beginning of her industrialization, she will pay her loans by her usual export of raw materials such as tungsten, tin, antimony, silk, tea, tung oil, and some other farm products. She can also pay a part of her debts by exporting products of handicrafts. Later on, when the finished products roll out, they will be exported to pay her debts. Loans or capital investments may be in the form of material, machinery or equipment. For this war, billions of dollars and pounds have been spent to establish new manufacturing plants in U. S. A. and in England. After the war, these new machineries are bound to lay idle and deteriorate. Your statesmen, economists and industrialists are now busily engaged in investigating and planning the post-war utilization of such a tremendous amount of machinery and equipment. Well, here is one of the possible solutions. They can be sold or loaned to China serving as a basis for building up her industry. We will leave the details of such capital or investment to the financial experts.

K. Y. Chen assistant Chief, Far Eastern Division, UNRRA, before American Society of Mechanical Engineers, Washington, D. C., June 21, 1944.

FOREIGN LITERATURE ABSTRACTS

DETERMINATION OF ALKALI METALS IN PORTLAND CEMENT

A METHOD for determining alkali metals in Portland cement has been developed which is superior to the method recommended by the American Society for Testing Materials in that the reagents used are very simple and considerably less time is required.

Method of analysis is roughly as follows: a mixture of 5 g. cement, 1 g. ammonium chloride and 5 g. calcium carbonate is heated in a platinum crucible up to 500 deg. in a 15 min. period and up to approximately 900 deg. in the next 45 min. The resulting mass is transferred to another dish, treated with boiling distilled water several times and washed, and then concentrated to about 50 cc. Ammonium carbonate (3 g.) is added gradually, the mixture boiled for several seconds, filtered and washed with 50 cc. of a solution of ammonium hydroxide and ammonium carbonate in distilled water. This liquor is then concentrated to 20 cc., neutralized with concentrated ammonium hydroxide and the last traces of calcium precipitated out with 5 cc. of an ammonium oxalate solution. Ammonium compounds are then eliminated by neutralization and heating, the residue is dissolved in 10 cc. water, washed, and the SO_4 ion eliminated with 10 percent barium chloride. After further treatment the residue is treated with 15 cc. of an alcoholic solution of perchloric acid, washed, dried, etc. The weight of the residue multiplied by the factor 0.34 gives the quantity of potassium (in K_2O) contained in 5 g. of the sample analyzed. After further treatment, 6 drops of sulphuric acid are added to the residue and the residue calcined and weighed. Its weight, multiplied by the factor 0.4366, gives the quantity of sodium oxide contained in 5 g. of sample analyzed.

Digest from "Determination of Alkali Metals in Portland Cement," by Jose Jorge Nogueira and Francisco J. Maffei. *Anais da Associacao Quimica do Brasil* III, No. 1, 8-12, 1944. (Published in Brazil.)

CATALYTIC OXIDATION OF ACETYLENE

OXIDATION of acetylene, using active manganese dioxide as catalyst, was carried out in connection with the problem of purifying air of low concentrations of acetylene. Technical acetylene was used in a concentration of 0.04-0.57 percent of the air-acetylene mixture. The commercial active manganese dioxide used as catalyst was pressed into tablets, crushed and screened into fractions of the desired fineness. The air came through a blower outside the building, was passed through a layer of cotton and activated carbon to remove traces of oil and dried with calcium chloride. The air and acetylene were passed through flow meters, mixed, heated by passage through a coil and made to flow at the rate of 30-100 l. per hr. per cc. of catalyst. The temperature was also raised by the heat of reaction in the tube. The heat liberated per hour, q, can be calculated from $\Delta t V \rho C p$, Δt being the difference in temperature of the entering and of the exit gas, ρ the density and Cp the heat capacity. The amount of heat liberated per hour when all the acetylene was completely oxidized could also be calculated. The temperatures shown by the thermocouple indicating the value of Δt and the mercury thermometer in the catalyst mass showed that heat exchange between the catalyst and the gas was slow, an indication of diffusion kinetics. The temperature of the catalyst mass was taken as the temperature of the experiment. Comparison of the results calculated for percentage of acetylene oxidized with the results from photo-colorimetric analysis indicated that the authors' thermochemical method was more exact.

Apparent order of the reaction depended upon temperature, a characteristic of reactions taking place on porous materials. According to Zeldovich (1939), if it is assumed that the reaction takes place in the region of diffusion at 220 deg. and in the inner kinetic region at 142 deg., the order of the reaction 0.75 found at 190 deg. corresponds to the occurrence of the reaction in the transitional or inner diffusion region. The order of the reaction in this region should be equal to the arithemetical mean of the orders of reaction in the kinetic and the diffusion regions.

Velocity-temperature curves for varying space velocities and temperatures exhibit turns or changes in curvature indicating change in mechanism accompanying change in temperature. Breaks in a curve mark changes in apparent energy of activation. In one case no dependence upon temperature appeared above 219 deg. and this was considered to correspond to the diffusion region. There was a transitional region or region of inner diffusion down to 170 deg. and below 170 deg. the energy of activation rose in jumps, this being the kinetic region. A rise in velocity shifted the limit of the diffusion region toward higher temperatures, in accordance with theory. At lower temperatures, the rate of reaction was practically independent of grain size; but upon transition into the diffusion region, increased grain size was accompanied by marked increase in rate of reaction. This was confirmed by experiments with catalysts of different grain size. Reduction of the rate of reaction which occurred when the diameter of the grain was reduced to below 1.25-1.5 mm. is not explained, unless it is due to greater resistance to the flow of the gas mixture.

Digest from "Kinetics of Catalytic Oxidation of Acetylene on Active Manganese Dioxide," by V. Rolter and M. Rusov. *Zhurnal Fizicheskoi Khimii* 17, 87-96, 1943. (Published in Russia.)

MONOPHENYL THIOUREA PRODUCTION

A METHOD for the direct production of monophenyl thiourea from aniline hydrochloride and ammonium thiocyanate has been developed recently in Germany.

Aniline hydrochloride is added to ammonium thiocyanate in aqueous solution, and the aniline thiocyanate formed in quantitative yield is readily converted into monophenyl thiourea by application of heat. Since the latter can react further with aniline hydrochloride to form diphenyl thiourea, which is not suitable for making synthetic resins, it is necessary to use an excess of ammonium thiocyanate (25-30 percent). The latter remains in the mother liquor after separation of the monophenyl thiourea.

There is no difficulty in separating the monophenyl thiourea from the ammonium chloride formed simultaneously. On heating the reaction product to about 100 deg. C. the urea derivative separates out at the bottom of the vessel as an oily layer which can be run off and after solidification crystallized from alcohol with a 90 percent yield of pure monophenyl thiourea. From 5 to 8 percent more of a mixture of mono- and diphenyl thiourea is obtained by evaporation of the alcohol. The ammonium chloride separates out when the mother liquor is cooled so that it can be separated out and the mother liquor returned to the process. The ammonium chloride is washed with the alcohol subsequently used for the recrystallization of the monophenyl thiourea. Aniline sulphate can be used instead of aniline hydrochloride, the two solid reactants being mixed in the presence of alcohol in this case. Aniline thiocyanate is formed quantitatively by brief warming to 50-60 deg. C. The difficultly soluble ammonium sulphate is separated by filtration and the final conversion to monophenyl thiourea carried out in an alcoholic solution which is practically free of inorganic matter.

Either method permits continuous operation and yields of 95 percent of pure monophenyl thiourea with complete recovery of the alcohol used and with solid ammonium compounds as useful by-products.

Digest from "Thiourea from Ammonium Thiocyanate," by W. Klempt, *Die Chemische Technik*, Jan. 10, 1942. (Published in Germany.)

CHROMIUM PRODUCTION IN BRAZIL

There are five chromium producing regions in Brazil. Three are in the state of Baia, one in the state of Minas Gerais and one in the state of Goiaz. In normal times chromium mineral with a Cr_2O_3 content or up to 48 percent and a chromium-iron proportion of approximately 3 is used for metallurgical purposes. When the chromium content is relatively low, the mineral is used in the chemical or refractory industries.

The Formoso mine in Baia is estimated to have a reserve of several tens of thousands of tons of mineral suitable for metallurgical purposes and two or three hundred tons of mineral which can be used as refractory. Brazil's total chromium mineral production in the last five years has been from the state of Baia and is as follows: 850 tons in 1937, 940 in 1938, 3,760 in 1939, 4,580 in 1940 and 4,450 tons in 1941.

Digest from "Brazil 1942, Mineral Resources," Bulletin No. 56, p. 30, 1943. (Published in Brazil.)

CHEMICAL ENGINEER'S BOOKSHELF

LESTER B. POPE, Assistant Editor

POPULAR PLASTICS

Plastic Horizons. *By B. H. Weil and Victor J. Anhorn. Published by The Jaques Cattell Press, Lancaster, Pa. 169 pages. Price $2.50.*

Reviewed by Chaplin Tyler

This compact little book on plastics was written primarily for the layman. However, the authors, who are staff members of the Gulf Research and Development Co., have said a great deal that could be read with profit by the scientific and technological fraternity.

After a lucid description of various major plastic products, the authors present statistics showing the growth of the plastics industry and the quantities of raw materials consumed. Next there is an excellent account of war applications of plastics. This is followed by a review of synthetic fibers and synthetic rubber-like materials. The book concludes on future applications of plastics in construction, automobiles, aircraft, home furnishings, and less well-defined fields. The authors have treated their subject sanely, avoiding wild predictions of a magical plastics age. They are optimistic, but do not foresee in plastics the doom of steel and other metals. They give credit generously to various companies in the industry.

Only in a few instances does the reviewer question the authors' technical accuracy: On p. 26 they refer to the casting of polymethyl methacrylate as though a "molten resin" is used. This not the case at least in layman's language. On p. 32, the authors refer to "polyvinyl alcohol—known as Resistoflex." That the two terms are synonymous is questioned. On p. 133 the price of cellulose nitrate plastic is given as $28 per cubic foot of 92 pounds. In recent years the average value at factory of sheets, rods, and tubes has been roundly three times this figure. Typographical errors were noted on pp. 16, 38, 61, and 99.

NOTHING NEW

Principles of Powder Metallurgy. *By Franz Skaupy. Published by Philosophical Library, New York, N. Y. 80 pages. Price $3.*

Reviewed by W. P. Sykes

This 80-page booklet deals almost exclusively with the properties of tungsten and molybdenum and the methods of their production. A few pages are devoted to the hard carbides. The introductory chapter consists mainly of theoretical speculations which are decidedly controversial in nature.

As indicated by the references and the limited scope of the subject matter this booklet is a translation of several German papers none of which were published later than 1930, and the few illustrations, especially the photomicrographs, are distinctly unilluminating.

Evidently the translator is sadly unfamiliar with metallurgical terms for not a page is lacking in one or more amusing examples of inadequate translation. Throughout the text the word "wolfram" (or even "wolframite") is used in place of "tungsten." To speak of a wire drawing die as a "nozzle"; grain boundaries as "points of impact"; hydrochloric acid as "salt acid" and clamps as "manacles" may indeed introduce the desired element of humor but hardly contributes to clarity of exposition.

Perhaps something might be said to recommend the book for its historical value although this is not implied in the title. Taking all in all it does not appear to contribute anything new to the knowledge of powder metallurgy and certainly is not to be compared with other available books dealing with this subject.

RECENT BOOKS RECEIVED

The Bureaucrat. By John H. Crider. B. Lippincott Co. $3.

Dictionary of Organic Chemistry. Vol. I. Ed. by I. M. Heilbron, H. M. Bunbury, E. R. H. Jones & W. E. Jones. Oxford University Press. $30.

Phosphates and Superphosphate. 2nd ed. By A. N. Gray. Lewis (London). 21s.

Thermodynamic Charts. 2nd ed. By F. O. Ellenwood & C. O. Mackey. Wiley. $2.75.

FOR BULLETS AND BOMBS

The Science of Explosives. *By Martin Meyer. Published by Thomas Y. Crowell Co., New York, N. Y. 452 pages. Price $4.50.*

There has been, as Prof. Meyer admits, much written in the field of explosives. His purpose in adding further to this literature is to provide a single source of information on the chemistry, production and anaylsis of explosives. The book apparently was intended to serve as a text for courses in explosives since each of its 16 chapters concludes with a series of discussion questions and exercises. The exposition is clear and the whole field is well covered. Opening with a chapter on history, the book continues with discussions of the various explosives. In addition, there is considerable material on acids and nitration, initiators, explosive and initiating devices, inspection and analysis, applications and use, packing, shipping, storing and safety. On the whole, a competent job seems to have been done by the author and a worthwhile addition made to the literature of a subject of considerable wartime importance.

MICROSCOPE PLUS CAMERA

Photomicrography, Theory & Practice. *By Charles Patten Shillaber. Published by John Wiley & Sons, New York, N. Y. 773 pages. Price $10.*

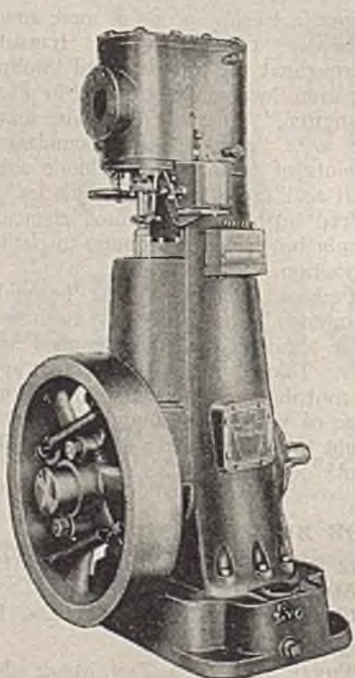
Reviewed by Richard W. Porter

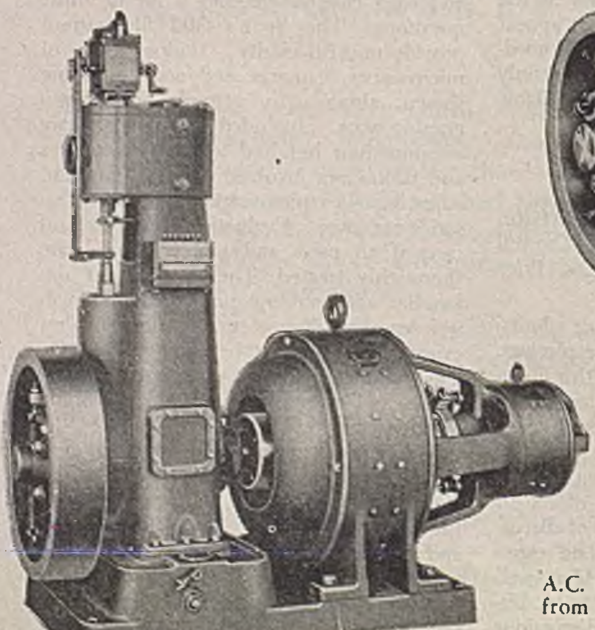
While there are several good works on both microscopy and photography, the subject of photomicrography has never been thoroughly covered and this volume appears to fill a real need. It is a combination textbook and reference work on the application of photography to the compound microscope. The material given is basic and deals primarily with the actual problems encountered in this field. While the fundamental principles of microscopy are based on optics and mechanics, these subjects are treated only insofar as they have a practical value to the student of photomicrography. Such special phases as color photography, ultraviolet and infrared radiation, and polarized light are not considered.

Considerable detail is used by the author to describe the many phases of photomicrography and his method of treatment is logical and complete. Each subject is discussed in its component parts and the results summarized in tabular form. Laboratory experiments and exercises are outlined and each chapter contains a list of study questions. The book's 300 illustrations provide unusual clarity. Various kinds of microscopes, cameras and accessories are shown, along with examples of photographic work. Included also is a glossary of some four hundred terms. Procedures and techniques involved in setting up and adjusting the microscope with its accessories are given. Evaluation, selection and care of all parts and materials used are thoroughly treated. The microscopist unfamiliar with photographic technique will welcome the discussion on cameras, film, exposure time, and other practical details. Theory of developing photosensitive materials and many formulas of developing solutions are included.

While six out of eight chapters deal almost wholly with equipment, accessories and materials used in photomicrography, the last two chapters deal with methods and materials used in preparing specimens, and with the analysis of photomicrographic problems. Mounting media, stains, reagents, and solvents are discussed in detail with respect to their use and application. All types of specimens are classified into eight groups. The problems dealing with each group are analyzed to acquaint the technician with the best methods of approach.

All things considered, the subject has been well treated to provide a real contribution as a textbook, reference and guide.





PREDICT THE DAMAGE

EXPLOSIONS THEIR ANATOMY AND DESTRUCTIVENESS. *By Clark Shove Robinson. Published by McGraw-Hill Book Co., New York, N. Y. 88 pages. Price $1.50.*

Reviewed by G. F. Kinney

THIS short study of explosions is based on lectures given to auditors from the Safety and Security Branch of the Office of Ordnance, Army Service Forces. Its purpose is to give some knowledge of the hazards involved in possible explosions.

Damage from explosions may be caused by the blast of hot gases, by the detonation wave, and by flying missiles. Each effect may be analyzed separately, the effective range predicted, and the total probable destruction then estimated. The hazards thus associated with a possible explosion prescribe the minimum distances for specified degrees of protection. The protection afforded by standard safety practices is discussed, and it seems that minor modifications could perhaps be made in some of them.

The book contains much information that is not readily available from other sources. It is required reading for ordnance men, safety engineers, and others who work with explosives.

MAGNETIC METHODS

MAGNETOCHEMISTRY. *By Pierce W. Selwood. Published by Interscience Publishers, Inc., New York, N. Y. 287 pages. Price $5.*

Reviewed by Linus Pauling

MAGNETOCHEMISTRY is defined by the author of this book as the application of magnetic susceptibilities and of closely related quantities to the solution of chemical problems. The usefulness of magnetic methods in chemistry has not been very widely recognized. By his clear, simple discussion of the experimental methods of magnetochemistry and of the results which have been obtained by the application of these methods. Professor Selwood has made an important contribution to science, and has done his part in calling the usefulness and power of magnetic methods to the attention of chemists. It is clear from his book that magnetochemistry is a most fertile and promising field of research, and that magnetic methods may be used for the solution of problems in industrial chemistry as well as pure chemistry.

In successive chapters the author presents brief descriptions of the principal experimental methods of measurement of magnetic susceptibility, the theory and experimental information of the diamagnetism of atoms, ions, and molecules, the theory of atomic paramagnetism, experimental values of magnetic moments of ions, the paramagnetism of molecules and complexes, the diamagnetism and paramagnetism of metals, ferromagnetism, and the use of magnetic methods in analysis. The treatment throughout is experimental and practical rather than theoretical; the author is, of course, justified in keeping the discussion of magnetic theory brief because of the existence of the excellent book by J. H. Van Vleck on the theory of electric and magnetic susceptibilities.

A very satisfactory survey of the entire field of the application of magnetic methods to chemistry is presented in the book—so far as the reviewer is aware, the author has omitted mention of no important magnetochemical study. The subject of magnetochemistry is so closely related to molecular structure that a decision must be made in the presentation of the subject as to where to stop the discussion of the structural interpretation of magnetic data. The author has made a reasonable compromise in this matter—he has included enough discussion of molecular structure to show the usefulness of magnetochemical data, without allowing moleoular structure to assume primary importance. A feature of the book which will interest inorganic chemists is the discussion of the structure of complexes of the individual elements as indicated by their magnetic properties.

Reference is given to most of the original papers in which the results of magnetochemical investigations have been published; the number quoted is greater than 1,250.

EXPLOSIVES TESTING

Laboratory Manual of Explosive Chemistry. *By A. L. Olsen and J. W. Greene. Published by John Wiley & Sons, New York, N. Y. 106 pages. Price $1.75.*

Textbook for a one-semester course in the testing of explosives and related materials, this small book is the result of the authors' experience in presenting ESMWT courses. Detailed directions are given and, since laboratory work with explosives entails certain hazards, adequate safety precautions are stressed throughout. Upon satisfactory completion of the work, the student is well acquainted with prescribed U. S. Army tests.

CRITICAL COMPILATION

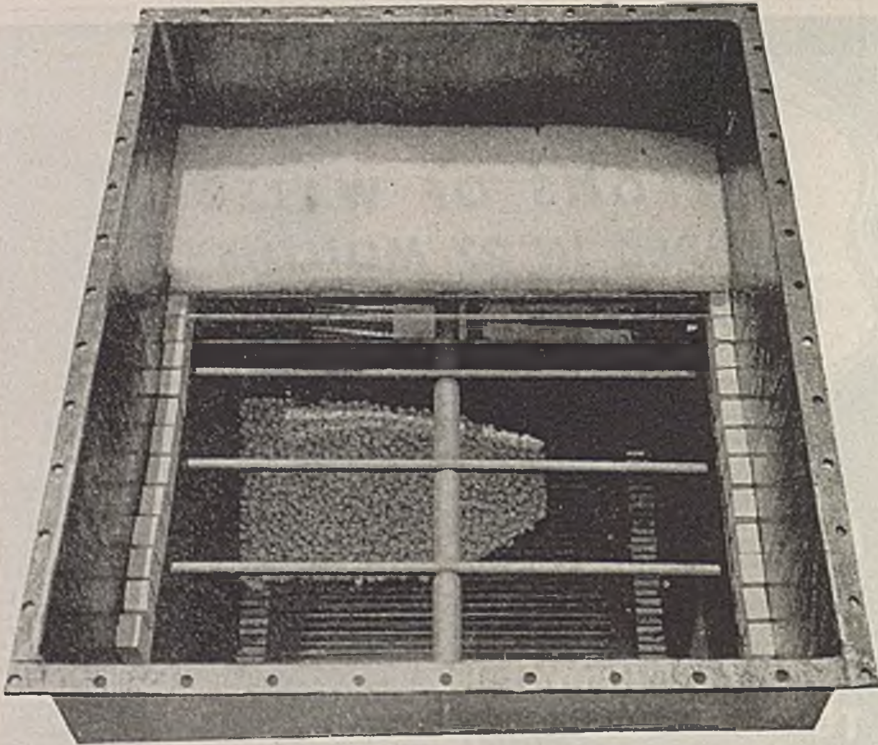
Colorimetric Determination of Traces of Metals. *By E. B. Sandell. Published by Interscience Publishers, Inc., New York, N. Y. 487 pages. Price $7.*

Reviewed by F. C. Nachod

A great number of papers have been written dealing with analysis of small traces but no critical compilation was available to the researcher. Thus, Dr. Sandell's book will be welcomed by many, and will save many hours of search for suitable methods.

The book is grouped into two main portions, a general part which discusses methods of trace analysis, separation and isolation methods, colorimetry and spectrophotometry, and specific reagents. There is also a special part in which the analytical procedures for the various metals are described. Each of these portions in the special part are subdivided into three sections; separations, methods of determination, and applications. The factual material of this special part is quite impressive, comprising methods of analysis for 45 elements (not including those for rare earths). Tables of logarithms, transmission-extinction values and atomic weights are appended.

A few minor criticisms are recorded: In the first lines of Chap. I, p. 3, the reader is referred to Fig. 1, after he has worked his way through to p. 10, he finds this



Gas entry side of fume washer.

illustration. The style does not make easy reading throughout all the book and the first lines of the text bear this out. The term hexavalent is by far more common usage than sexivalent (p. 16). No complete consistency is shown in the use of the teminology, and both terms, γ and microgram are used on one page (19). Care should be taken to differentiate between density and optical density of solutions (p. 34). However, these are minor criticisms and the aim to "provide for a collection of modern methods in this field of analysis" seems to have been accomplished very well. Congratulations should go to the author as well as the publishers.'

LABORATORY MANUAL

A LABORATORY MANUAL OF PLASTICS AND SYNTHETIC RESINS. *By G. F. D'Alelio. Published by John Wiley & Sons, Inc., New York, N. Y. 134 pages. Price $2.*

CONTAINING 88 experiments and 26 test methods, this spiral bound manual is usable as a part of a laboratory course in plastics to be undertaken by students who have studied organic chemistry. Not designed as a signpost to manufacturing procedures, it is intended to illustrate the chemical principles underlying the preparation of plastics and synthetic resins, and is supplemented by such data as check-up lists, methods for testing and sources for chemical supplies. Most of the commonly known resins and plastics which are readily prepared, are treated in this manual, in order to serve as a guide to the demonstration of the chemical fundamentals in the field.

OPERATIONS AND APPARATUS

MODERN WOOD ADHESIVES. *By Thomas D. Perry. Published by Pitman Publishing Corp., New York, N. Y. 208 pages. Price $3.*

Reviewed by Jerome Alexander

THE 16 Chapters bear the following headings: Origin of Glues and Their Uses (10 pp.); Animal Glues (9 pp.); Vegetable Glues (9 pp.); Casein Glues (6 pp.); Soybean Glues (10 pp.); Synthetic Resin Adhesives (22 pp.); Silicate of Soda Glues (5 pp.); Albumin Glues (6 pp.); Prepared Glues (4 pp.); Methods of Comparing Glues (17 pp.); Glue Mixing and Spreading Equipment (16 pp.); Pressure in Gluing (20 pp.); Adhesion Secured by Heat (13 pp.); Redriers for Glue Solvents (7 pp.); Impregnation (14 pp.); Glue Testing (18 pp.). The book opens with a 13-page Glossary of Trade Terms Used in the Wood-Adhesive Industry (many hardly require special definition), and closes with a 7-page Index of subjects. There is no author index, but each chapter has a "bibliography," followed by a series of "Questions" such as are often found in elementary textbooks.

As will be seen from the above epitome, the book is strongest in dealing with practical operations and apparatus; but it is weak scientifically, and can hardly be called (p.v.) "a reference book." The author is employed by a producer of resin glues and feels "especially indebted" to about 15 firms "who have given friendly cooperation in the preparation of the copy, and have granted permission to reprint excerpts or synopses of copyrighted material." Much of interest to the chemist is omitted, though it may be found in other books or in patents or other literature. For example: (p. 25) glues "are defoamed"—but how and with what?; (p. 50) in a formula there is a "waterproofing compound," with nothing further about it; (p. 62) in speaking of "Catalysts or Hardeners" they are referred to as "chemicals" which are "frequently combined with other chemicals for the better regulation of standard bonding cycles."..."It is important that resin-adhesive users consult their suppliers to ascertain what extenders are compatible with specific resins and the exact ratios that can be used to secure the desired results."

While no one should expect that a book of this kind will give scientific details of value to competitors, it should give at least a fair resumé of what is already public, and not expose the reader to a blackout. In the case of machinery and practical operations, however, the author gives much detail and useful illustrations, evidence of his experience.

In Chapter III on vegetable glues, even when it is stated that the processing of cassava is little practised at present, the processing is described as "subjecting the starch to chemical action, followed by washing out or neutralizing the chemicals, and these methods were mostly patented." Originally, in order to get a sufficiently concentrated yet workable starch dispersion, the starch, before treatment with caustic soda, was made thin-boiling by treatment with dilute mineral acid below the gelatinizing point, or by oxidizing agents like sodium peroxide. These patents have run out or were knocked out, and secrecy is no longer needed. However, in the formulas on pp. 37–38 the cassava flour is referred to as "blended," whatever that may mean.

In Chapter IV on Casein Glues, no mention is made of casein made by use of rennin, which is generally not used for making glue. But the author gives this insipid statement: "Raw caseins very considerably in quality, and certain types are more useful as glues than others. Experience is required to make suitable selection of types that possess gluing characteristics."

If, instead of depending so heavily upon suppliers of adhesives, the author had gone to the literature, books and patents for information, he could have added this to his own experience and made the "material" part of his book as useful as the "practical" part. As it is, the reader is left in the hands of the "suppliers."

DYE HISTORY

ANCIENT AND MEDIEVAL DYES. *By W. F. Leggett. Published by Chemical Publishing Co., Brooklyn, N. Y. 94 pages. Price $2.50.*

Reviewed by S. Sussman

THIS little volume describes the discovery and development of vegetable, animal and mineral coloring materials by ancient and primitive peoples. While it cannot be considered a reference work on the subject, it will provide entertaining reading for those interested in the history of chemistry or in the origins of the dye industry.

RECENT BOOKS & PAMPHLETS

Transactions of the American Institute of Chemical Engineers, Vol. XXXIX, 1943. Published by the Institute, 50 E. 41st St., New York 17, N. Y. 857 pages. Containing all technical papers published during the year 1943.

Contractors Guide. Pamphlet No. 34-2, issued by War Department, Washington 25, D. C. 48 pages. Suggestions to war contractors as to preparation for and methods of contract terminations applying to fixed-price supply contracts of the War Department.

Practical Design for Arc Welding. Vol. I. By R. E. Kinkead. Published by The Hobart Brothers Co., Troy 1, Ohio. Price $3.50. First of three volumes. An illustrated working book of information and drawings showing how tubing, sheets, and other forms can be used to fabricate products.

Principles of Heat Treating Steel. By H. L. Walker. Engineering Experiment Station Reprint Series No. 31, published by the University of Illinois. Urbana, Ill. 45 pages. Price, 15 cents. A reprint from *Ceramic Industry*.

Industrial Recreation. Published by the P. Goldsmith Sons, Inc., Cincinnati 14, Ohio. 16 pages. An aid in planning off-time play for industrial employees.

Reconversion—The Job Ahead. By J. A. Livingston. Pamphlet No. 94 published by Public Affairs Committee, Inc., 30 Rockefeller Plaza, New York 20, N. Y. 32 pages. Price 10 cents. An analysis by the editor of *War Progress*.

Practical Metallurgy for Engineers. Fourth edition. Published by E. F. Houghton & Co., Philadelphia, Pa. 439 pages. Price $3. The experience of members of the Houghton research staff made a matter of record.

Orienting the New Worker. Prepared by Policyholders Service Bureau, Metropolitan Life Insurance Co., New York 10, N. Y. 60 pages. Gratis when requested on business stationery. Plans and techniques designed to enhance friendly relations with new employees.

MAPI Accounting Manual. Published by Machinery and Allied Products Institute, Chicago, Ill. Price $5. An accounting manual for use in capital goods industries. Broadly applicable to other lines of business.

A Summary of Data on Synthetic Rubber. Revised edition. Published by the Rubber Manufacturers Association, 444 Madison Ave., New York 22, N. Y. 36 pages. Digest of information and background data on the subject of synthetic rubber.

Standard System of Nomenclature for Chemical Engineering Unit Operations. Published by American Institute of Chemical Engineers, 15 E. 41st St., New York 17, N. Y. 18 pages. A listing of symbols and nomenclature with typical units and recommended abbreviations. Reprinted from *Trans.* A. I. Ch. E., corrected to July 1, 1944.

Handling and Storage of Paper Shipping Sacks. Manual B-1 published by Manufacturing Chemists' Association, 608 Woodward Bldg., Washington 5, D. C. 6 pages. Price 15 cents. Recommended practice in the handling and storage of Multiwall paper bags when filled with chemicals or allied products.

Fiscal and Monetary Policy. By Beardsley Ruml and H. C. Sonne. Pamphlet No. 35, published by National Planning Association, 800-21st St., N.W., Washington 6, D. C. 42 pages. Price 25 cents. Recommendations for a national fiscal, monetary and tax program.

Koppers. Published by the Koppers Co., Pittsburgh 19, Pa. 32 pages. A profusely illustrated book commemorating the 50th anniversary of the introduction of the first by-product coke ovens in the United States.

Stratigraphy of the Colorado Group, Upper Cretaceous, in Northern New Mexico. By C. H. Rankin. Bulletin No. 20, New Mexico School of Mines, Socorro, N. M. 30 pages. Price 25 cents.

Engineering Papers—Fourth Annual Contest. Published by Hydraulic Institute, 90 West St., New York 6, N. Y. Price $1.50. Five engineering papers on subjects pertaining to pumps: Special operating conditions of centrifugal pumps; A common language for hydraulic engineers; Critical speed; Direct-acting steam pumps; Effect of entrained or dissolved gas on rotary pump performance.

The *Stake* of the United States in Expanding World Trade

WITH the war in Europe racing to a climax, and with a sure pattern for the defeat of Japan already outlined, American business is confronted with the need for an immediate decision on long-term economic policy.

What is this country's foreign trade program to be after the war?

No intelligent appraisal of all the factors any longer can allow us to postpone considering the issue merely because, in the past, foreign trade absorbed barely eight per cent of our production.

Actually, a whole new set of conditions was injected into the picture by the first World War; but we persisted in ignoring these new factors.

Almost overnight, the United States was transformed from the largest debtor nation in the world to the second largest creditor nation. At the same time, we made faster technological progress than any other nation. Thus we created the need for more dollar exchange on the part of the rest of the world and simultaneously made it harder for other nations to earn dollars.

Today, as another, far vaster war is approaching its end, those changed circumstances are magnified. America has new responsibilities—to itself, and to the world.

Our war-inflated industrial capacity cannot be allowed to drop back to prewar levels without causing a domestic crisis which we dare not permit.

And, because so much of the world is geared to the American industrial machine, we can no longer contemplate calmly the repercussions of a largely self-sufficient trade program or of an unplanned foreign trade program. Either would inevitably set the stage for the next world war.

☆ ☆ ☆

If we are going to prepare ourselves intelligently to cope with this new problem, we must acknowledge certain basic principles.

World trade cannot be rebuilt simply by attempting to restore *prewar* flows of goods. The war has so completely changed the economic fiber of many countries that it is necessary to develop *new* trade relationships. The East Indies, for example, may find the demand for their rubber considerably reduced; the United States may, to a large extent, have to cease exporting cotton; Japan will need to find new substitutes for much of its exports of silk; the British will need new markets to replace the income which they formerly derived from their large overseas investments.

We cannot expand markets for our goods, at home or abroad, unless we find ways of buying more supplies from more people at home or abroad, so that they will have more dollars to spend.

And we probably cannot create increasing buying power abroad without first exporting more of our technical skills—our engineers, our production and management men—to build new markets for our own specialties.

☆ ☆ ☆

What is needed to rebuild the world's economic system?

1. Most basic of all, of course, are stable governments which command popular support. In the absence of strong governments, currency stability cannot be achieved.

2. Most war-stricken countries, for a year or two, will need rehabilitation loans, because they will require far more raw materials, equipment, and live stock than they can pay for out of current production.

3. Loans, however, are only a stop-gap, though often a necessary one. Far more important than rehabilitation loans will be the creation of better opportunities for war-stricken countries to sell to the rest of the world, particularly to the United States, South America, South Africa, and India. The ravages of war do not completely destroy the ability of a country to sell. Indeed, it is surprising what large supplies of certain commodities war-torn countries have on hand even before devastated industries have been restored. The invading troops in Normandy found shoes almost non-existent, but they found food more plentiful than in Britain.

   Better opportunities for war-stricken countries to sell would create opportunities for them to buy the things they will require to restore scattered industries and depleted farms, and would help those countries to get rid of the exchange controls which are now universal. So long as a country is able to expand its exports only slowly and painfully, and is dependent upon foreign loans to prevent the depreciation of its currency, so long will it carefully preserve exchange controls and other restrictions in imports. That is why large advances, either through an International Monetary Fund or an International Investment Bank, can make only limited contribution to the removal of trade restrictions.

4. Permanent monetary and credit arrangements are needed to protect nations against temporary pressure upon their currencies, to permit necessary changes in exchange rates to be made in an orderly manner, and to assure that governments never again will repeat the "beggar-my-neighbor" policies of 1931 and 1932.

5. Finally, the world needs a reversal of the trend toward economic self-sufficiency, which received a strong impetus from the first World War and an even stronger one from the great depression of the Thirties. This does not mean that the efforts of many raw-material producing countries to diversify their industries should be opposed. During the late Nineteenth Century and the first part of

this century, the international specialization of production was carried too far, with the result that many countries became dependent for a large part of their standard of living upon the export of one or two raw materials—coffee, sugar, rubber, silk, wheat, wool, and meat. Between the two World Wars, however, the pendulum swung much too far in the direction of self-sufficiency. Some densely populated industrial countries of Europe (Italy, France, and Germany) even attempted to become self-sufficient in wheat, fats, and sugar. So limited are the natural resources and technical skills of most countries that each one finds many things which it can produce only at prohibitive costs. Between the extreme specialization of the late Nineteenth Century and the more recent trend toward extreme self-sufficiency, a happy medium should be sought.

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What role should the United States play in reconstructing the world's international economic system?

There are those who suggest that the United States be a more or less permanent Santa Claus. They believe that an excess of exports could be financed only by "loans"—loans that would eventually turn into gifts, after producing bitter controversy over why the "debtor" country did not meet its obligations. The persons who assert that full employment can be provided only by an excess of exports are in effect saying that our economy cannot become self-supporting. That is a confession of economic defeatism which a young and vigorous nation should not be willing to make.

The most immediate contribution which the United States can make to world reconstruction is to make itself prosperous.

Prosperity here means a large demand by our industries for imports. The more we import, the easier will it be for foreign countries to meet their large and urgent needs for goods. In 1939, with a gross national product of $100 billion, our imports were $3 billion. After the war, with 55 million people employed and a gross national product of $155 billion, our imports would be about $7 billion or $8 billion.

Not only should the United States make itself prosperous, but it should *keep* itself prosperous. *So important is the United States in the world economy that a depression here is bound to produce a disastrous drop in the price of raw materials throughout the world and to throw most countries into an economic tailspin.*

The United States should support the principle of a large fund to protect the exchanges of the world from temporary pressure. We should not permit differences over the details to prevent its establishment in ample time to be available during the critical period when war-stricken countries will need goods far in excess of their immediate ability to pay for them. Some arrangement, even though imperfect in details, will be infinitely superior to no arrangement.

Finally, the United States should take the lead in breaking down barriers to trade. We are the logical country to do this, partly because of our immense domestic market, and partly because for most of the last twenty-five years this country has been able to sell other countries more goods than they have been able to sell to us. One of the greatest contributions which the United States could make to a sound and expanding world economy would be to bring our imports, as soon as practicable, up to our exports. *In other words, the United States, in the long run, should be hard to borrow from but easy to sell to.* The United States should implement this policy (1) by continuing the negotiation of reciprocal reductions in duty, and (2) by accepting exchange rates which make foreign currencies cheaper in dollars than they were in 1939. So great will be the world's need for goods that we can be sure that any dollar exchange earned by sales to us will be converted into American-made goods and will lead to larger exports.

Time was when the United States obtained about eight per cent of its standard of living by sending goods abroad and bringing back other goods. Before the war, however, we were getting less than five per cent of our living by international trade. If, after the war, we were gradually to raise the proportion of our standard of living obtained by trading with other countries to ten per cent of domestic production, our imports would be about $15 billion or $16 billion a year. Our people would be able to buy many things which they now cannot afford, and scores of countries which export raw materials and luxury products would feel the stimulus of rapidly expanding markets. Their expanded demand for road building machinery, mining machinery, machine tools, agricultural implements, locomotives, railroad cars, electrical equipment, trucks, automobiles, and a multitude of products of our factories would create a million or more additional jobs in our factories.

Although the United States would raise its standard of living by increasing its imports and its exports, it should honestly face the fact that the resulting shifts in production and employment would temporarily be painful for some people. The increase in imports would be in commodities which other countries can produce for less than the cost at which much of our output is produced—such as sugar, wool, copper, some fats and oils, wines, winter vegetables and fruits. The increase in our exports would come from those industries in which our superiority is greatest—particularly the manufacturing industries. Finally it would be advantageous, to the country as a whole, to shift a million or two workers from agriculture, where they earn about 60 cents an hour at best, to manufacturing, where they earn better than 80 cents an hour.

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The very fact that in economic matters the rest of the world is dependent upon the United States, exposes our country to great demands and to envy and misunderstanding. The United States must be willing to help the rest of the world, but its help should take the form of assisting other countries to help themselves. Never in all history has one country had such an opportunity to give the world a rising standard of living, to foster conditions under which peace flourishes. What greater tragedy could there be than to make the sacrifices which we are now making and fail to seize this chance to create a world of hope and opportunity in which the spirit of goodwill among nations is able to flourish.

James H. McGraw, Jr.

President McGraw-Hill Publishing Company, Inc.

GOVERNMENT PUBLICATIONS

The following recently issued documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. In ordering any publication noted in this list always give the complete title and the issuing office. Remittance should be made by postal money order, coupons, or check. Do not send postage stamps. All publications are in paper covers unless otherwise specified. When no price is indicated, the pamphlet is free and should be ordered from the Bureau responsible for its issue.

Hydrogen Generator ML-303/TM. War Department Technical Manual TM 11-2413. Price 10 cents.

Containers and Packages for Household Insecticides (Liquid Spray Type). National Bureau of Standards Simplified Practice Recommendation R203-44. Price 5 cents.

Standard Samples Issued or in Preparation by the National Bureau of Standards. National Bureau of Standards Supplement to Circular C398. Free on application to the Bureau.

Control of Humidity by Saturated Salt Solutions. National Bureau of Standards, Letter Circular LC 752. Mimeographed.

Polishes. National Bureau of Standards, Letter Circular LC 753. Mimeographed.

Sweeping Compounds (Also Known as "Floor Sweep" and "Dust Down"). National Bureau of Standards, Letter Circular LC 754. Mimeographed.

Laboratory Studies on the Toxicity of Tartar Emetic to the Mexican Fruitfly. By C. C. Plummer. Bureau of Entomology and Plant Quarantine, Circular 697C. Price 5 cents.

Influence of Temperature on Effectiveness of Lead Arsenate Against Larvae of the Japanese Beetle in the Soil. By W. E. Fleming and W. W. Mains. Bureau of Entomology and Plant Quarantine, E-622. Mimeographed.

Curing and Storage Methods in Relation to Quality of Porto Rico Sweetpotatoes. By J. M. Lutz. Department of Agriculture, Circular No. 699. Price 5 cents.

Information on Noreseal—A New Cork Substitute. By S. I. Aronovsky, W. F. Talburt, and E. C. Lathrop. Bureau of Agricultural and Industrial Chemistry, AIC-44. Mimeographed.

Processing Soybeans for Oil and Meal. Bureau of Agricultural and Industrial Chemistry, AIC-45. Mimeographed.

Selected Bibliography on Freezing Preservation of Fruits and Vegetables 1920-1943. Bureau of Agricultural and Industrial Chemistry, AIC-46. Mimeographed.

The Background of Penicillin Production. By R. D. Coghill. Bureau of Agricultural and Industrial Chemistry, AIC-49. Mimeographed.

Wheat Flour—A Potential Raw Material for the Expanded Production of Starch and Sirups. By G. E. Hilbert, R. J. Dimler, and C. E. Rist. Bureau of Agricultural and Industrial Chemistry, AIC-50. Mimeographed.

Hydrolysis of Wood by Percolation With Dilute Sulfuric Acid and the Fermentation of the Resulting Wood Liquors. By E. E. Harris. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R1446, Mar. 1944.

Study of Factors Affecting the Hydrolysis of Wood: Progress Report. By J. F. Saeman. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R1446-A, Jan. 1944. A progress report covering early phases of the Laboratory investigation of the theory of wood hydrolysis.

Moisture Excluding Effectiveness and Weight of Aircraft Finishes on Papreg and on Plywood. By F. L. Browne and A. C. Schwebs. Forest Products Laboratory, Madison, Wisconsin. FPL 1598, May 1944. Results of a preliminary survey indicate that the moisture excluding effectiveness of finishes on papreg vary through nearly the same range as finishes on wood.

Experiments with Preservatives for Soybean Glue and Soybean-Glued Plywood. By F. H. Kaufert and J. O. Blew. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R1447, March 1944.

Effect of High and Low Temperatures on Resin Glue Joints in Birch Plywood. By R. F. Blomquist. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. 1345, revised Jan. 1944.

Summary of Information on the Durability of Aircraft Glues. By F. F. Waugaard. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. 1530, May 1944. Brings together available Forest Products Laboratory data pertinent to the durability of those types of glues used in aircraft at the present time, or proposed for that purpose.

Weatherproof Solid Fiberboard: An evaluation of the quality of commercial boards and the development of an improved weatherproof board. By F. A. Simmonds, J. N. McGovern, and C. O. Seborg. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R1444, Feb. 1944.

Fiber-Saturation Point of Wood. Forest Products Laboratory, Madison, Wisconsin. FPL Tech. Note 252. June 1944.

Fire-Test Methods Used in Research at the Forest Products Laboratory. By G. C. McNaughton and Arthur Van Kleeck. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R1443, 1944. Describes seven fire test methods for wood and wood assemblies and presents data showing the effect of such variables as moisture content, density, species, types of fire-retardant treatment and details of fabrication upon test behavior.

Methods of Applying Wood Preservatives. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R154, revised April 1944. Discusses the preparation of wood for treatment and describes both nonpressure and pressure methods of applying preservatives; mentions various specifications covering treatments, the proper handling of wood after treatment, the effect of treatment on the strength of wood, and the inspection of treated forest products.

Treating Wood in Pentachlorphenol Solutions by the Cold-Soaking Method. By J. O. Blew. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. R1445, March, 1944. Discusses a limited purpose treatment for fence posts and lumber in oil solutions of pentachlorphenol and preservatives of similar type. Cold-soaking can be used to advantage particularly in treating pine sapwood, where more thorough impregnation is impractical and where protection greater than that obtained by simple dipping is required.

When Preservative Treatment of Wood is an Economy. Forest Products Laboratory, Madison, Wisconsin. FPL Tech. Note 165, revised August 1943.

Estimating the Specific Gravity of Plywood. By B. H. Paul and J. P. Limbach. Forest Products Laboratory, Madison, Wisconsin. FPL Mimeo. 1589, June 1944. A formula that takes into account the constants and variables involved in the manufacture of plywood, provides a value which represents the increase in specific gravity of plywood over the weighted average specific gravity of the constituent veneer. Use of a graphic representation of the formula eliminates computations.

Welding Instructions. U. S. Maritime Commission. Third Edition. Revised April 1944. Price 10 cents. For use by Welding Supervisors, Leadermen, etc., of all Crafts Concerned with Shipyard Welding.

Chemical Character of Surface Waters of Georgia. By William L. Lamar. Geological Survey Water-Supply Paper 889-E. Price 15 cents.

Exploratory Water-Well Drilling in the Houston District, Texas. By Nicholas A. Rose, W. N. White and Penn Livingston. Geological Survey Water-Supply Paper 889-D. Price 15 cents.

Water Levels and Artesian Pressure in Observation Wells in the United States in 1942, part 2, Southeastern States. By O. E. Meinzer, L. K. Wenzel, and others. Geological Survey Water-Supply Paper 945. Price 40 cents.

Mining in the Northern Copper River Region Alaska. By Fred H. Moffit. Geological Survey Bulletin 943-B. Price 10 cents.

Geology of the Hanover-York District Pennsylvania. By Anna Jonas Stose and George W.

Stose. Geological Survey Professional Paper 204. Price $1.75.

The Molluscan Fauna of the Alum Bluff Group of Florida. Part VII. Stenoglossa (in part). By Julia Gardner. Geological Survey Professional Paper 142-G. Price 25 cents.

Manganese Deposits in Costa Rica. By Ralph J. Roberts. Geological Survey Bulletin 935-H. Price 15 cents.

Observations on the Use of Cyclohexylamine in Steamheating Systems. By A. A. Berk. Bureau of Mines, Report of Investigations R.I. 3754. Mimeographed.

Technical and Economic Study of Packaged Fuel. By V. F. Parry. Bureau of Mines, Report of Investigations R. I. 3757. Mimeographed.

Domestic Storage of Subbituminous Coal and Its Performance in a Hand-fired Furnace. By W. S. Landers and V. F. Parry. Bureau of Mines Report of Investigations R. I. 3759. Mimeographed.

Work of the Survey of Carbonizing Properties of American Coals. By J. D. Davis and D. A. Reynolds. Bureau of Mines, Report of Investigations R. I. 3760. Mimeographed.

The Preparation and Properties of Metal Carbides with Critical Comment as to Their Significance in the Fischer-Tropsch Synthesis. By I. J. E. Hofer. Bureau of Mines Report of Investigations R. I. 3770. Mimeographed.

Influence of Humidity upon the Resistivity of Solid Dielectrics and Upon the Dissipation of Static Electricity. By E. M. Cohn and P. G. Guest. Bureau of Mines, Information Circular I. C. 7286. Mimeographed.

Precautions to be Taken When Approaching Old Mine Workings. By D. Harrington and R. G. Warncke. Bureau of Mines, Information Circular I. C. 7288. Mimeographed.

Mineral Statistics. Preliminary figures for 1943 production of metals, minerals, and mineral products have recently been released in the Mineral Market Reports of the U. S. Bureau of Mines as one- or two-page mimeographed press releases of the "MMS" series. The following subjects have been reported on: Antimony; Iron Ore; Secondary Aluminum; Secondary Copper and Brass; Secondary Zinc; Secondary Nickel; Magnesium; Pig Iron; Pennsylvania Anthracite; Zinc; Lead; Asphalt; Coke and Byproducts; Lime; Fuller's Earth; Bentonite; Fire Clay; Ball Clay; Sulfur and Pyrites; Distribution of Clay; Zinc Sulfate; Barite and Barium Chemicals; Portland and other Hydraulic Cements; Roofing Granules.

Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1942-43. U. S. Department of Agriculture, Miscellaneous Publication No. 510. Price 25 cents.

Agriculture Handbook. Sixteenth Census of the United States: 1940. This book shows the detailed information that may be obtained from the data of the Agriculture Census. Bureau of the Census. Price 45 cents.

Wood Aircraft Inspection and Fabrication, 1944. Army-Navy-Civil Committee on Aircraft Design Criteria, ANC Bulletin 19. Price $1.00.

A Preview as to Women Workers in Transition from War to Peace. By Mary Elizabeth Pidgeon. Women's Bureau, Special Bulletin No. 18. Price 10 cents.

Report No. FT 121. Imports from Canada and Mexico in country-by-commodity arrangement showing for each country the total value of all imports including strategic, critical and military commodities and the amount of each commodity imported except strategic, critical and military, available six months after the period covered. Calendar year 1943—total for year, individual calendar months not shown separately. Price 50 cents. Monthly, starting with figures for January 1944. Price per issue 30 cents. Yearly subscription, including 1944 calendar year annual, $3.00. Available from Bureau of the Census, Washington 25, D. C.

Report No. FT 421. Exports to Canada and Mexico in country-by-commodity arrangement showing for each country the total value of all exports including strategic, critical and military commodities and the amount of each commodity exported except strategic, critical and military, available six months after the period covered. Calendar Year 1943—total for year, individual calendar months not shown separately. Price 60 cents. Monthly, starting with figures for January 1944. Price per issue 50 cents. Yearly subscription, including 1944 calendar year annual, $5.00. Available from Bureau of the Census, Washington 25, D. C.

MANUFACTURERS' LATEST PUBLICATIONS

Publications listed here are available from the manufacturers themselves, without cost unless a price is specifically mentioned. To limit the circulation of their literature to responsible engineers, production men and industrial executives, manufacturers usually specify that requests be made on business letterhead

Automatic Control. Johnson Service Co., Milwaukee 2, Wis.—4-page folder showing how the Duo-Stat for temperature regulation ties into the Government's effort to conserve fuel. Includes advantages and sketch. Bulletin No. 390A.

Cooling Towers. The Marley Co., Inc., Kansas City, Kan.—34-page brochure fully picturing double-flow horizontal induced-draft cooling towers, illustrating typical installations and their uses in industrial plants. Includes cross sections, advantages, capacity graphs. Bulletin No. 700-A.

Drive Equipment. The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.—24-page catalog giving data on group drives; standard steel split pulleys; special purpose pulleys; standard split pulleys with list prices; steel split pulley bore sizes, hub lengths, extras; standard split steel pulleys, face widths and weights; bushings; shaft collars; shaft hangars and bearings; conveyor pulleys; high-torque motor pulleys; flat leather belts; cord belts, and Econ-o-matic drives. Catalog No. FBD-44.

Electric Control. Leeds and Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.—16-page pamphlet describing the use of the Micromax electric control with a direct sighting Rayotube detector to enable open hearth furnaces to run for top production, without endangering roofs. Illustrates the Model S Micromax Controller and the Model R and gives maintenance, installation data and detailed specifications. Bulletin No. N-33B-643(1).

Engines and Compressors. Clark Bros. Co., Inc., Olean, N. Y.—Vol. I, No. 1 of a new employee's magazine, called "The Clark Angle," containing articles of general interest about the concern's war role, personal notes, sports, department news.

Film. Goetze Gasket & Packing Co., Inc., 17 Allen Ave., New Brunswick, N. J.—35-mm. color and sound film available to employee groups, technical societies, engineering schools, telling the story of the importance of "biggest little things" in industry. Deals with sealing joints in vital equipment.

Filters. Hungerford and Terry, Inc., Clayton, N. J.—Two-color bulletin illustrating the Ferrosand Filter, giving its qualifications, specifications and capacities. Bulletin No. FF.

Furnace Black. Witco Research Laboratories, 6200 West 51st St., Chicago 38, Ill.—20-page report, describing Continex SRF, a semi-reinforcing furnace black, and giving its fundamental properties. Supplement by tables of characteristics, increasing loadings in rubber, comparison of blacks in rubber and the same data applied to GR-S. Bulletin No. 44-3.

Gages. Watson-Stillman Co., Roselle, N. J.—4-page bulletin illustrating direct stem and flush mounted gages and giving specifications and construction. Bulletin No. 230-A.

Gear Reduction Units. The Cleveland Worm & Gear Co., Cleveland 4, Ohio—16-page bulletin discussing Speedaire fan-cooled worm-gear reduction units, illustrated by cutaway drawings, charts, diagrams and engineering tables containing unit ratings and dimensions. Includes detailed installation data and shipping weight information. Catalog No. 300.

Heat Exchange. National Carbon Co., Inc., Carbon Sales Division, 30 East 42nd St., New York, N. Y.—24-page illustrated catalog setting forth data on heat conductivity and the physical and chemical properties of carbon, graphite and Karbate materials. Contains technical data charts, tables and drawings indicating the applications of these materials in heating and cooling units. Cat. Sect. M-8802.

Hydraulic Handbook. The Aldrich Pump Co., Allentown, Pa.—60-page illustrated bulletin containing complete information about pumps and hydraulic equipment under the following headings: water head equivalents, pump plunger loads, hydraulic formulas, plunger displacement, pressure equivalents, capacity of shafts, electrical data, pump discharge diagrams, accumulator volumes, friction losses in fittings and pipes, capacities of pumps and cylinders, barometric pressures, and pipe data. Also contains a discussion of this concern's manufacturing facilities and a condensed catalog of pumps and hydraulic equipment. Bulletin No. 50.

Industrial · Seeing Conditions. E. I. du Pont de Nemours & Co., Inc., Finishes Division, Wilmington 98, Del.—20-page illustrated booklet on "Three-Dimensional Seeing, The Science of Color and Light For Better Vision In Industry," containing information derived from color-conditioning installations in more than a thousand plants. Discusses the safety color code for industry and gives illustrated examples of the applications of this material.

Insulations. Simplex Wire and Cable Co., 79 Sidney St., Cambridge 39, Mass.—12-page report, designed for notebook insertion, dealing with synthetic rubber insulations, giving a progress report on buna S, (GR-S), with complete data tables.

Jar Mills. The U. S. Stoneware Co., Akron, Ohio—4-page booklet describing various types of jar mills, mill jars and other equipment for mixing, grinding and pulverizing chemicals. Gives specificaton tables for single, double and quadruple jar mills and mill jars. Bulletin No. 255.

Lubrication Systems. The Farval Corp., 3295 East 80th St., Cleveland 4, Ohio—16-page, three-color booklet portraying the theory and practice of mechanical lubrication, discussing the problems and the economics of this system, and explaining with cutaway drawings the operation of the lubrication system. Treats construction of both manual and automatic pumping units and installation details of various units. Bulletin No. 25.

Lubrication. The Farval Corp., 3248 East 80th St., Cleveland 4, Ohio—4-page leaflet entitled "Aloft is no Place for A.W.O.L.," dealing with the elimination of hazards due to manual lubrication of presses, cranes and "off the floor" equipment and explaining this concern's lubrication system. Form No. 207.

Luminescence. The New Jersey Zinc Co., 160 Front St., New York, N. Y.—24-page booklet discussing the characteristics, properties, limitations and applications of luminescent inorganic pigments. Simplified form designed to clarify the subject, includes illustrations of various terms.

Plant Facilities. Montville Chemical Works, S. B. Penick & Co., 50 Church St., New York 7, N. Y.—8-page illustrated booklet setting forth the organization, products and facilities of this concern.

Plastics. The Hydraulic Press Mfg. Co., Mount Gilead, Ohio—18-page booklet aimed at postwar planners considering plastics, describing and illustrating with sketches and halftones the various materials, processes and equipment involved in plastic production. Bulletin No. 4404.

Refractories. Basic Refractories, Inc., 845 Hanna Bldg., Cleveland 15, Ohio—8-page booklet describing a new series of basic, acid and neutral refractories for use in furnace linings. Includes data on a cold-ramming magnesia refractory for new hearth construction and major repairs.

Refractory Lining. Ironton Fire Brick Co., Ironton, Ohio—4-page pamphlet describing the Ironton "Caro-line" monolithic refractory linings for foundry ladles, side-blow converters, acid electric furnaces and cupola breast and slag holes. Includes directions for preparation, uses, specifications.

Regulators. Victory Equipment Co., 844-54 Folsom St., San Francisco, Calif.—16-page brochure illustrating the design and construction features of single- and two-stage reduction regulators employed in welding, cutting and allied flame applications. Includes graphs of maximum flow rates for Models V, VN, SR, VTS, A, and SR44. Form No. 40.

Safety Valves. J. E. Lonergan Co., Second and Race Sts., Philadelphia 6, Pa.—8-page bulletin discussing new safety valve standards, including tables summarizing sizes, connections, service limits, and other standard specifications for each type of valve. Includes blueprints of each design. Bulletin No. 501-A.

Scales. Yale and Towne Mfg. Co., Philadelphia Division, 4530 Tacony St., Philadelphia

24, Pa.—Catalog aimed at buyers of precision instruments, describing this concern's line of Kron scales for use in materials handling programs. Discusses entire line from dormant and portable platform types to special counting, batching, tensile strength and dynamometer models. Catalog No. R-44.

Screens. Hendrick Mfg. Co., Carbondale, Pa.—4-page folder describing this concern's Wedge-Slot screen for industrial applications, giving its outstanding features, advantages, uses and specifications.

Shears. Watson-Stillman Co., Roselle, N. J. —8-page folder dealing with features of hydraulic and hand shears for cutting commercial grade wire rope, flat bars, round bars and varying shapes and metals. Discusses applications, specificatons, capacities, spare parts and prices. Bulletin No. A-6, Edition 3.

Speed-Jack Drives. The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.—4-page booklet dealing with structural features, industrial uses and applications of Speed-Jack variable-speed drives. Supplemented with installation sketches. Bulletin No. SJ-44.

Steam Equipment. Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.—8-page Vol. 1, No. 1 of the "Yarway News," a new house organ to be issued quarterly, containing news, operating hints, new ideas and process information.

Storage. The Nicholson Co., Inc., 10 Rockefeller Plaza, New York 20, N. Y.—32-page, detailed booklet concerning the streamlining of storage systems, with 20 examples of installations, reaching from abrasives through water industries. Includes sketches of systems and capacities of circular bins for both anthracite and bituminous coal, grain and cement.

Testing Price List. United States Testing Co., Inc., Hoboken, N. J.—27-page price list featuring specific test charges for bacteriological, textile, chemical, food, and engineering tests, supplemented by information on research service.

Thermal Control. Fenwal Inc., 200 Pleasant St., Ashland, Mass.—44-page thorough booklet detailing the complete line of thermoswitches for temperature regulation, and giving a 14 in. cutaway drawing of the principle. Describes and gives modification tables for types of thermoswitches with scale sketches, includes section of accessories and modifications, and detailed data on selection and application. Bulletin No. G.C.—1.

Tubes. Wolverine Tube Division, Calumet and Hecla Consolidated Copper Co., 1411 Central Ave., Detroit, Mich.—6-page folder of engineering information on seamless copper and brass tubes, giving chemical and physical characteristics tables and safe working pressures charts. Bulletin No. 575.

Ventilators. Powermatic Ventilator Co., 4019 Prospect Ave., Cleveland 3, Ohio—2-page folder describing this company's new "Iron Lung" motor-operated roof ventilator for industrial plant application. Contains cut-away drawing and a part-by-part description.

War Production. Worthington Pump & Machinery Corp., Harrison, N. J.—32-page illustrated booklet presenting a description of this concern's mobilization for war production, the uses of their products in the war machine, and their postwar plans.

Waste. George S. May Foundation, 111 South Dearborn St., Chicago 3, Ill.—12-page report called "How Waste Reduction Boosts Production," describing how production can be increased by elimination of common waste factors. Supplemented by a series of 225 questions aimed at management. Report No. 148.

Welding. Engineering Dept., Rm. 1113, Eutectic Welding Alloys Co., 40 Worth St., New York 13, N. Y.—4-page leaflet called "The Theory of Soldering, Brazing and 'Low Temperature' Welding," describing the history and principle of the Eutectic process. Gives definitions relevant to the new process and applications. Technical release G.

Welding. The Lincoln Electric Company, Cleveland, Ohio.—A new calculator designed to readily determine the welding preheating and interpass temperatures of steels. 6¼ in. in diameter and consists of four movable sections of heavy cardboard stock. Contains complete instructions for use. Price $.25.

X-Ray Unit. Picker X-Ray Corp., 300 Fourth Ave., New York, N. Y.—8-page booklet illustrating and describing a new KV Industrial X-Ray Unit for low kilovoltage X-Ray inspection. Discusses many applications, detailed information on size and installation, dimensional data and catalog listing. Bulletin No. 1444.

CHEMICAL ECONOMICS

H. M. BATTERS, Market Editor

SPOTTY CONDITIONS IN MANY LARGE INDUSTRIES AFFECTS CONSUMPTION OF CHEMICALS

General production, as indicated by the indexes of the Federal Reserve Board, has fallen off somewhat in the last few months but the decline has been of moderate proportions and has not been general throughout industry as some lines have increased their operating rates while others have been subject to curtailment. This spotty condition in manufacturing industries has had its influence on the disappearance of chemicals with the net result registering a drop in volume for chemicals consumed in industrial fields. Various factors have contributed to this situation. In the first place there has been a speeding up of activities at munitions works with a corresponding rise in demand for the chemicals which are essential in such manufacture. This accounts for the current tightening in the market for nitric acid, for the curtailment of shipments of sulphuric acid and ammonia to the fertilizer trade, and for the probability that, later on, petroleum refineries may be forced to use spent sulphuric in order to satisfy their acid requirements.

The scarcity of sulphuric acid promises to be but temporary as new plant capacities get into operation. The new production, with annual additional capacities, and proposed completion dates are: Summers Fertilizer Co., Scarsport, Me., 25,200 tons, Sept. 1944; Virginia-Carolina Chemical Corp., Wilmington, N. C., 25,200 tons, Sept. 1944; Stauffer Chemical Co., Dominguez, Calif., 72,000 tons, Sept. 1944; Standard Wholesale Phosphate & Acid Works, Baltimore, 109,600 tons, Oct. 1944; General Chemical Co., Front Royal, Va., 65,000 tons, Nov. 1944, and 65,000 tons, Feb. 1945; Consolidated Chemical Industries, Houston, Tex., 108,000 tons, Nov. 1944 and Baton Rouge, La., 93,600 tons, Dec. 1944; Davison Chemical Co., Baltimore, 12,000 tons, Dec. 1944; and Garfield Chemical Co., Garfield, Utah, 54,000 tons, March 1945.

Increased ordnance requirements for nitric acid have resulted in a situation whereby none of this acid will be shipped to industry after Oct. 1 and preference for the acid made in industry will be given to end uses which have a direct or indirect bearing on the war effort. This may lead to the reopening of pot muffle processing plants which were closed a year ago. These plants use nitrate of soda and sulphuric acid as raw materials and the proposal to put them back in production has also brought the proposal that attempts be made to increase the volume of nitrate of soda imports so that fertilizer requirements of this material may not be impaired and arrangements all being made to import 850,000 tons.

The *Chem. & Met.* index for industrial consumption of chemicals dropped to 176.50 in July as compared with a revised figure of 185.29 for June. Last year the indexes for these two months were 172.42 and 177.35 respectively, hence the monthly ratings continue to hold well above those of the corresponding periods of last year. A good part of the decline in the index for July is due to a sharp drop in the output of superphosphate and a general slowing up in activities at fertilizer plants. Ordinarily seasonal conditions are responsible for reducing fertilizer outputs during the summer months but the schedule for superphosphate production has been raised to an extent where full monthly operations are necessary if the program is to be met. Hence it is probable that scarcity of some important raw materials required in munitions manufacture was a factor in upsetting the schedule.

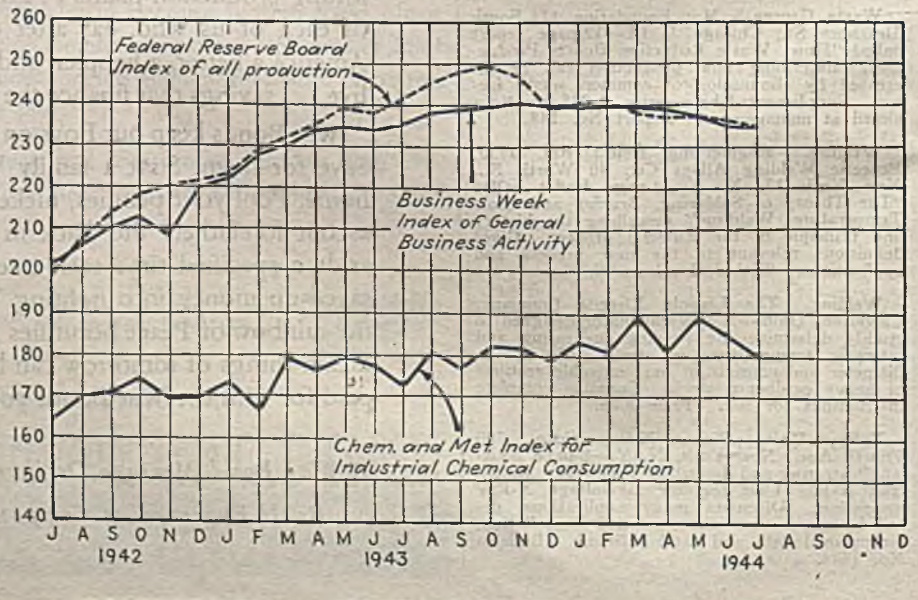
Chem. & Met. Index for Industrial Consumption of Chemicals

	June revised	July
Fertilizers	39.44	36.00
Pulp and paper	19.65	18.70
Petroleum refining	18.28	18.70
Glass	21.40	19.70
Paint and varnish	18.47	16.80
Iron and steel	13.16	13.46
Rayon	16.82	15.75
Textiles	10.23	9.60
Coal products	9.93	10.29
Leather	4.05	4.00
Industrial explosives	5.66	5.30
Rubber	3.00	3.00
Plastics	5.20	5.20
	185.29	176.50

Record rate of operations in the fertilizer industry have been checked because of the curtailment in some of the important raw materials. For the present, ammonia has been diverted to other consuming fields and the same is true of nitrate of ammonia although fertilizer plants may still receive considerable of this material brought in from Canada. The munitions program likewise is responsible for a reduction in the supply of sulphuric acid made available for producing phosphate rock and earlier estimates for superphosphate output are being scaled down.

Reports on operations at cotton mills likewise have not been favorable and this industry continues to maintain a level far below that reported for 1942. Mill equipment has passed through a long period of forced operation with very little chance for overhauling and for replacements. Trained labor has been taken away for military service or has shifted to other fields of greater remuneration. This combination makes it difficult to heed recent requests that production be enlarged and tends to check optimistic views regarding the outlook for the remainder of the year.

In the paper trade, uncertainty about the future supply of woodpulp is giving concern. It was recently announced that Army and Navy requirements for pulp used in the manufacture of explosives and ammunition will be more than twice as high in the third quarter of this year than in the first quarter and demands in the final quarter will exceed those of the third quarter. Without an increase in production, this is equivalent to a notice that civilian allotments of paper are likely to be cut down.



HERE is a suggestion based on experience in pickling steel cartridge cases that may help substantially to prolong the life of your hard-to-replace stainless steel equipment.

Producers of steel cartridge cases found that 1% to 3% Ferrisul (anhydrous ferric sulfate) in their 5% to 10% sulfuric acid pickling solutions acted as a passivating agent on their stainless steel pickling equipment, much of it originally designed for handling copper cases. As a result, the stainless steel was protected from sulfuric acid attack, yet the acid remained effective against the annealing scale on the cases themselves.

If any of *your* stainless steel equipment is exposed to similar attack . . . and if small additions of ferric sulfate to the materials being processed in that equipment can be tolerated . . . we will be glad to send samples of Ferrisul for your further investigation.

Ferrisul is widely used as a mild oxidizing agent in many metal finishing processes, as a highly efficient coagulant in the treatment of water and sewage and in various organic reactions. It contains a minimum of 90% soluble ferric sulfate with a maximum of approximately 5% insoluble. If the insoluble is undesirable, however, it can be removed with comparative ease.

A dry, granular powder, Ferrisul is easy to store, handle and use, is readily soluble in water and is now available in ample quantity.

For free sample quantities large enough for thorough trials, simply mail the coupon below: MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston 49, Massachusetts.

Ferrisul (anhydrous ferric sulfate)
Standard Form: Pellets 4-40 mesh
Color: Pale, reddish brown
Typical Analysis: 90% min. $Fe_2(SO_4)_3$
Apparent Density: 70 lbs. to cu. ft.
Angle of slip: 34°
Heat of Solution: 260 BTU to lb. of Ferrisul

MONSANTO CHEMICALS
SERVING INDUSTRY...WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY
Merrimac Division, Everett Station, Boston 49, Mass.

Please send me a large enough sample of Ferrisul for a plant trial at no obligation to me.

Name ______________________

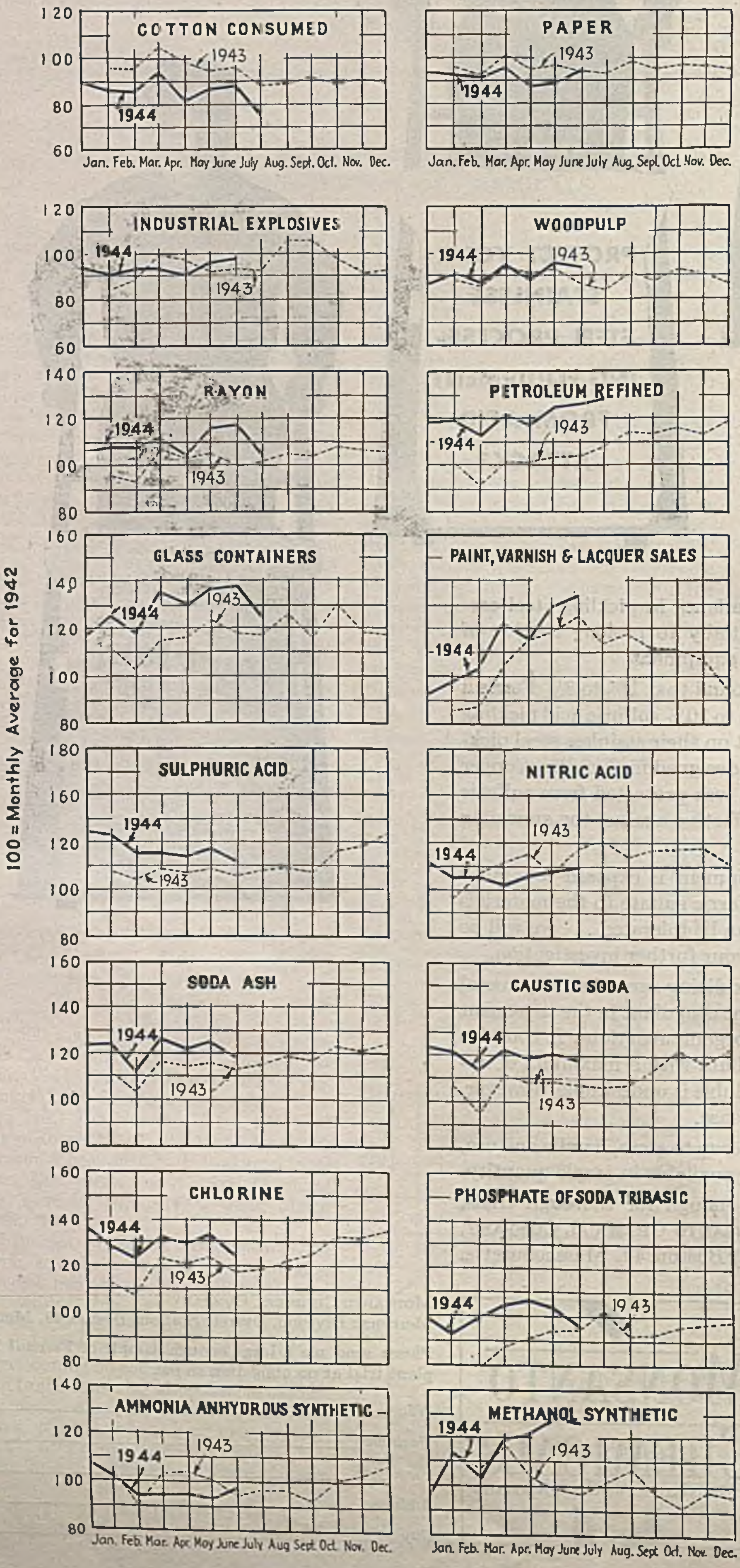
Position ______________________

Firm ______________________

Address ______________________

City ______________________

PRODUCTION AND CONSUMPTION TRENDS



Most important factor on production of chemicals in recent weeks has been the speeding up of munitions production with a corresponding interest in the chemicals which enter into such manufacture. This was directly responsible for the reports about scarcities of sulphuric and nitric acids and ammonia. However the request for larger outputs of heavy explosives was followed by a similar request regarding high-octane gasoline. As toluol is an important raw material in both these lines of manufacture, it has found such a consumptive demand that the supply situation has given concern. Allotments for civilian use have been sharply lowered but there still is an inadequate supply for the most essential uses and, for a while at least, the oil industry may find the preference given to munitions manufacture.

Production data for certain synthetic organic chemicals have been made public. While the separate chemicals have been subject to varying influences, the data indicate that in general, production in June was a little off in volume from that for the preceding month but apparently this was due to the smaller number of working days and the industry seems to be moving along a steady course as far as operating rates are concerned. In some cases, notably butyl acetate, ethyl acetate, technical lactic acid, methyl chloride, refined naphthalene, and oxalic acid, the June totals actually were higher than those for May. Producers stocks also were lowered in the majority of cases which should reflect the status of consuming demands.

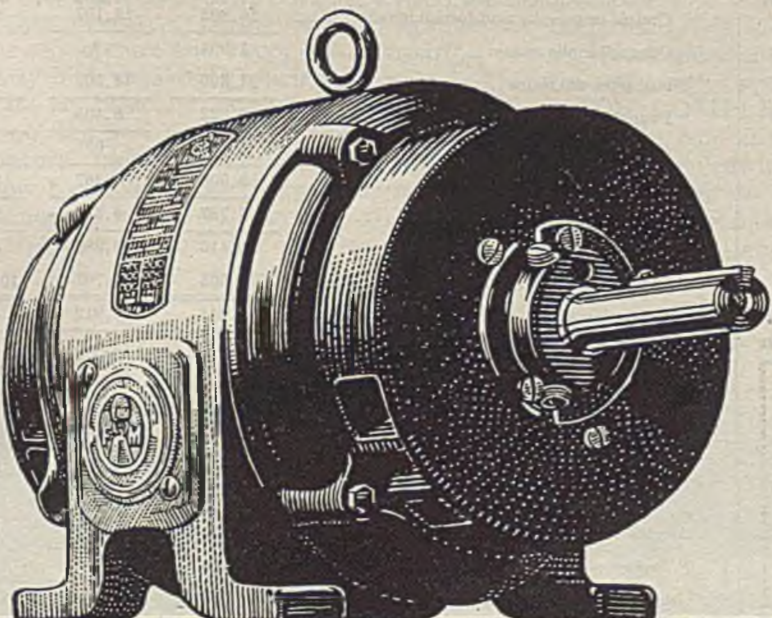
Latest figures for activities in the vegetable oil industry refer to July operations and record a moderate increase of crude oil over the June totals. This was accomplished despite drops in the outputs of cottonseed, peanut, and coconut oils. Refining data are not complete but from the figures made available it is probable that production of refined oil in July was a little less than in June. Total production of oils and fats in July fell below the June figures in spite of enlarged supplies of vegetable and fish oils. The reduction in animal fats was responsible for the unfavorable showing of the group as a whole.

A review of the chemical products which have been recently removed from allocation controls offers evidence that civilian needs can now be more fully met but among the chemicals which show a different status are chromic acid and bichromates. A survey made by WPB found that requirements for these products are such as to give them a critical rating. Little hope is held out for any immediate rise in production and stockpiles have dwindled. Conservation of these chemicals by using them only in processes for which substitutes are not available, by reclaiming where possible, and by avoiding waste is now advocated. As a conservation measure it is recommended that if a chromium chemical must be used, preference should be given to bichromate as chromic acid is so scarce as to warrant the use of two pounds of bichromate to conserve one pound of the acid.

A name worth remembering!

FAIRBANKS-MORSE

After the war, the name Fairbanks-Morse will continue to mark performance-proved products only, as it has for 114 years. No race to get civilian products onto the market early will tempt us to break this pledge.



Features of the New Fairbanks-Morse General-Purpose Motor

- *It is a 40° C. motor.*
- *It is a protected motor.*
- *It has an optional conduit box assembly.*
- *It has cross-flow ventilation.*
- *It has ball bearings, sealed in and protected.*
- *It has the exclusive Fairbanks-Morse* Copperspun Rotor.

BUY MORE WAR BONDS

DIESEL LOCOMOTIVES • DIESEL ENGINES • GENERATORS • MOTORS • SCALES • PUMPS • STOKERS • RAILROAD AND FARM EQUIPMENT

FAIRBANKS, MORSE & CO., CHICAGO 5, ILLINOIS

Comparison of U. S. Production and Sales of Synthetic Organic Chemicals

(Average 1937-41, annual 1942 and 1943. Production and sales in thousands of pounds; sales value in thousands of dollars. Data from U. S. Tariff Commission.)

Product	1937–41 Average	1942	1943	Percent Change 1943 over 1942
Cyclic chemicals:				
Intermediates:				
Production	679,399	[1]1,243,754	[1,2]1,524,133	22.5
Sales	286,062	[1]097,054	[1,2]1,011,466	45.1
Sales value	42,102	93,905	[2]133,277	41.9
Finished cyclic products:				
Production	479,187	773,296	1,398,533	80.9
Sales	394,081	631,449	1,229,708	94.7
Sales value	168,307	307,795	454,612	47.7
Dyes:				
Production	124,125	151,878	143,913	−5.2
Sales	123,962	144,847	145,392	0.4
Sales value	75,535	99,431	105,134	5.7
Medicals:				
Production	17,815	35,840	50,550	41.0
Sales	14,734	32,581	45,333	39.1
Sales value	17,968	59,921	99,020	65.3
Flavors and perfume materials:				
Production	5,792	7,956	8,120	2.1
Sales	5,353	7,245	7,073	10.0
Sales value	4,891	9,846	9,799	−0.5
Cyclic resins:				
Production	199,035	297,020	378,846	27.5
Sales	147,887	249,777	337,800	35.2
Sales value	32,321	76,460	76,701	0.3
All other:[3]				
Production	131,520	280,602	817,104	191.2
Sales	102,145	196,906	693,210	251.9
Sales value	37,592	62,137	163,958	163.9
Non-cyclic chemicals:				
Production	3,386,021	7,202,902	9,346,228	29.8
Sales	1,704,724	3,682,964	5,317,661	44.4
Sales value	221,243	533,864	851,822	59.6

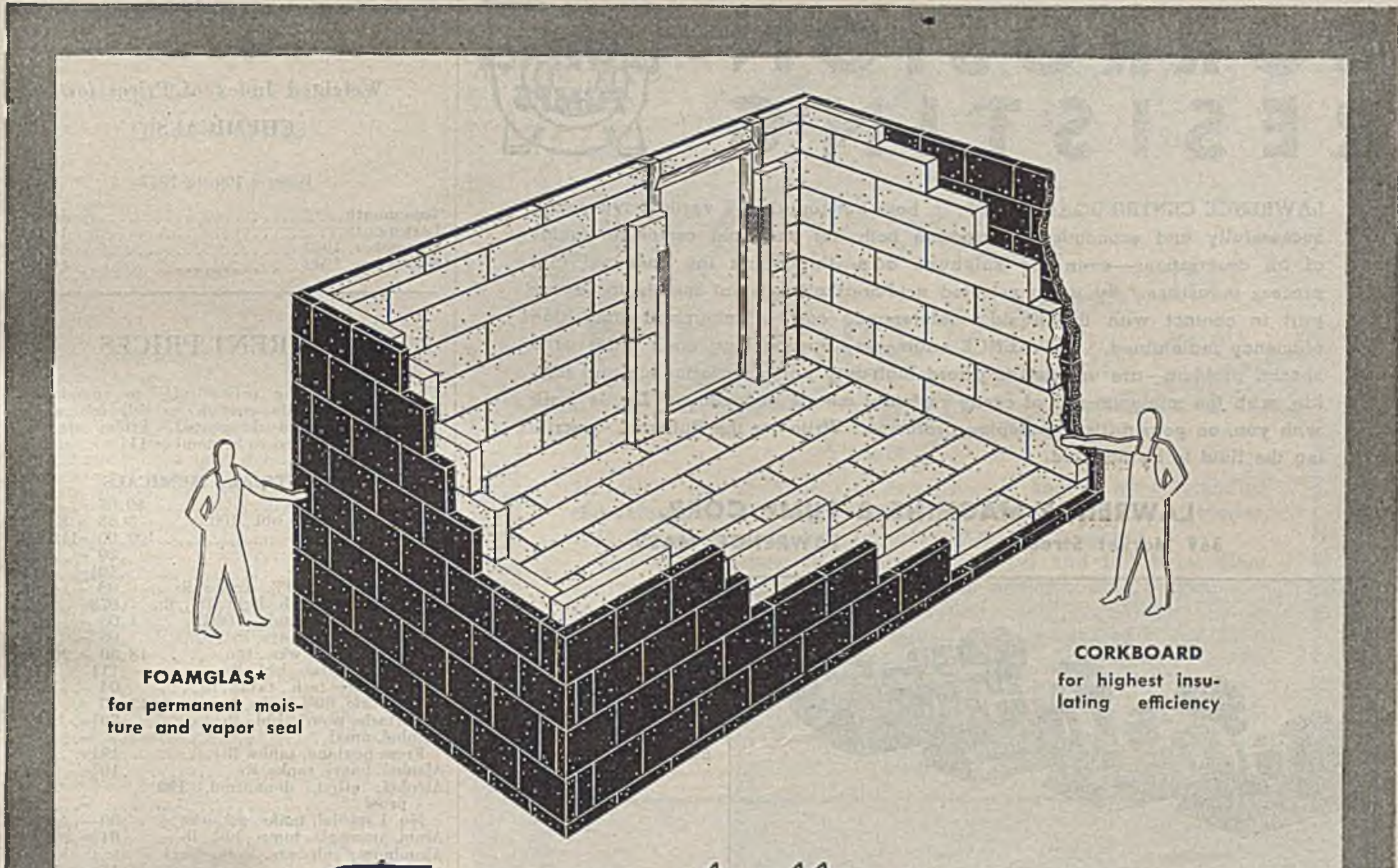
[1]Includes intermediates produced from petroleum sources. [2]Includes quantity and value of sales of intermediates reported to the Bureau of Mines. [3]Includes color lakes, rubber chemicals, elastomers, and miscellaneous cyclic products not shown separately.

U. S. Production and Sales of Certain Plastics Materials in 1943

(Production and sales in thousands of pounds; sales value in thousands of dollars; unit value in cents per pound.)

Product	Production Quantity	Sales Quantity	Sales Value	Unit Value
Cyclic, total	378,846	337,800	76,701	23
Alkyd resins (phthalic anhydride)[1]	154,385	124,992	23,649	19
For protective coatings	153,398	124,184	23,451	19
For textiles	514	[2]	[2]	..
For molding and casting	291	[2]	[2]	..
For miscellaneous uses	182	[2]	[2]	..
Phenolic resins, total	142,912	[3]	[3]	..
Phenol-formaldehyde	124,204	118,395	38,210	32
For molding	61,424	60,371	21,971	36
For casting	2,838	2,845	1,270	45
For laminating	22,606	18,353	4,478	24
For protective coatings	15,519	15,273	5,140	34
For adhesives	10,290	10,247	2,079	20
For miscellaneous uses	11,527	11,306	3,272	29
Cresols or cresylic acid-formaldehyde	16,805	13,192	3,986	30
Other phenolic resins	1,904	[3]	[3]	..
Mixed phenolic resins	21,395	18,567	3,915	21
Phenol-cresol-aldehyde	10,322	8,405	1,549	18
Cresol-xylenol-aldehyde	1,164	695	126	18
Other mixed phenolic resins	9,909	9,467	2,240	24
Polystyrene	6,737	6,374	2,239	35
Other cyclic resins[4]	53,416	56,280	4,702	8
Noncyclic, total	272,665	229,767	101,290	44
Alkyd resins, total	49,644	45,912	8,384	18
Abietic acid, abietic and maleic acids	11,789	12,263	1,416	44
Furmaric acid	9,035	6,222	1,815	29
Maleic anhydride	24,803	23,420	4,122	18
Other alkyd resins	4,017	4,007	1,031	26
Nitrogen noncyclic resins:				
Urea-formaldehyde	53,859	51,733	13,288	26
For adhesives	32,546	30,521	6,966	23
For protective coatings	4,857	4,559	1,182	26
Miscellaneous uses	16,456	16,653	5,140	31
Alcohol polymerization resins[5]	522	415	326	79
Polyvinyl alcohol-aldehyde	14,435	12,349	8,232	67
Other noncyclic resins	154,205	119,358	71,060	60

[1]Includes anhydride-alcohol-oil chemically combined. [2]Data are confidential. They are, however, included in alkyd resin total. [3]Quantities included in "Other cyclic resins" total. [4]Includes petroleum derived from cyclic resins. [5]Includes allyl alcohol and furfuryl alcohol polymerization resins.



For permanently efficient low-temperature protection

Armstrong Offers a New Insulation Construction

ARMSTRONG has developed a new type of low-temperature insulation construction that combines Armstrong's Corkboard with Foamglas* and takes advantage of the best properties of both materials. This new construction furnishes a positive, permanent seal against infiltration of moisture and vapor—thus assuring permanently high insulating efficiency.

Since it is basically standard corkboard construction, the new combination retains corkboard's natural moisture resistance and exceptionally low thermal conductivity. This assures high efficiency for heavy-duty work.

However, the outer shell is Foamglas—to seal out all moisture. This insulation material is glass in cellular form, with each tiny cell wholly isolated from the others. Hence, Foamglas is moistureproof, vaporproof, and fireproof.

The new construction is easy to erect since both materials are erected in accordance with standard specifications. Interior wall finishes are the same as for standard corkboard construction.

FOR COMPLETE INFORMATION about the new combination construction—including engineering drawings and erection specifications—write today to Armstrong Cork Co., Building Materials Division, 3309 Concord Street, Lancaster, Pennsylvania.

*Reg. U. S. Pat. Off. Product Mfg. by Pittsburgh Corning Corp.

ARMSTRONG CORK COMPANY

Insulation Headquarters

CHEM. & MET.
Weighted Index of Prices for
CHEMICALS

Base = 100 for 1937

This month	109.37
Last month	109.48
September, 1943	109.03
September, 1942	109.30

CURRENT PRICES

The accompanying prices refer to round lots. Where it is trade custom to sell fob works, quotations are so designated. Prices are corrected to September 11

INDUSTRIAL CHEMICALS

Acetone, tanks, lb	$0.07 –	....
Acid, acetic, 28%, bbl., 100 lb	3.38 –	$3.63
Boric, bbl., ton	109.00 –	113.00
Citric, kegs, lb	.20 –	.23
Formic, cbys, lb	.10½ –	.11
Hydrofluoric, 30%, drums, lb	.08 –	.085
Lactic, 44%, tech., light, bbl., lb.	.073 –	.075
Muriatic, 18°, tanks, 100 lb	1.05 –	....
Nitric, 36°, carboys, lb	.05 –	.05½
Oleum, tanks, wks., ton	18.50 –	20.00
Oxalic, crystals, bbl., lb	.11¼	.12½
Phosphoric tech., tanks, lb	.04 –	....
Sulphuric, 60°, tanks, ton	13.00 –	....
Tartaric, powd., bbl., lb	.70½ –	....
Alcohol, amyl	.... –	....
From pentane, tanks, lb	.131 –	....
Alcohol, butyl, tanks, lb	.10¾ –	.18½
Alcohol, ethyl, denatured, 190 proof	.... –	....
No. 1 special, tanks, gal. wks	.50 –	....
Alum, ammonia, lump., bbl., lb	.04¾ –	....
Aluminum, sulphate, com. bags, 100 lb	1.15 –	1.40
Ammonia, anhydrous, cyl., lb	.16 –	....
tanks, lb	.04½ –	....
Ammonium carbonate, powd. tech., casks, lb	.09½ –	.12
Sulphate, wks, ton	28.20 –	....
Amyl acetate, tech., from pentane, tanks, lb	.145 –	....
Aqua ammonia, 26°, drums, lb	.02¼ –	.03
tanks, ton	65.00 –	....
Arsenic, white, powd., bbl., lb	.04 –	.04¼
Barium carbonate, bbl., ton	65.00 –	75.00
Chloride, bbl., ton	75.00 –	78.00
Nitrate, casks, lb	.09½ –	.11
Blanc fix, dry, bags, ton	60.00 –	70.00
Bleaching powder, f.o.b., wks., drums, 100 lb	2.50 –	3.00
Borax, gran., bags, ton	45.00 –	....
Calcium acetate, bags	3.00 –	....
Arsenate, dr. lb	.07 –	.08
Carbide, drums, ton	50.00 –	....
Chloride, flake, bags, del., ton	18.50 –	25.00
Carbon bisulphide, drums, lb	.05 –	.05½
Tetrachloride drums, gal	.73 –	.80
Chlorine, liquid, tanks, wks., 100 lb.	1.75 –	2.00
Copperas, bgs., f. o. b., wks., ton.	17.00 –	18.00
Copper carbonate, bbl., lb	.19½ –	.20
Sulphate, bbl., 100 lb	5.00 –	5.50
Cream of tartar, bbl., lb	.57 –	....
Diethylene glycol, dr., lb	.14½ –	.15½
Epsom salt, dom.; tech., bbl., 100 lb	1.90 –	2.00
Ethyl acetate, tanks, lb	.11½ –	....
Formaldehyde, 40%, tanks, lb	.032 –	....
Furfural, tanks, lb	.09½ –	....
Glaubers salt, bags, 100 lb	1.05 –	1.10
Glycerine, c.p., drums, extra, lb	.18¾ –	....
Lead:		
White, basic carbonate, dry casks, lb	.08¼ –	....
Red, dry, sck, lb	.09½ –	....
Lead acetate, white crys., bbl., lb.	.12¾ –	.13
Lead arsenate, powd., bag, lb	.11½ –	.12
Lithopone, bags, lb	.04½ –	.04¾
Magnesium carb., tech., bags, lb	.06¼ –	.06½
Methanol, 95%, tanks, gal	.58 –	....
Synthetic, tanks, gal	.24 –	....
Phosphorus, yellow, cases, lb	.23 –	.25
Potassium bichromate, casks, lb	.09¼ –	.10
Chlorate, powd., lb	.09¾ –	.12
Hydroxide (c'stic potash) dr., lb.	.07 –	.0½
Muriate, 60% bags, unit	.53½ –	....
Nitrate, bbl., lb	.05½ –	.06
Permanganate, drums, lb	.19¾ –	.20
Prussiate, yellow, casks, lb	.17 –	.18
Sal ammoniac, white, casks, lb	.0515 –	.06
Salsoda, bbl., 100 lb	1.00 –	1.05
Salt cake, bulk, ton	15.00 –	....
Soda ash, light, 58%, bags, contract, 100 lb	1.05 –	....
Dense, bags, 100 lb	1.15 –	....
Soda, caustic, 76%, solid, drums, 100 lb	2.30 –	3.00
Acetate, del., bbl., lb	.05 –	.06
Bicarbonate, bbl., 100 lb	1.70 –	2.00
Bichromate, casks, lb	.07¼ –	.08
Bisulphate, bulk, ton	16.00 –	17.00
Bisulphite, bbl., lb	.03 –	.04

CHEM. & MET.
Weighted Index of Prices for
OILS & FATS

Base = 100 for 1937

This month	145.04
Last month	145.24
September, 1943	145.55
September, 1942	141.01

Chlorate, kegs, lb	.06¼–	.06½
Cyanide, cases, dom., lb	.14½–	.15
Fluoride, bb., lb	.07 –	.08
Hyposulphite, bbl., 100 lb	2.40 –	2.50
Metasilicate, bbl., 100 lb	2.50 –	2.65
Nitrate, bulk, 100 lb	1.35 –	....
Nitrite, casks, lb	.06¼–	.07
Phosphate, tribasic, bags, lb	2.70 –	....
Prussiate, yel. bags, lb	.09¾–	.10
Silicate (40°) dr., wks., 100 lb	.80 –	.85
Sulphide, bbl., lb	.02½–	....
Sulphite, crys, bbl., lb	.02¼–	.02½
Sulphur, crude at mine, long ton	16.00 –	....
Dioxide, cyl., lb	.07 –	.08
Tin crystals, bbl., lb	.39½–	....
Zinc chloride, gran, bbl., lb	.05¾–	.06
Oxide, lead free, bag, lb	.07¼–	....
Oxide, 5% leaded, bags, lb	.07¼–	....
Sulphate, bbl., cwt	3.85 –	4.00

OILS AND FATS

Castor oil, No. 3 bbl., lb	$0.13¾–	$0.14½
Chinawood oil, tanks, lb	.38¾–	....
Coconut oil, ceylon, dr. N. Y., lb	.0885	....
Corn oil crude, tanks (f.o.b. mill), lb	.12¾–	....
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.12¾–	....
Linseed oil, raw, car lots, bbl., lb.	.151–	....
Palm casks, lb	.087–	....
Peanut oil, crude, tanks (mill), lb	.13 –	....
Rapeseed oil, refined, bbl., lb	nom	
Soy bean, tank, lb	.11¾–	....
Menhaden, light pressed, dr., lb	.126–	....
Crude, tanks (f.o.b. factory) lb.	.089 –	....
Grease, yellow, loose, lb	.08¼–	....
Oleo stearine, lb	.09½–	....
Oleo oil, No. 1, lb	.11½–	....
Red oil, distilled, bbl., lb	.12¾–	....
Tallow extra, loose, lb	.08¾–	....

COAL-TAR PRODUCTS

Alpha-napthol, crude, bbl., lb	$0.52 –	$0.55
Alpha-naphthylamine, bbl., lb	.32 –	.34
Aniline oil, drums, extra, lb	.15 –	.16
Aniline salts, bbl., lb	.22 –	.24
Benzaldehyde, U. S. P., dr., lb	.85 –	.95
Benzidine base, bbl., lb	.70 –	.75
Benzoic acid, U. S. P., kgs., lb	.54 –	.56
Benzol, 90%, tanks, works, gal	.15 –	....
Benzyl chloride, tech., dr., lb	.23 –	.25
Beta-naphthol, tech., drums, lb	.23 –	.24
Cresol, U. S. P., dr., lb	.11 –	....
Cresylic acid, dr., wks., gal	.81 –	.83
Diphenyl, bbl., lb	.15 –	....
Diethylaniline, dr., lb	.40 –	.45
Dinitrotoluol, bbl., lb	.18 –	.19
Dinitrophenol bbl., lb	.22 –	.23
Dip oil, 15%, dr., gal	.23 –	.25
Diphenylamine, dr. f.o.b. wks., lb.	.60 –	....
H-acid, bbl., lb	.45 –	.50
Hydroquinone, bbl., lb	.90 –	....
Naphthalene, flake, bbl., lb	.07 –	.07¼
Nitrobenzene, dr., lb	.08 –	.09
Paracresol, bbl., lb	.41 –	....
Para-nitraniline, bbl., lb	.47 –	.49
Phenol, U. S. A., drums, lb	.10½–	.11
Picric acid, bbl., lb	.35 –	.40
Pyridine, dr., gal	1.70 –	1.80
Resorcinol, tech, kegs, lb	.75 –	.80
Salicylic acid, tech., bbl., lb	.33 –	.40
Solvent naphtha, w.w., tanks, gal.	.27 –	....
Tolidine, bbl., lb	.86 –	.88
Toluol, drums, works, gal	.33 –	....
Xylol, com., tanks, gal	.26 –	....

MISCELLANEOUS

Casein, tech., bbl., lb	$0.18 –	$0.24
Dry colors		
Carbon gas, black (wks.), lb	.0335–	.30
Prussian blue, bbl., lb	.36 –	.37
Ultramarine blue, bbl., lb	.11 –	.26
Chrome green, bbl., lb	.21½–	.30
Carmine, red, tins, lb	4.60 –	4.75
Para toner, lb	.75 –	.80
Vermilion, English, bbl., lb	2.75 –	2.80
Chrome, yellow, C. P., bbl., lb.	.14½–	.15½
Gum copal, Congo, bags, lb	.09 –	.30
Manila, bags, lb	.09 –	.15
Demar, Batavia, cases, lb	.10 –	.22
Kauri, cases, lb	.18 –	.60
Magnesite, calc., ton	64.00 –	....
Pumice stone, lump, bbl., lb	.05 –	.07
Rosin, H., 100 lb	6.10 –	....
Turpentine, gal	.87 –	....
Shellac, orange, fine, bags, lb	.39 –	....
Bleached, bonedry, bags, lb	.39 –	....
T. N. bags, lb	.31 –	....

NEW CONSTRUCTION

	Current Projects		Cumulative 1944	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$40,000	$40,000	$850,000	$1,762,000
Middle Atlantic	125,000	100,000	7,227,000	10,573,000
South	....	4,600,000	12,207,000	24,431,000
Middle West	16,787,000	300,000	17,566,000	29,296,000
West of Mississippi	5,630,000	1,200,000	32,145,000	24,843,000
Far West	....	40,000	7,209,000	12,546,000
Canada	1,565,000	....	9,512,000	6,227,000
Total	$24,147,000	$6,280,000	$86,806,000	$109,678,000

PROPOSED WORK

Conn., Bridgeport—Bridgeport Deoxidized Bronze & Metal Co., 459 Iranistan Ave., plans to rebuild its plant recently destroyed by fire. Estimated cost $40,000.

Md., Baltimore—Tomke Aluminum Co., c/o Kubitz & Koenig, Engrs., Emerson Tower Bldg., plans to construct a 1 story, 80x260 ft. plant. Estimated cost $75,000.

N. J., Kearney—Congoleum-Nairn Co., 195 Belgrove Dr., is having plans prepared by Albert Kahn Associates, New Center Bldg., Detroit, Mich., for the construction of a factory. Estimated cost $50,000.

N. M., Eunice—Panhandle Carbon Co., Inc., Eunice, plans to construct addition to its plant. Estimated cost $1,000,000.

O., Brecksville—B. F. Goodrich Co., 500 South Main St., Akron, plans to construct a rubber research and development laboratory. Shreve, Lamb & Harmon, Associates, 11 East 44th St., New York, N. Y., Archts. Estimated cost $1,500,000.

O., Toledo—Libby-Owens-Ford Glass Co., Nicholas Bldg., plans to construct an addition to its factory. Estimated cost $787,000.

Okla., Ponca City—Continental Oil Co. plans to reconstruct portion of its plant recently destroyed by fire. Estimated cost will exceed $40,000.

Tex., Ark—Petroleum Dehydrating Co. plans the construction of a tank bottom treating unit at its plant here. Estimated cost will exceed $40,000.

Tex., Harlingen—Tom Gilcrease & Associates, Milan Bldg., San Antonio, plans improvements to its oil refinery. Estimated cost $50,000.

Tex., McGregor—Defense Plant Corp., Washington, D. C., plans to expand its ordnance plant here to be operated by National Gypsum Co., McGregor. Estimated cost $3,000,000.

Tex., Waco—Defense Plant Corp., Washington, D. C., plans to construct a plant here to be operated by General Tire & Rubber Co., 1708 East Market St., Akron, O. Estimated cost $1,500,000.

Wis., Merrimac—U. S. Eng., 408 Federal Bldg., Milwaukee, plans to construct addition to powder plant at Badger Ordnance Plant. Mason & Hangar Co., 500 Fifth Ave., New York, N. Y., Archts. & Engrs. Hercules Powder Co., Wilmington, Del., will operate. Estimated cost $14,500,000.

B. C., New Westminster—Alaska Pine Co., Ltd., 4th Ave. and 15th St., plans the construction of a wood distillation plant for the manufacture of wood alcohol, wood vinegar and other derivatives from waste material.

B. C., Prince George—Eagle Lake Sawmills, Ltd., Giscoma, contemplates the construction of a pulp mill here. Estimated cost $1,000,000.

Ont., Hawkesbury—Canadian International Paper Co., Ltd., Sun Life Bldg., Montreal, Que., plans the construction of additional buildings at its plant. Estimated cost $485,000.

Ont., Toronto—Art Chemical Products, Ltd., c/o Ross Hossack, 302 Bay St., plans the construction of a chemical products plant. Estimated cost $40,000.

CONTRACTS AWARDED

Ala., Childersburg—E. I. du Pont de Nemours & Co., Childersburg, has awarded the contract for the construction of a blending tower to Rust Engineering Co., Liberty Life Insurance Bldg., Birmingham. Estimated cost $60,000.

Calif., Richmond—Kinetic Chemicals, Inc., subsidiary of E. I. du Pont de Nemours & Co. and General Motors Corp., has awarded the contract for the construction of a combination repackaging station and warehouse to Sinerton & Walberg, 225 Bush St., San Francisco.

Ga., Savannah—Union Bag & Paper Co., Lathrop Ave., has awarded the contract for the design and construction of a pressure steam plant, new power and generating station, etc., to Rust Engineering Co., Liberty Life Insurance Bldg., Birmingham, Ala. Estimated cost $1,500,000.

La., Gretna—Gulf Distilling Corp., 135 Amelia St., New Orleans, has awarded the contract for foundation for distillery fermenter building to R. P. Farnsworth & Co., 1515 South Salcedo St., New Orleans. Estimated cost $40,000.

Me., Cumberland Mills—S. D. Warren Co., 102 Cumberland St., Westbrook, has awarded the contract for a soda recovery unit and turbine building to Tredenneck-Billings Co., 10 High St., Boston, Mass. Estimated cost will exceed $40,000.

Miss., West Point—Defense Plant Corp., Washington, D. C., has awarded the contract for loading facilities of Gulf Ordnance Plant, to be operated by Procter & Gamble Co., Gwynne Bldg., Cincinnati, O., to Foster & Creighton Co. and Oman Construction Co., American Bank Bldg., Nashville, Tenn. Estimated cost $3,000,000.

N. J., Paterson—Patent Chemicals, Inc., 57 Wilkenson Ave., Jersey City, has awarded the contract for the construction of a laboratory to James F. Mitchell, 40 Clinton St., Newark. Estimated cost $50,000.

N. J., Ridgefield—Union Ink Co., Route 17, East Rutherford, has awarded the contract for a 110x140 ft. manufacturing building and laboratory to C. A. Hunt Engineering Co., 485 Fort Lee Rd., Teaneck. Estimated cost $50,000.

O., Akron—Rubber Reserve Co., c/o Goodyear Tire & Rubber Co., J. Hergett in charge, 1144 East Market St., has awarded the contract for a 1 and 2 story, 65x172 ft. cooling tower and buildings, etc., to Indiana Engineering & Construction Co., 109 North Union Ave.; cooling system and piping to Kaighin & Hughes, 125 South Huron St., Toledo. Estimated cost $300,000.

Okla., Oklahoma City—Peppers Gasoline Refining Co., First Natl. Bank Bldg., is constructing a natural gasoline plant with its own forces. Estimated cost $250,000.

Tex., Houston—Eastern States Petroleum Co., Inc., Second National Bank Bldg., has awarded the contract for converting existing Butadiene plant into feed stock unit for aviation gasoline to J. F. Pritchard & Co., Gulf Bldg. Project will be financed by Defense Plant Corp., Washington, D. C. Estimated cost $200,000.

Tex., Passadena—Southern Acid & Sulphur Co., 7621 Wallisville Rd., Houston, has awarded the contract for a chemical plant to United Engineers & Constructors c/o owner. Estimated cost, $3,750,000.

Do You Like Your Cigarettes *FRESH?*

KEEPING cigarettes conditioned within moisture limits, both on the store shelf and in the consumer's pocket, is a perpetual problem with cigarette manufacturers. The conditioning agent must do its job as long as possible—under moisture conditions ranging from low to high humidity. Further, it must be tasteless and non-toxic. Unless the conditioner is right, the smoker may find his cigarettes in any condition—dry, crumbly and sharp-burning, or too soggy and acrid for smoking comfort.

Conditioners now used have certain disadvantages. Excessive moisture is absorbed at high humidities, while moisture is lost at low humidities. Consequently, cigarettes vary widely in moisture content and in pleasure for the smoker.

Arlex can overcome these difficulties—with a plus-value to the smoker. At low humidities, Arlex gives off less moisture; at high humidities, it absorbs relatively little. It is a moisture stabilizer that gives the smoker cigarettes that stay in condition longer. This is a plus-value in itself—but more, Arlex is completely non-volatile, has no unpleasant taste, is non-toxic and does not produce throat-irritating acrolein.

Actually, Arlex adds pleasure to smoking—and may add sales appeal to your product, too. We'd like to discuss your specific conditioning problems with you. Write us to arrange a date.

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Arlex is now available for all end uses—critical and non-critical. There is no longer any red tape to getting Arlex; it was deleted from allocation order M-300 on August 22. Arlex will be shipped promptly upon receipt of your order.

There is No Humectant like ARLEX

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Conditioner	*Chemically*	*Physiologically*
Narrow Humectant Range	Hexahydroxylic Character	Bland, Sweet Taste
Non-Volatility	Neutral Reaction	Non-Irritant
High Viscosity	Virtual Absence of Reducing Substances	Moderate Osmotic Pressure
Chemical Stability	Stability to Light and Air	
Wide Compatibility	Does Not Decompose to Acrolein	Assimilability

Arlex: Reg. U. S. Pat. Off.

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