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FEDERATION OF SEWAGE WORKS ASSOCIATIONS

SEWAGE WORKS JOURNAL

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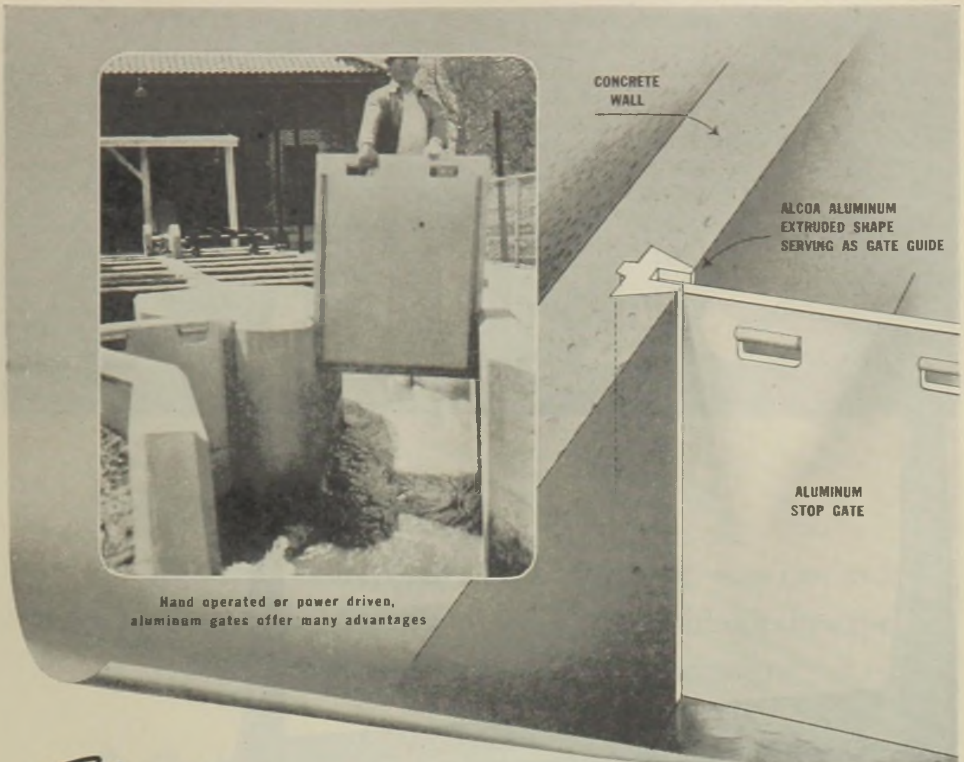
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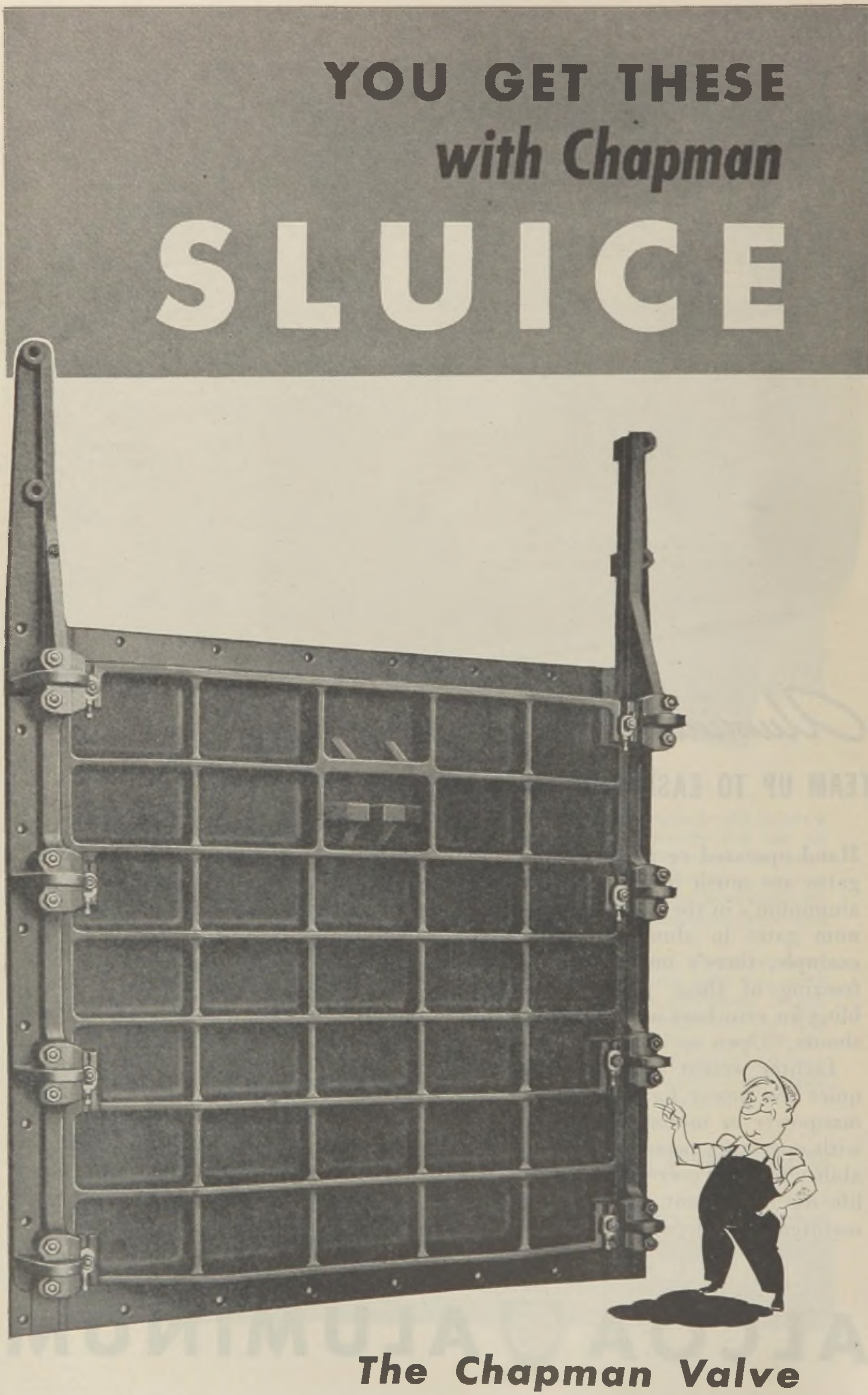
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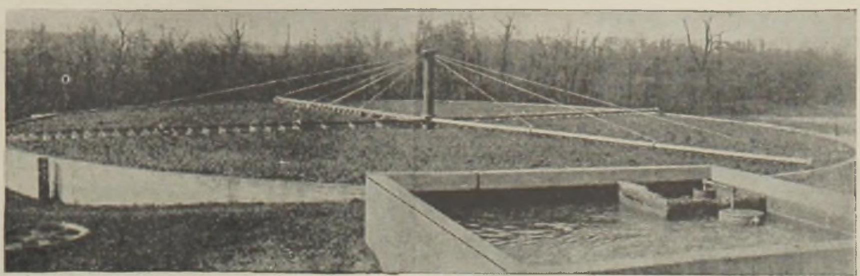

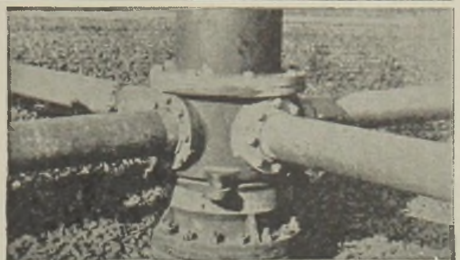

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Plant Operation

GARBAGE DISPOSAL AS A SEWAGE PROBLEM

By Harold E. Babbitt

Professor of Sanitary Engineering, University of Illinois

Slightly more than a generation ago dry methods for the collection of human excreta were widely practiced in this country and abroad. In fact, such methods are still in use in some foreign cities, and the "Passing of The Old Backhouse" has not yet been completely attained in all American cities despite the title of Riley's well-known poem. Nevertheless, the water-carriage method of collecting human excreta is recognized as the proper method of accomplishing this service, and those urban regions depending on dry methods of collection represent the less desirable places in which to live.

Our status with respect to the collection of garbage is much the same as was the collection of human excreta a century ago. For garbage disposal today, most cities depend on home treatment and collection by vehicles for hauling to the point of final disposal. The t mbril, the night-soil wagon, the "honey" wagon are of the past but the garbage wagon is still a familiar implement of municipal housekeeping. A few cities have installed the water-carriage method of garbage collection by dumping ground garbage into the sewers and a few others are hauling garbage to the sewage treatment plant where it is ground and dumped into the sewage or into digestion tanks.

Householders in widely scattered regions are grinding garbage in their own homes and discharging the slurry into the house plumbing. Statistics on the extent of this practice are not available but might be obtained from the manufacturers of such grinding equipment. The convenience of this method of house treatment of garbage is widely affirmed by those who have used it, but its universal adoption is limited by the cost of the grinder and its installation, and the fear of uncertain municipal officials concerning the effect of the garbage on the sewer and the sewage treatment plant.

Among the first attempts by a municipality to use the water-carriage method of garbage collection is the attempt reported by Fox and Davis at Lebanon, Penna. (1) in 1924. However, the practice of dumping unground garbage into sewers probably antedates this planned attempt because it was the appearance of such material in a screen chamber which gave the idea to Messrs. Fox and Davis. It is probable that the practice continues today (2). It is to be noted that municipal officials have been studying the problem for about twenty-five years and that a survey of the literature shows that most of the researches and experience are reported in the last ten years.

Cities reporting experience with the disposal of garbage into sewers, or of dumping garbage into the sewage treatment plant, include the following:

Findlay, Ohio (24)	Lansing, Mich. (8)
Flint, Mich. (21)	Lebanon, Penna. (1)
Fond du Lac, Wis. (10)	Marion, Ind. (9)
Gary, Ind. (11)	Midland, Mich. (23)
Goshen, N. Y. (11)	Rock Id., Ill. (11)
Indianapolis, Ind. (5)	St. Louis, Mo. (22)

The list is probably incomplete, but a cursory examination of the Census of Sewage Treatment Plants recently published by the U. S. Public Health Service (3) indicates that the number of cities using the procedure represents an extremely small percentage of the total number of cities treating their sewage, and is even a smaller percentage of those cities which have garbage to collect and to dispose of. Operation experience with the process has resulted in opinions varying from tolerance to enthusiasm. None seems discouraged, despite difficulties reported. The practice seems to be established as the latest method of garbage collection and as an addition to known methods of garbage disposal.

The effect on the sewer system and on the sewage treatment plant depends somewhat on whether or not the garbage is ground and dumped into the sewer above the treatment plant or whether it is carried to the plant and dumped into the digestion tank. It has been reported by the author (4) that the water-carriage method of collection adds 25 per cent to 100 per cent to the B.O.D. load on secondary treatment devices. When garbage is washed with sewage 23 to 63 per cent of the garbage volatile solids will go into solution. On the other hand, Tolman at Indianapolis (5) reports that "during garbage grinding the air used for the activated sludge was not increased over that used for a similar period the preceding year, and yet the removals and final effluents were almost identical. In bioflocculation comparable removals were accomplished with less air during garbage grinding than during the same months of the preceding year."

Advantages of the water-carriage method of collecting garbage, from the point of view of the garbage producer, that is, the householder, are obvious. It is as desirable as the water-carriage method for the collection of excreta. The apprehensive municipal official fears the effect on the sewers, not so much through fear that the sewers do not have the capacity to carry the load, but through fear that solids and grease may cause stoppage in the sewer. The principles of hydraulics will tell us that so long as the garbage solids are well ground and are mixed with the sewage to form a slurry or suspension, the water-carriage of the solids is theoretically possible. Inspections of plumbing pipes through which ground garbage has been discharged show them to be cleaner than pipes carrying household water-carried wastes without ground garbage. Greasy slime coating the inside surface of the "normal" soil pipe was not found on the inside of the garbage-carrying pipe.

Insofar as the clogging of sewers by ground garbage is concerned, the evidence is all negative, in that no mention of such difficulties was found in reviewing the literature of the subject. It is only proper to point out, however, that nearly all of the writers on the subject are either operators of sewage treatment plants, or researchers in experiment stations. No sewer superintendent has been heard from. That there are uncertainties in the minds of responsible officials may be evidenced by the fact that some cities have ordinances prohibiting the installation of household grinders or the dumping of garbage into sewers.

Some municipal officials, assured that the process will function, hesitate to inaugurate it as a municipal enterprise because of the uncertainties of its cost. Little or no information on cost data resulting from experience are available. Where no garbage disposal plant exists and it is intended to treat or dispose of the garbage with sewage, the grinding equipment and the extension to the sewage treatment plant will constitute additional first cost. If a garbage collection system is now functioning and it is intended to install home grinders, the total cost of the installation and of its operation will be diminished by the saving in the cost of the collection equipment and its operation, and no central grinding equipment will be required. The needed increase in the size of the sewage treatment plant must be considered. After the method has been installed, the additional overall cost of operation will be diminished by the value of the additional gas generated. That the method will cost money cannot be correctly denied. The additional cost must be balanced against the service given; just as in the installation of sewers and of a sewage treatment plant.

To open a discussion on the feasibility of the process it may be asked: "Is the treatment of garbage with sewage in a sewage treatment plant a practicable method of garbage disposal?" In answering this question it is significant that all authors listed in the references in this paper agree that the method is practicable, and may be successful. No evidence has been found to indicate that garbage solids will not digest either with sewage solids or without sewage solids. This fact was demonstrated by Malcolm (6) in his studies at Cornell University. It is emphasized through out knowledge of the Beccari process of garbage disposal and through experience in the disposal of garbage on land, or in land fills, as in New York City and at Treasure Island in San Francisco Bay, where the temperature of the digesting organic solids has risen into the thermophilic range. Emerson, during a discussion reported in SEWAGE WORKS JOURNAL in July, 1937, p. 654, asks: "Will the efficiency of the tanks for removal of suspended solids be decreased or increased? Will it increase the load of solids? Will the effect on removal be changed? Garbage from municipalities contains a great deal of grease; scum removal will be a great problem." Those questions have been answered by investigators and operators. The answers are reported in this paper. The report by Wyllie (7, 8) from Lansing, Mich., is frank and convincing. He states: "The most serious problem encountered in the handling of garbage solids was the plugging of digested sludge lines with ground bone fragments, egg shells, bottle caps, and fruit pits. As much as 15 to 20 cu. ft. of this material is now removed daily by flushing the pipe lines. Excessive gas production caused the gas seals on the digesters to overflow. Difficulty with high solids concentration in the supernatant liquor (2.0 to 2.4 per cent) is at least partly attributable to the high gas production and loading due to garbage solids. The average daily sewage volatile solids added to the digester was 11,800 lb. and of garbage volatile solids, 8,650 lb., which are 93 per cent and 61 per cent, respectively, of total solids added. The digested sludge averages 9.1 per cent solids and 48.1 per cent volatile. The sludge filters well on vacuum filters without excessive quantities of conditioning chemicals.

"Gas production increased from about 100,000 cu. ft. prior to introduction of garbage solids to an average of 231,000 cu. ft. per day with a variation in individual days of the week of 50,000 cu. ft. Quality of gas changed slightly with an increase of carbon dioxide from 30 to 36 per cent."

What difference can it make to the organic constituents in a kernel of corn, a piece of meat, or an Idaho potato whether it passes through the human alimentary tract and is discharged into the sewer as excreta, or whether it enters the sewer as ground garbage? In either event it will arrive at the sewage treatment plant as organic matter susceptible to change by biologic action. Cohn (9) has attempted to simplify what might otherwise be a confusing situation, through his statement: "Bit by bit we have developed a curve which begins to demonstrate that sewage-garbage mixtures are digestible in those proportions which will be produced by average community life," and again: "Since garbage acts like sewage it must be the same material."

Among advantages claimed for the process are: (1) it is a successful method for the disposal of garbage; (2) the cost of the process is low and may be entirely defrayed through the value of the additional gas produced; (3) the sludge produced will dry readily on sand beds, although the solids content may be somewhat less than the solids content of the sludge from sewage alone; (4) the coagulating effect of the garbage solids increased the efficiency of solids removal in settling tanks.

In connection with the increased value of the gas produced Donohue (10) states that a South African engineer has demonstrated the economic usefulness of sludge gas by utilizing it to drive trucks. He reports that 171 cu. ft. of sludge gas is equivalent to one gal. of gasoline. Tolman (11) reports that the gas engines at Findlay, Ohio, compress 100 cu. ft. of air per cu. ft. of digester gas. The value of this air can be estimated from the fact that 825 cu. ft. are used per pound of B.O.D. removed in the activated sludge process. Tolman fixes the figure as $3.34 per million cu. ft. of gas when applied merely to the power savings for operating the compressors.

Among the disadvantages of the process may be included the fact that where garbage is first mixed with sewage, the B.O.D. load on secondary treatment may be increased as much as 15 to 20 per cent. Tolman (5) reports that the addition of garbage to sewage under the conditions of his test increased the suspended solids in the raw sewage by 16 per cent; increased the B.O.D. 12 to 15 per cent; increased the volume of primary sludge 28 per cent; increased the suspended solids in the primary by 3 per cent; and increased the B.O.D. of the primary effluent by 11 per cent. He states that no increase was necessitated in the size of the primary tanks; that the secondary tanks were increased 5 to 6 per cent; and that the increased cost of operation of the activated sludge process for air was only 11 per cent.

Another disadvantage of the process is the need for the removal of inorganic matter and the thorough grinding of the garbage before dumping it into a sewer or into a digestion tank. It has been found (4) that the finer the grinding of the garbage the better the behavior of the digestion tank.

Where works are to be designed, or existing sewage treatment works are to be used for the dual disposal of garbage and sewage, the bases upon which the capacities of the various treatment units are to be determined can be reduced to a relatively simple consideration. Digestion tanks must be designed to care for the volatile solids expected, regardless of the source of the solids, either sewage or garbage. Secondary devices must be designed to care for the soluble solids and B.O.D. resulting from the addition of garbage to the sewage. Knowledge of the garbage volatile solids to be expected, the increase in soluble solids, and in B.O.D. is not extensive. In fact, information on quantities and qualities of garbages in various communities is widely variable. All that can be given here are a few generalized figures used in existing designs or experienced at plants now operating.

An important feature of the design of the new or renovated plant is provision for the collection and storage of the relatively large amount of gas that will be produced. It may be anticipated that the gas production may average 10 to 12 cu. ft. per pound of volatile solids added, and that this gas production may fluctuate during operation of the plant, between 75 and 150 per cent of the average rate of production. The greatest rate will occur shortly after the digestion tank has received a charge of garbage.

The capacity of the digestion tank is another important feature in design. This capacity, the period of digestion, other conditions of operation, and the rate of dosing of the tank are interdependent factors in successful operation. In general, the designer should allow about 4 cu. ft. of tank capacity per capita, although larger volumes have been required by some operators.

Some conditions under the control of the operator that should be considered in the successful operation of a digestion tank, whether for garbage solids, sewage solids, or a mixture of the two, are: (1) the temperature of digestion; (2) the period of digestion; (3) agitation of the tank contents; (4) the manner of dosing the tank; (5) the ratio of garbage solids to sewage solids in the tank; (6) the concentration of solids in the digestion tank, and (7) the quality of the garbage treated.

Temperature of Digestion

With regard to the temperature of digestion, an optimum temperature of operation within a few degrees of 90° F. should be maintained. Fair and Moore (12) and Heukelekian (13, 14) have fixed the optimum mesophilic range of temperature as within a few degrees above or below 33° C.

Period of Digestion

Successful periods of retention at the optimum temperature of 90° F. have varied in practice from 4 days, reported by Bloodgood (5) through 30 days, the period used by the author in experiments at the University of Illinois (4). Tolman (5) recommends a period of 10 days as standard. It is true that digestion can be accomplished in four days under optimum conditions. Some factor of safety is desirable, however, and it must be left to the designer what allowance is to be made. The operator controls the period of digestion by the rate of feeding the digester, the volume of the daily charge being equal to the product of the volume of the tank, the period between doses in days, and the reciprocal of the desired period of retention in days.

Agitation

The mixing of the contents of the digestion tank with incoming fresh solids is conducive to more rapid and thorough digestion, and is essential to successful operation. Stirring devices also break up scum and keep solids surrounded with liquid, thus enhancing digestion. One successful method of agitation is to circulate the solids by pumping them continuously at a rate which will frequently turn over the contents of the tank. The 6,000-gal. tanks at the University of Illinois were turned over 8 to 12 times a day. Possibly one or two complete overturns between dosings would be satisfactory.

Dosing

The dose of ground garbage and sewage sludge should be well mixed before charging into the digestion tank. To avoid scum formation, due to floating solids in the charge, it is desirable that the charge be inserted well below the surface of the digester.

Ratio of Garbage to Sewage Solids

Investigators and operators differ upon the optimum or limiting ratios of garbage solids to sewage solids in the charge. If it is to be admitted that garbage solids and sewage solids are identical, then there is no limiting ratio. One hundred per cent of either form of solids can be treated successfully. If it be assumed that the data in Table 1 are representative, then the normal ratio of sewage to garbage volatile solids should be approximately 1 : 1 if all of the garbage and all of the domestic sewage of a community reaches the treatment plant. Regardless of the proportion of the total garbage, or sewage, or of industrial wastes

TABLE 1.—*Assumed Average Quantities and Qualities of Garbage and Sewage Produced in North American Cities per Capita per Day* (17).

Sewage	100 gal.
Plain sedimentation sludge	3.3 lb.
Dry solids in sludge	5 per cent
Volatile solids in dry sludge	70 per cent
Garbage	0.5 lb.
Dry solids in garbage	25 per cent
Volatile solids in dry garbage	90 per cent

which reach the plant, the operator can safely dose the digester with all of the solids which come to him, the relative proportions from different sources automatically adjusting themselves. It is to be expected that the success of the operation of the plant will not be affected by the relative proportions of the solids from garbage and sewage in the digestion tank.

Solids Concentration in Digestion Tank

The control of the concentration of solids in the digestion tank is an essential feature of successful operation. Rudolf (15) has set the upper limit as 15 per cent. The author (4) has found that the lower limit should also be close to this figure.

Quality of Garbage

No standard for the specification of garbage quality has been widely accepted. If garbage is to be considered as the waste food from a community, then the quality of the garbage will depend on the habits and economic status of the community, the season, and other factors,

TABLE 2.—*Quality of Ground Garbage at Indianapolis* (5)

	Lbs. per Ton of Green Garbage
Total solids	350
Insoluble suspended solids after coarse grinding	260
Oxygen consumed	153
B.O.D.	152
Total organic nitrogen	7.59
Petroleum ether soluble	40.2

including home treatment, method and efficiency of collection, existence of other methods of disposal such as hog feeding, and other factors. Insofar as digestive processes are involved, there is but one important characteristic to measure the quality of garbage, and that is the percentage of volatile solids present in the total solids of the garbage.

Where the garbage is carefully selected and is of such quality as may be considered "fit for a hog to eat," the percentage of volatile solids may reach 95. Tolman (5) states that at Indianapolis the garbage has a total solids content of 17.5 per cent, of which 90 per cent is volatile. Figures given by Tolman are shown in Table 2.

Quality of Gas

The principal gaseous products of the biolysis of organic matter are methane and carbon dioxide. These two gases normally form more than 95 per cent by volume of the gas evolved. In general, the higher the percentage of methane the better the digestion. This does not seem to be an invariable index. Buswell and Boruff (16) state that sour and foaming tanks produce less methane, and Rudolfs (17) reported low methane, high carbon dioxide, and high nitrogen for the first stage of digestion during which gasification had not attained a high rate. Malcolm (6) at Ithaca found the following gas composition, stated in percentage by volume:

Carbon dioxide	26.15
Methane	54.59
Hydrogen	5.65
Oxygen	1.27
Undetermined	12.34

The presence of oxygen can usually be taken to indicate leakage in the gas collection system, since oxygen is not a normal constituent of anaerobic digestion.

Rate of gas production is irregular, the highest rates occurring shortly after a charge of solids has been put into the tank. Little or no valuable information has been reported on these fluctuations but it can be assumed that they will vary widely and that considerable gas storage facilities should be provided in design.

Rate of Gas Production

The maximum amount of gas that can be produced by the digestion of sewage and garbage solids is in the order of 15 to 18 cu. ft. per lb. (22). No investigator or operator has reported so high a rate of production in full-scale plant operation, but the approach to this ceiling may be used as a measure of the completeness of digestion. It may be assumed that the rate of gas production is probably the most significant and easily measured parameter of rate of digestion and behavior of the digestion process. Stegeman (23) reports only 2.5 cu. ft. of gas per pound of garbage at Midland. Tolman (5) states that Keefer and Kratz determined gas production to be at a rate of 12 cu. ft., and Malcolm, at Ithaca (6), reports approximately 10 cu. ft. for sludge alone, and 12 cu. ft. for garbage alone. Tolman (11) states that the addition of all of the garbage from a municipality to the digestion tanks can be expected to double the gas production.

Concentration of Volatile Solids

It is to be expected that the establishment of a constant ratio between the volatile solids in the digestion tank and the volatile solids added to the tank will indicate that constant conditions have been established for the particular rate of dosing. No limit has been stated for this concentration, but in tests at the University of Illinois (4) concentrations up to 80,000 p.p.m. were reached without indication that a limit had been approached insofar as the behavior of the digestion process was concerned. It is possible, however, that this concentration may seriously affect the concentration of solids in the supernatant liquor. In general, it may be desirable to maintain solids in the supernatant liquor below 0.5 per cent, *i.e.*, 5,000 p.p.m. Wyllie (8) reports experiencing a concentration of 2.4 per cent in the supernatant liquor at Lansing, giving considerable trouble in operation, which he hoped to overcome by stage digestion.

Acidity and pH

pH is an important index of digestion which is relatively easily and quickly observed. The optimum value lies about 7.1 or 7.2. One objection to pH as an index is that it may change rather slowly as conditions in the tank deteriorate. However, when the pH is on the acid side, it is generally safe to conclude that digestion is not at its best, and the tank is operating unsatisfactorily. Remedial measures should be applied.

Volatile Acids

In the production of gas during the decomposition of organic solids there is first a combination with water to form the simpler organic acids, such as acetic, propionic, etc., and these acids then decompose to give methane and carbon dioxide. Buswell states (18, 19): "The limit of acidity for smooth, continuous fermentation has been found for most materials to be about 2,000 p.p.m., calculated as acetic."

Grease

Many investigators have reported that grease digests readily (20) and there is a rapid decomposition of grease in the normal process of sludge digestion. The determination of the grease content of the dose and of the digesting solids is, therefore, an important index to the digestion process.

Sludge Characteristics

The physical characteristics of well digested sludge which is comparatively easy to dry and to dispose of without nuisance include a relatively high solids content, a relatively high percentage of ash as compared with these constituents in poorly digested sludge, a black color, a typical inoffensive garden-soil odor, and quick drainability.

Desirable chemical characteristics include a pH between 7.0 and 8.0, a high nitrogen content, and a low grease content. It is to be expected that the sludge from this process will have such characteristics.

Odor

The gas evolved from the digestion process should be odorless. Unsatisfactory conditions of digestion are indicated by the production of hydrogen sulfide, skatol, indol, mercaptans, and other substances, mere traces of which may impart intense, characteristic, and highly offensive odors.

B.O.D.

Although B.O.D. is an important measure of the quality of an effluent to be discharged into a stream, or the load upon a sewage treatment plant, it is not considered that it is an important measure of the behavior of the digestion process in a digestion tank. It is not, therefore, an index which need normally be observed in controlling the operation of such a tank.

Conclusion

In conclusion, it should be emphasized that the water-carriage method of collecting garbage and its dual disposal with sewage offer outstanding advantages to the garbage and to the sewage producer. It provides more work, and hence more jobs and greater public appreciation, of and for the sewage plant operator and the sewer superintendent who provide this service to the public.

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SLUDGE DISPOSAL EXPERIENCES AT SPRINGFIELD, MASS.*

By Lieutenant John D. McDonald

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Gould once remarked that the disposal of sludge may very well become the tail which wags the dog. The wisdom of this observation has many times been driven home in the operation of the Main sewage treatment plant at Springfield, Mass. However, recent changes in the drying process, which result in the marketing of flash-dried sludge instead of incineration to destruction, will tend to make the sludge disposal operation self-supporting rather than a liability.

The Springfield plant is a primary treatment works designed for a maximum average flow of 30 m.g.d. and is situated on the west bank of the Connecticut River opposite the south end of the city. At present, the plant is handling an average of 19.0 m.g.d. with a connected population estimated to be 130,000 persons. The industrial load is not heavy and the strength of the resulting sewage averages about 475 p.p.m. total solids of which about 200 p.p.m. are suspended. The five day B.O.D. averages 180 p.p.m. The solids removal averages 55 per cent of the suspended solids and the average B.O.D. reduction is 35 per cent.

The treatment consists of coarse, manually cleaned bar racks with 3-inch spacing, grit removal by Dorr detritors, screenings handled and returned to the flow by Chicago comminutors, and sedimentation in straight line type settling tanks. The resulting effluent is returned to the Connecticut River with no further treatment although provisions have been made for future chlorination when deemed necessary.

The sludge is removed several times daily and is transferred by Chicago centrifugal scrupeller sludge pumps to the digestion tanks. There are four 55-foot diameter concrete digesters equipped with P.F.T. floating covers, having gas collection and utilization appliances. A temperature of 95° F. is maintained in the digesters and the theoretical digestion period at the present loading is 40 days. The raw sludge has a pH of about 6.4, an alkalinity of 400 p.p.m. and a volatile content of 75 per cent, while after digestion the pH is 7.6, alkalinity is 3,200 p.p.m. and the volatility has dropped to about 45 per cent.

From the digesters, the sludge is withdrawn, as required, to the elutriation tanks where, by the application of Genter's counter-current process, the alkalinity is reduced to approximately 200 p.p.m. and the total solids raised to 15 per cent.

This elutriated, digested sludge is then conveyed by bucket elevator to be conditioned and vacuum filtered. After filtering, the moisture content is reduced about 60–65 per cent which for our sludge is about

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the economic limit for mechanical dewatering. From the filters, the sludge cake is delivered by an endless belt to a Raymond flash drying type incinerator where the sludge is either dried or completely burned.

The conditioning coagulant in use at present is ferric chloride, although aluminum sulfate has been used with varying degrees of success. The dosage of ferric chloride since the plant was opened in 1940 has averaged 1.50 per cent. As the required dose varies directly with the alkalinity, the value of the counter-current elutriation process can be readily seen. There are many other factors which vitally affect economical operation and one which comes to mind at once is the cleanliness of the buckets delivering sludge for conditioning, for the chemical feeder is operated by the elevator and is based upon the buckets being of constant capacity. If the bottoms of the buckets are allowed to fill with grit and the capacity reduced, the sludge will be over-conditioned with a resultant waste of chemical. Good operation will soon disclose this because the pH of the filtrate is checked periodically and any drop below 6.0 to 6.2, which has been found to be the optimum, will indicate trouble and call for investigation. It has also been observed that violent agitation is not necessary or desirable in the conditioning of sludge. This is particularly true in the use of aluminum sulfate. The alum floc is easily formed and larger than that formed by ferric chloride but is far less stable. It is this unstability which leads to the preference of ferric chloride at the present time but further studies are in order as there are many advantages to alum, such as ease of storage, less corrosiveness and low cost.

We are using filter cloths of 12 oz. wool and the average life has been about 600–700 hours. The cause of blinding appears to be oils and grease and the cloths have been successfully cleaned by use of solvents. However, the nap is pretty well destroyed after 600–700 hours use and the expense of cleaning is not warranted solely to prolong their life at a reduced production rate. All other mechanisms have to be reduced to this rate although power and labor costs remain the same as for maximum rates.

As previously stated, the incinerator is the flash drying type using either digester gas or oil as auxiliary fuel. During the first two years of operation, all sludge was burned except for small quantities used as a soil conditioner around the grounds and at one location where the city had abandoned a public dump. Analyses of the dried sludge prior to burning showed a content of 1.75 per cent nitrogen, 1.50 per cent phosphoric acid, and 0.40 per cent potash. With this in mind, work was begun early in 1943 to burn surplus digester gas and from this heat to dry the sludge and remove it from the system before burning, with a view toward the possible sale as a fertilizer base or carrier.

The material was advertised, bids called for and a contract was finally made with a commercial fertilizer company for the sale of one year's output of the flash-dried sludge. A pneumatic transport system was installed which intercepted the dried sludge just prior to burning and removed it to a small loading building constructed in the rear of the sludge disposal building. The sludge is blown into containers, each of which holds 2,500 pounds of sludge containing only about 5 per cent moisture and less than 10 per cent ether soluble matter.

These containers are large, well constructed wooden boxes, 39 inches wide, 54 inches long and 60 inches deep. Each box is on a dolly having two rear wheels and a bracket in front for a one wheel lifting mechanism for use when moving. The dried sludge is diverted to a small hopper at the base of the drying cyclone and thence into the transport system by the pull of air from a 24-inch fan at 3600 r.p.m. located on the discharge side of a separating cyclone on the roof of the loading building. This fan was placed on the clean air side so that it would not be affected by the abrasiveness of the dried sludge. The system

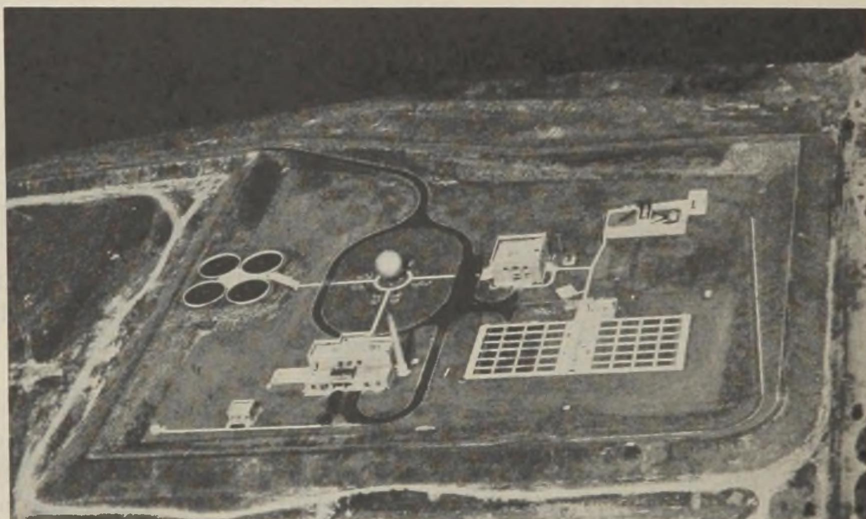

Fig. 1.—Air view of sewage treatment plant, Springfield, Mass. Courtesy McLaughlin Air Service.

was designed to handle 1,000 pounds of solids per hour through a 5-inch line with a ratio of 3 pounds of air per pound of solids. The free air end of the line was extended outside the building to prevent any air deficiency in the building and to aid in lowering the temperature of the sludge which emerges from the cyclone at about 190 degrees F. At all bends, the elbows are split and replaceable as wear was anticipated. After separation in a cyclone and passage through the air lock, the dried sludge is delivered through a discharge pipe to the open-top wooden boxes. As normal operation produces 750 pounds per hour, it means that this operation places practically no burden on the operator for the boxes require changing only once every several hours. The full boxes are stored and wheeled into the purchasers' trucks and, as the annual production is about 1,200 tons and the price $5.00 per ton F. O. B. our platform, the proposition seems very advantageous provided the demand for dried sludge continues to exist when the present emergency is over.

Fig. 2.—Springfield, Mass. sewage treatment plant. Gas Building in right foreground. Sludge Disposal Building, with elutriation tanks, in center. Administration Building in background.

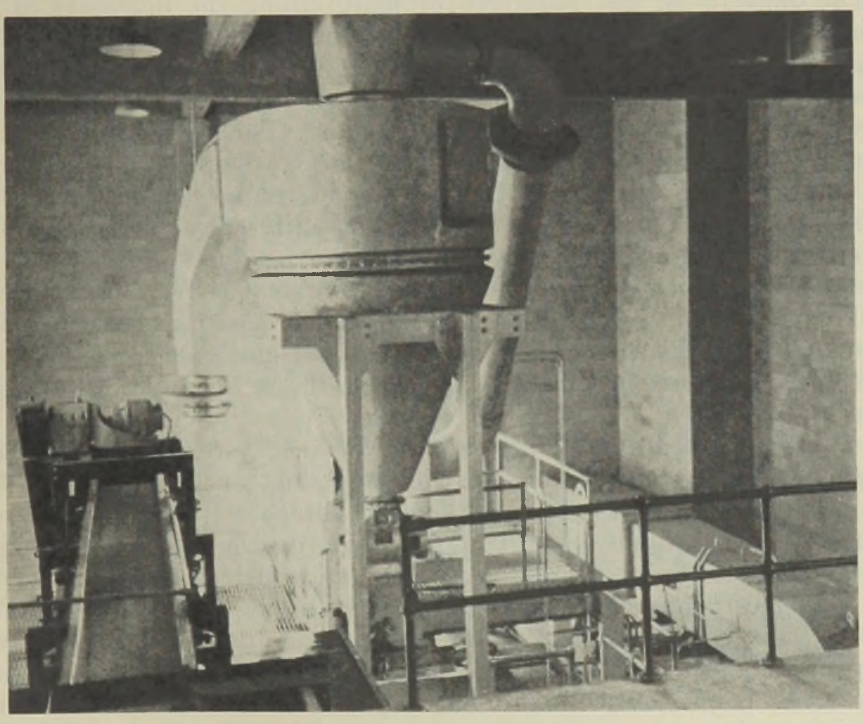

Fig. 3.—View of upper portion of sludge drying and incineration equipment, Springfield, Mass.

The design capacity of the incinerator is 878 lbs. of solids per hour with a cake containing 67.5 per cent moisture. This requires the evaporation of 1,825 lbs. of water which is really the criteria of the maximum amount of work which can be performed by this installation. The plan was to use digester gas and experiment showed that the maximum consumption with all four gas burners on was 4,600 cubic feet of gas per hour. Our problem was to obtain as high a solids content of the filter cake as possible to gain a high yield of dried solids per cubic foot of gas consumed.

The daily removal of solids to the digesters amounts to 15,000 pounds or 5,500,000 pounds per year and, after digestion, this quantity is reduced to 2,500,000 pounds which is the quantity to be dried and handled. The total gas production per year is 42,000,000 cubic feet which is an average of about 0.9 cubic foot per capita per day. By keeping the filter cake moisture content at 65 per cent, the evaporation of 4,650,000 pounds of water will be required per year. Using the actual figures, 4,600 cubic feet of gas per hour will evaporate 1,435 pounds of water per hour based upon an assumed thermal efficiency of 55 per cent for our drying equipment. This will call for an annual gas consumption for drying of 15,000,000 cubic feet and a total operating time of 3,250 hours. Another million cubic feet will be used for starting, shutting down and standby time. On a unit basis, this amounts to 12,500 cubic feet of digester gas per ton of solids dried.

The quantity of gas required for maintaining the digesters at the proper temperature varies seasonally from 15,000 to 30,000 cubic ft. per day. Annually this will total about 10,000,000 cubic feet while heat for the buildings, hot water, laboratories and other uses will consume another 10,000,000 cubic feet per year. The summation of these requirements totals 36,000,000 cubic feet per year which apparently would indicate a surplus of gas. However, under actual conditions, this is not true as there will be many consecutive days in the cold seasons when the consumption will exceed the production if the drying operation is spread uniformly over the entire year. Therefore, success will depend upon two essential factors: first, precautions must be taken to insure the driest possible filter cake and second, a schedule will have to be adhered to which will use the gas at the most advantageous seasons.

This will mean the operation of the drying system for a period of about 35 weeks a year, working a double shift or 16 hours per day. During these periods, sufficient sludge will be withdrawn to insure proper digester conditions. This procedure can be made more flexible by burning sludge when necessary or by augmenting the gas heat with oil salvaged from the digesters (see *Water Works and Sewerage*, Feb. 1944). The periods when filtration and drying are not in progress will be profitably utilized by using the staff on reconditioning, painting, and a program of preventive maintenance. During these periods, the electric power demand can be kept at a minimum while, during the other periods, the increased consumption at a normal demand will result in a low unit cost per kilowatt hour. This method of operation is estimated to save $1,000 annually in power costs.

The unit cost of conditioning and filtration has been about $3.80 per ton and that of incineration about $5.50 per ton on a dry digested solids basis. On a per million gallons basis, these costs are $0.65 per m.g. for filtering and $0.95 per m.g. for incineration. The filtration costs will not be altered regardless of the method of disposal but, by drying with a selling price of $5.00 per ton, the incineration costs will be almost nullified. In addition to this tangible income, other advantages which are evident are greater ease of operation, due to more readily controlled temperatures while using only gas heat, and longer life expectancy for the incinerator itself, due to burning only gas with the resultant lack of slagging and reduced ash removal.

Regarding the use of aluminum sulfate as a sludge conditioner, it was found that under normal drying and burning operations fair results were obtained. The consumption of alum averaged 3.5 per cent but this was compensated for by its low initial cost. It had just about been decided that there were some advantages in the use of alum when operations were changed over to drying only and then the necessity of dry cake became the ruling factor. The alum floc seemed very fragile and evidently crushed against the cloth, preventing further dewatering of the outer particles and resulting in a cake which often reached 70 per cent in moisture content. With ferric chloride, moisture contents as low as 60 per cent were common and, with heat at a premium, the advantage seems to lie with this conditioner. This difference in moisture content seems small until one considers that at 70 per cent there are $2\frac{1}{3}$ lbs. of water per lb. of solids while this ratio drops to $1\frac{1}{2}$ lbs. of water per lb. of solids for a 60 per cent cake.

The loading building and platform was designed so that, in the eventuality of the present demand being of a temporary nature, the structure would continue to be an asset to the plant. The new building with its handy concrete platform will provide an opportunity to purchase and store chemicals in carload lots and thereby afford advantage of the correspondingly more favorable prices.

Since arriving in Springfield today, I have learned of some recent difficulties caused by abrasiveness in the new drying system. The high velocity of the dried sludge particles has already worn through the separating cyclone. Attempts have been made to reduce this velocity and the interior of the cyclone may be lined with a more resistant material. It may be advantageous to have replaceable sections in the cyclone and change them periodically. This latest problem once more brings forth the fact that sludge disposal can be the most interesting but also the most obstinate problem at a sewage treatment plant.

HIGH RATE ACTIVATED SLUDGE TREATMENT OF SEWAGE *

By E. Sherman Chase

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The history of the art and science of sewage disposal is largely a record of attempts to reduce the area required for treatment plants. It is a far cry from the old broad irrigation fields of Paris and Berlin, requiring 12,000 acres and 43,000 acres, respectively, to the high rate activated sludge plant recently recommended for Los Angeles, upon a site of about 200 acres, for a somewhat larger population than was involved in either Paris or Berlin.

Basic Principles of Sewage Treatment

The fundamentals of sewage treatment have long been known, from the days of Edward Frankland, through the work of the Lawrence Experiment Station and of the Royal Commission on Sewage Disposal to the present time of the publications in Sewage Works Journal of many research workers and observers. Broadly, all sewage treatment consists of two processes, namely, separation of suspended solids and oxidation of dissolved solids. Each of these processes may or may not involve secondary processes. After the separation of the solids from the liquid, the sludge obtained must be disposed of either directly as produced, or after digestion. The dissolved solids remaining in the liquid part of the sewage must then be treated either to the extent of oxidation of the readily oxidized carbonaceous matter or to the further extent of nitrification. In the earliest methods of treatment, such as land irrigation and intermittent sand filtration, the two principal processes were effected by the same device. The inherent difficulties in such practice led to the development of increasingly complex processes and equipment with greater and greater diversity of function. This is particularly true as regards the handling of the sludge. Furthermore, experience has demonstrated that the removal of solids capable of settling and forming deposits in the receiving body of water is of relatively greater importance than the oxidation of dissolved solids. Consequently, a few years ago somewhat greater attention was paid to the handling and processing of sludge than to the oxidation processes. In more recent years there has developed a renewed interest in oxidation processes and it is these processes with which this paper deals.

Oxidation Processes

Sewage discharged into a body of water more or less saturated with oxygen undergoes a natural oxidation process which proceeds so long

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as oxygen is present. When sewage is discharged onto land, oxidation also occurs if the interstices of the soil are adequately supplied with air. This oxidation is brought about by the organisms and enzymes present in the sewage, in the water or on the soil.

So-called artificial oxidation processes are analogous to natural processes. The natural oxidation brought about by soil is simulated and accelerated by the oxidation resulting from the application of sewage to specially prepared sand beds or to coarse-grained beds of the trickling filter type. The natural oxidation which occurs in a stream, lake or ocean is simulated and accelerated in the activated sludge process. In the first instance, the sewage passes over the living film of organisms growing on fixed media, and in the second instance the organisms are circulating throughout the moving stream of sewage.

Flocculation

Although the emphasis in this discussion is placed upon the biological aspects of treatment, it must not be overlooked that there are physical causes at work which bring about flocculation of finely divided and colloidal particles. Agitation by air or paddles, contact with surfaces and attraction between particles, all tend to produce clumps or flocs of solid matter capable of removal by sedimentation. Such flocculation can be coincident with biological action. Thus, a certain amount of the purification effected by so-called biological processes is by purely physical means.

High Rate Oxidation Treatment

In the early days of sewage treatment one criterion for the efficiency of treatment plants was the degree of nitrification obtained. This was due in part, at least, to the fact that the development of sewage treatment practice began in England and New England where there were large concentrations of populations on relatively small streams and where highly purified effluents appeared necessary to avoid nuisance conditions in the receiving streams. With the recognition of the disproportionately large benefits from removal of solids and the comparative ease with which first-stage oxidation could be accomplished, the reductions in oxygen demand and suspended solids have become generally accepted criteria of treatment plant accomplishment.

In all oxidation processes there are certain fundamental factors which largely determine the degree of purification effected. These factors are temperature, time, available oxygen and oxidizing organisms. The designer of treatment plants employing biological processes must, therefore, bear these factors constantly in mind.

Temperature has an important bearing not only upon the activity of purifying organisms but also upon the quantity of oxygen present in sewage. Within normal ranges, the higher the temperature the greater the biological activity and the greater the rate of purification. On the other hand, the capacity of water to contain dissolved oxygen is less with high temperatures than with cold, and warm sewage may reach treatment plants very low in or completely devoid of oxygen and the rate of reabsorption of oxygen is not as rapid as with cold sewage. Consequently, the higher temperature is not an unmixed blessing. This is particularly true where already stale sewage receives treatment by sedimentation only.

Oxygen is essential for life processes and must be supplied in ample quantities to permit the inoffensive disposal of sewage. This oxygen must be supplied either in the treatment process or in the receiving body of water. Where conditions permit, the latter source is permissible. Where circumstances require, purification must be effected and oxygen supplied by artificial means. In such cases the utilization of oxygen by the living organisms, to purify the sewage, is analogous to the purification of the impure blood by the lungs. This analogy involves two of the other factors previously referred to, namely, time and numbers of oxidizing organisms.

The oxidizing organisms, comparable to the living cells of the membrane of the lungs, exist as "bacterial films" on the surface of fixed filter media or on and in the circulating sludge in the activated sludge process. Theoretically, the more organisms the quicker the oxidation or the more complete the purification. Practically, it is the area of biologically active material which can be brought in contact with the sewage in the presence of oxygen, which is important. In the fine-grained filters of the intermittent sand type the areas involved are considerably greater than those in the coarse-grained filters of the broken stone type. In the case of activated sludge the areas of biological films are variable and difficult to determine, but are obviously considerable. In addition to the quantity of film the character of the organisms present is important. This depends upon environmental conditions, such as character of the sewage, temperature, oxygen available, and presence or absence of toxic substances.

The time during which the living organisms can act is very intimately connected with the kind and degree of purification effected. It is this factor which is of particular significance in all so-called "high rate" methods of sewage treatment, whether trickling filters or activated sludge plants. In the intermittent sand filters the time available for the purifying organisms to function may be one or more days. On the other hand, the purification taking place in a trickling filter occurs in a relatively few minutes. It is apparent, therefore, that the trickling filter in its time relation more closely resembles the lung than does the intermittent sand filter. The activated sludge process is intermediate, as far as the time factor is concerned, between the sand filter and the trickling filter. Standard practice in the activated sludge process involves four to six hours of aeration contact.

Although recent research has aroused current interest in methods by which the period of aeration can be shortened, early investigations had already indicated that short periods of aeration produced substantial purification. As long ago as 1910, Black and Phelps showed that simple aeration of fairly weak sewage for a period slightly under 3 hours and with but 0.23 cu. ft. of air per gallon, produced a marked degree of purification as measured by relative stability. In 1915, tests at Houston, Texas indicated that relatively high purification could be obtained with only one hour of aeration by the activated sludge process operating with 25 to 30 per cent return sludge. The purification effected as measured by reduction in suspended solids and oxygen demand was 98 per cent and 94 per cent, respectively. At Milwaukee, also in 1915, tests by Copeland showed that with two hours' aeration and 1.32 cubic feet of air per gallon, a clear, partly nitrified effluent could be obtained with a reduction of over 80 per cent in bacterial counts. At both Houston and Milwaukee the sewage was fairly strong.

Personally communicated information indicates that other investigators, including Blew at Philadelphia and Goudey at Los Angeles, have obtained results comparable to those reported elsewhere.

Large scale experience with short periods of aeration has been had at the North Side plant in Chicago and at the Bowery Bay plant in New York. At the North Side plant two batteries of aeration tanks were operated, with aeration periods of 3 hours and 0.37 cubic feet of air per gallon. Their final effluents showed an average removal of 91 per cent in oxygen demand. At the Bowery Bay plant an aeration period of 2.6 hours and an air consumption of 0.59 cubic feet per gallon resulted in an 85 per cent reduction in oxygen demand.

In England, at Birmingham, experiments in 1921 showed that the activated sludge process destroyed offensive odors in a strong settled sewage in less than an hour and at the same time flocculated almost all of the sludge-forming material. Later, two so-called "bioflocculation" plants were built, employing short-period aeration with low return sludge for strong sewage. The second of these plants was completed in 1930. These plants operated with one hour of aeration and 7 per cent return sludge, the return sludge itself being reaerated for 8 hours. The effluents from these plants were given additional treatment on trickling filters to produce the high degree of purification required.

At Leominster, Massachusetts, during May, 1943, and April, 1944, the 2 m.g.d. activated sludge plant was operated with average aeration periods of 3.3 and 3.7 hours and 0.54 and 0.64 cubic feet of air per gallon, respectively. The final effluent, in May, 1943, contained on the average 12 parts per million of suspended solids and 14 parts per million of 5-day B.O.D. In April, 1944, these figures were 12 and 15, respectively. The Leominster sewage receives preliminary sedimentation and was moderately weak during these months of short-period aeration.

Pilot plant tests at the Wards Island sewage treatment plant, New York City, are reported by Setter in Sewage Works Journal for 1943 and by Setter and Edwards in 1944. It was found that 1.5 hours' aeration of settled sewage with return of sludge and secondary settling produced 65 to 75 per cent reduction of the suspended solids and oxygen demand, and that 3-hour aeration with return sludge resulted in 75 to

85 per cent reductions. These reductions referred to the constituents in the influent to the aeration tanks, which was settled sewage.

Following the work of Setter and Edwards, the Jamaica sewage treatment works of New York have been used to demonstrate on a large scale the conclusions drawn from the pilot plant tests. This plant scale investigation has been under way several months and appears to have verified the pilot plant data.

Setter and Edwards use the term ''modified sewage aeration'' rather than ''high rate activated sludge treatment.'' They define it as ''a process of activated sludge sewage treatment consisting of a short aeration period and a relatively small amount of return solids.'' The American Society of Civil Engineers has adopted the following definition of the activated sludge process:

"Sewage treatment in which sewage standing in or flowing through a tank is brought into intimate contact with air and biologically active sludge, previously produced by the same process. The effluent is subsequently clarified by sedimentation."

In view of this definition it would seem as though the term ''modified'' is not quite as descriptive as ''high rate.'' However, the use of terms is a matter of personal choice until some authority determines a standard for use.

It is interesting to compare the conclusions drawn by Setter and Edwards with respect to their recent investigation of short-period aeration, with the comments of Metcalf & Eddy in ''American Sewerage Practice'' upon the results obtained in 1915 at the Milwaukee testing station, with aeration periods of 1, 2, 3, 4 and 5 hours. Setter and Edwards state:

"Modified sewage aeration is a process of partial sewage treatment intermediate between primary sedimentation and high rate single stage filters or activated sludge. Any degree of treatment between sedimentation and activated sludge appears possible by controlling the air supply, the aeration period, and the amount of returned solids. For partial treatment, low air supply and small tank capacity are needed and dense excess sludge will be produced.

"For more complete treatment, a greater air supply and tank capacity are needed and a less dense excess sludge will be produced. The treatment apparently reaches a critical value when the aeration tank suspended solids exceed 600 to 800 p.p.m."

Metcalf and Eddy comment as follows:

"The data . . . indicate that all that is necessary to obtain an effluent of the desired quality is to select the appropriate detention period for the operating conditions. This, however, is not so simple as it appears, for these conditions, which are determined by factors such as the design of the tanks, the rate of application of the air, the character of the sewage and the quality and volume of the return sludge, may vary greatly and continuously in the same plant."

From these two comments it is clear that the results obtained by short aeration periods at Milwaukee in 1915 were comparable to those recently obtained at New York. At Milwaukee, however, the necessity for the discharge of effluent into Lake Michigan, the source of the city's water supply, necessitated the highest degree of purification practicable to obtain, and hence the adoption of a 6-hour period of aeration for the full size plant.

Design Conditions

Preliminary treatment by racks and grit chambers is essential. Presettling, desirable with any type of oxidation process, appears even more necessary in case of the high rate activated sludge process with strong sewage. Not only do primary settling tanks remove substantial quantities of non-activated, suspended organic solids, but they also remove much of the oil and grease likely to interfere with the oxidation action of the aeration tanks. Furthermore, relatively weak sewages are more readily purified by high rate treatment than the strong sewages. Hence, the reduction in strength by presettling is beneficial. Settling periods of 1 to 2 hours are satisfactory.

In the case of stale or septic sewages, prechlorination, preaeration or both should be provided, partly to control odors and partly because the presence of some oxygen at all stages in the treatment process facilitates purification.

Aeration tanks, preferably of the spiral circulation type, may be designed to give from 2 to 3 hours' detention, the shorter period being adapted to weaker sewage. The return sludge may vary from, say, 10 to 25 per cent of the sewage flow, depending upon the strength of sewage to be treated and the per cent solids in the sludge returned. At New York it was found advantageous to maintain the suspended solids content in the mixed liquor below 800 parts per million. At Leominster, during the two months of short-period aeration previously referred to, the quality of the effluent was somewhat better, with 725 p.p.m. of suspended solids in the mixed liquor and 3.3 hours' aeration in May, 1943, than with 505 p.p.m. and 3.7 hours' aeration in April, 1944. In both cases, final effluents averaging less than 15 p.p.m. of B.O.D. were obtained.

With respect to the quantity of air required, assuming an amount adequate to assure agitation and the continued suspension of solids, it is evident that the shorter aeration period the smaller the volume of air per gallon of sewage treated. In general, the air required will approximate 0.5 cu. ft. per gallon of sewage compared with 1.0 cu. ft. or more with standard rate treatment. At Leominster, during the months referred to above, the air used averaged 0.54 and 0.64 cubic feet per gallon for the respective months.

With the modified aeration tests at New York it was found that the solids collected by final sedimentation were more readily settleable and produced a denser sludge than in the case of standard activated sludge treatment. The New York experience indicated that the sludge from the modified process deteriorated more rapidly than that from standard treatment. Hence, its retention in final settling tanks should be as short as possible and the excess sludge should be disposed of promptly.

It seems possible that the distinction between "modified aeration" and "activated sludge" lies in the difference in the character and condition of the return sludge, as well as the percentages returned and period of aeration. With modified aeration the production of typical activated sludge is not attempted and the sludge formed more nearly resembles primary sedimentation sludge than activated sludge. Probably the types of organisms present in this sludge from modified aeration possess a limited and selective purification function. This, however, is purely speculative.

Summary

This paper deals mainly with the theory and practice of the aeration aspects of high rate activated sludge. The associated features of a complete plant such as preliminary and final sedimentation, disinfection, sludge treatment and disposal are discussed but briefly. These features, in general, conform to current practice with standard rate plants. The feature of the high rate plant lies in the shortness of the period of aeration and the relatively low proportion of suspended solids in the mixed liquor. Even here the record shows that early investigations disclosed the benefits which could be derived from short periods of aeration.

The evidence of investigations and operation of plants shows that periods of aeration shorter than those used in standard activated sludge plants can produce effluents of various degrees of purity intermediate between that from plain sedimentation and that from standard activated sludge. The design of high rate plants must provide for flexibility of operation to meet changing conditions. High rate treatment is susceptible to changes in quality of sewage, but can adapt itself to these changes more readily than standard treatment. Where conditions warrant, the high rate activated sludge treatment offers a means for substantial economies in construction and operating costs as compared with standard activated sludge.

Discussion

By Harrison P. Eddy, Jr.

For many years the criteria for the need of treating sewage before discharge into a body of water were, primarily, the hazard to drinking water supplies taken from a stream below the point of discharge and, secondarily, the likelihood of the creation of a gross nuisance by the discharge of raw sewage. Attractiveness of the stream or other body of water into which the sewage might be discharged was seldom considered of sufficient importance to justify the expense of sewage treatment.

Recreation, a generation or two ago, was of relatively little commercial value, and received an insignificant degree of attention in comparison with that of today. There were six full working days in the week and on the seventh day recreation was rather vigorously frowned upon.

During the last few decades, however, recreation has assumed a mounting importance. It became common practice to exempt Saturday afternoons from the working week, and for a large part of the population the entire week-end was devoted to recreation. Probably the automobile is responsible for this great change of custom in the United States. In many parts of the country, recreation during the '20's became an important source of wealth and was referred to as one of the major "industries." With the depression of the '30's came the general, almost country-wide adoption of the five-day week, which had started on a rather vigorous scale during the prosperous '20's.

It is difficult to predict the effect upon life in the United States of the conditions which will exist after the war, but certainly the trend which was interrupted by the war was toward greater and greater emphasis upon recreation, and particularly the recreational value of our natural resources.

While some of our state health departments and many of our municipalities still think of the need of sewage treatment only as measured by safety of water supplies and avoidance of nuisance, for a number of years forward-looking sanitarians have recognized and vigorously fostered the need of maintaining the attractiveness of our recreational waters and of restoring to an attractive condition many of those waters which had lost to one degree or another their attractiveness for recreational purposes.

The Santa Monica Bay beaches are among the most attractive natural beaches in the country. They are closely accessible to one of the largest centers of population. For many years practically raw sewage from Los Angeles and several nearby cities has been discharged into the ocean off this beach at Hyperion. The screening given the sewage before its discharge is so ineffective in removing solids that the discharge is virtually raw sewage. While the Japanese Current may move along the coast, the surface current induced by on-shore winds carries the sewage onto the beaches to such an extent that the waters, beaches, and atmosphere are grossly polluted. The State Health Department has found it necessary, in the interest of public health, to prohibit bathing along a stretch of beach several miles in length, adjacent to the point of discharge. An injunction proceeding has been brought against the City of Los Angeles, seeking to prevent the continuance of the present practice of discharging raw sewage into the ocean at Hyperion, and to recover from Los Angeles $1,000 a day for the continuance of this offense.

The value of the beaches now affected by the discharge of sewage from these cities is so great that, in our opinion, a high degree of sewage treatment is essential before discharge of the effluent into the ocean, and the point of discharge should be about a mile from shore in deep water. We believe that these waters should be made not only safe, but attractive as well, for bathing and recreation. It is not sufficient that the waters merely do not repel recreationists, but they should actually attract them. We feel sure that the public will soon come to realize that no lesser degree of treatment than that recommended would be sufficient.

SOME OBSERVATIONS ON GREASE IN SEWAGE AT ARMY CAMPS IN SOUTHEASTERN U. S.*†

By A. E. McCaskey, Jr. and F. L. Vermette

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Comparative figures on the characteristics of municipal sewage from separate systems and analyses of Army post sewage reveal that the Army sewage is somewhat stronger. C. E. Keefer shows a B.O.D. of 265 p.p.m., suspended solids of 243 p.p.m., and settleable solids of 7.2 ml. per l. for municipal sewage. The analyses of the Army post sewage in the Third Service Command taken from an average of the operating reports show a B.O.D. of 362 p.p.m., suspended solids of 311 p.p.m., and settleable solids of 6.2 ml. per l. The drop in settleable solids is attributed partially to grease flotation of the solids. Our records and observations indicate this to be true. After studies of activities at posts, we believe the grease content is due to:

First, lower water consumption per capita, which lends itself to stronger sewage.

Second, the fact that employees, in general, are not as saving as owners, and not because the food which is prepared in Army kitchens is excessively greasy.

Third, soap is more generously used than in most homes. Showers by groups are mandatory, and soaps of all kinds are used in great quantities.

It has been, and will continue to be, our thesis to collect all possible greases at the source rather than at any other place in the system. We realize that this method is ideal, something that can hardly be realized in civilian practice. Consequently, we will not stress this point in order to give some practical, worthwhile observations on the handling of the grease problem; however, please bear in mind that this is a resume of the picture from the military side. The military program has included the trapping of grease at mess halls and kitchens through a standard grease interceptor. Some of the specifications for this grease interceptor as set forth in War Department, Office of Chief of Engineers, Specifications PE-620 are:

"Each interceptor body shall be in one piece of either vitreous china or vitreous glazed earthenware. The periphery of the base coming in contact with the floor shall be grooved or scored so that in installation the interceptors can be keyed to the concrete floor with mastic or cement grouting. Each interceptor shall be provided with interior baffles of an impervious cement asbestos material. The baffles shall be removable and so arranged as to provide the maximum efficiency. Baffles shall be arranged to permit readily com-

* Presented at the 18th Annual Conference, Maryland-Delaware Water and Sewerage Assn., Baltimore, May 19–20, 1944.

† The term "grease" is taken to mean ether soluble fats, including waxes, animal, vegetable, and mineral fats and oils, both liquid and solid.

plete removal of grease accumulations. Each interceptor shall be provided with an internal air-relief device to prevent the siphoning of the contents of the interceptor. The air relief device shall be designed to prevent the escape of sewer gas when the cover is removed, and shall be constructed without moving parts. The body of the interceptor shall be equipped with a trap that will provide a water seal of not less than two (2) inches. The trap shall be integral with the body or assembled within the body in an approved manner. Each interceptor shall have a minimum flow capacity of twenty-five (25) gallons per minute, a minimum grease-retaining capacity of fifty (50) pounds, and shall have a minimum overall efficiency of ninety (90) per cent when operating at the specified rate of flow and within the limits of the grease-retaining capacity. A flow control fitting of the clean-out type shall be provided with each interceptor for installation on the horizontal drain line between the fixture and interceptor. The fitting shall be designed to limit the flow of waste water through the interceptor to that specified. The inlet and outlet tapping of the flow-control fitting shall be for one and one-half (1½) inch pipe. The orifice opening shall be self-scouring in design and shall be accurately reamed to one (1) inch in diameter."

The use of these traps has been the practice for two reasons: first, to reduce the maintenance cost on the operation of the sewerage system, and second, for the purpose of salvaging the trap grease.

Instructions have been issued that all kitchen greases shall be collected in suitable containers and prepared for salvage. We advocate the cleaning of all leavings on the dishes in the garbage rather than letting them get into the dish water and subsequently becoming part of the sewage. We believe that the grease traps are adequate; however, they must be cleaned on a set schedule, and we recommend that this schedule be once a day. The location of these traps in the vicinity of heat has lessened their effectiveness in some instances. Generally, the traps are located properly and in conjunction with the orifice flow control, which is part of this installation.

Kessler and Norgaard report that "operating logs at many posts show that the grease trap rehabilitation program and grease salvage have eliminated to a large extent the grease problems of filter operation. When the cleanout-type flow control tee has not been placed ahead of the grease traps, or an unvented siphon leg has been created by locating the ceramic traps below the mess hall floor, grease collection has not been satisfactory. At some posts where a definite schedule is not followed in cleaning the traps after the 50-pound retention capacity has been reached, grease accumulations are found in the sewers, and some eventually works its way to the plant in the form of grease balls and cakes. It is found that at stations, where salvage officers thoroughly understand the problem and unit commanders follow their suggestions, the officers report that the trap grease collection and removal are satisfactory. The reports of officers who had similar duties in World War I particularly confirm this conclusion.

"The Salvage Branch of the Office of the Quartermaster General states that approximately six million pounds of grease are being salvaged each month. This amount includes interceptor grease along with the frying fats and other kitchen fat wastes. This grease will produce 600,000 pounds of glycerine which is converted to an equal weight of nitroglycerine. Incidentally, the collected grease, being free from sewage solids, is highly desirable.''

I call to mind one instance where a sewage treatment plant was completely upset, and the only justifiable reason which could be found was from extra laundry waste. The laundry in a military establishment must, of necessity, work long hours since they process laundry, not only from their own posts, but from many military installations in the vicinity. We have installed water softeners in nearly all the laundries in an effort to reduce the use of soap, and from that standpoint alone, the saving of soap has more than paid for the installation of the softeners. The additional benefit, of course, is the lessening of the greases and oils in the sewage. We have made no special treatment of laundry wastes in this Command to date. It is not anticipated that these wastes will be such that they will necessitate treatment prior to that received in the sewage treatment plant. Other contributing factors of considerable importance are the airplane and auto repair and service shops. These activities necessitate some cleaning with gasoline. Some washings will carry greases and oils into the sewage. Wash racks, especially, contribute grease and grit and create unsightly conditions at the sewage treatment plant, and, by and large, are responsible for a noticeable quantity of grease in Army sewage. Where possible, we have advocated that wash racks be connected to the storm drainage system. This has helped somewhat.

With all these contributing factors, it is not difficult to imagine that the flotation which we presupposed in the beginning of this paper is easily verified. With all the methods and measures to control and remove grease at the source, it is not possible to remove more than a fair share by these means. Regardless of the effectiveness of any salvage program, quantities of grease will arrive at the sewage treatment plant. Our observations and tests reveal conclusively that there are a certain amount of floating greases, coupled with another portion of suspended oils or greases. We know that there is very little which we can do to eliminate or to take out the oils in suspension. It is possible that the suspended oils hold some of the otherwise settleable solids in suspension, as well as that which is floated by the floating particles of grease and oil. In our endeavor to arrive at an intelligent, economical method of removal or handling of the grease, we hit upon the scheme of taking as much grease from the sewage at the earliest opportunity as was practicably possible. We have collected this grease in practically every unit of the types of sewage treatment plants in this Command.

Basket screens, skimmers, and baffles have been utilized in wet wells, in trunk sewers, in screen chambers, in grit chambers, and in distribution channels of primary tanks, Imhoff and Doten tanks. We have used a method of separation from water by decantation, using special methods which were part of the original design of the plant. I might say that the method of decantation as set up in one of our plants is rather a strenuous activity. Our main method of separation of the grease from the sewage has been by skimming with hand tools after the grease has been collected by baffles. It is our thesis that there will be certain portions of these fats which will find their way into the digester and over which we have no control. These are the oils and the fats which settle out with the settleable solids. This load will reach the digester in spite of any action we can take. We have reason to believe that the digester can handle and digest that portion of grease; however, when that portion over which we have no control, and that over which we have some control, is sent to the digester, it "opens the door for trouble." I have seen heated digesters with a six-inch mat of floating grease and oil. To my way of thinking there is no sensible, good reason for subjecting the digester to this overload. We are not so dogmatic that we believe a digester cannot handle a certain amount of grease. We know that has been proven in the past; however, we wish to impress again the fact that large quantities of grease in the digester are undesirable.

No doubt some of you are going to wonder as to what method is used for the disposal of the skimmings taken from these various units which we have mentioned. I would like to suggest several:

a. Sewage plant grease has a value as salvage, and is presently being salvaged in many plants throughout the country.

b. Some of the skimmings are disposed of in connection with the garbage.

Some of this waste ultimately reaches rendering plants. Other installations resort to burial. Some stations disposed of these skimmings in the incinerator. This was discontinued wherever it was found to be the practice. Burning in open pits has been practiced with some success and can be resorted to in an emergency.

The value of the procedures which have been outlined is borne out by experiments which were conducted in the Second Service Command. The results of these experiments by Major R. Eliassen and H. B. Schulhoff were published in a paper * entitled "Auxiliary Methods of Grease Removal at Army Sewage Treatment Plants." This paper concluded that plain sedimentation is one of the most effective methods of grease removal. The opinion that expensive devices are not advisable in Army sewage treatment plants is also shared by the writers. The results of this paper again indicate that grease which settled in the primary sedimentation tank is of considerable amount and over which we have little or no control; therefore, the addition of the skimmings to the digester often creates a load which in time may call for increased digester capacity. This practice further increases the time of digestion, and the length of the drying time on the sludge drying beds is increased.

The grease entering the sewage treatment plant, that which it was not possible to remove at the source, must be removed in the primary unit, if the grease is not removed, it will cause trouble in the secondary unit. It will form an impervious layer on trickling filter, thus obstruct-

* *This Journal,* 16, 2, 296 (March, 1944).

ing the flow of sewage downward through the stone and stopping circulation of air, a condition which is not conducive to satisfactory operation.

Relative to the methods used for removing or for accomplishing the removal and proper supervision at installations contributing grease, various approaches are necessary. For instance, where quantities of gasoline or cleaning fluids are used and are entering the sewerage system from such places as airplane and motor repair shops, it is impressed on the supervisors of these shops that such material entering the sewerage system could very well be a major factor in causing a serious sewer explosion with a possible loss of life and the destruction of much valuable equipment and property. It has been found very effective to impress upon the mess hall personnel that greases passing grease interceptors and entering the sewerage system may congeal on the walls of the pipe to the point where sewage flow is completely obstructed. This may interrupt the service to the kitchens.

It is believed that the above practice of removing as much grease as quickly as possible has paid dividends and saved us many headaches.

Discussion

By Ralph E. Fuhrman and Paul D. McNamee

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Since Major McCaskey's subject is that of grease in sewage of Army posts, no direct discussion of this subject could be made fully by a civilian not attached to the War Department. As this subject has been aired to a large extent in recent literature, there is ample material for discussion.

The need for the removal of grease from sewage arose more than fifty years ago in the early work on sand filtration of sewage by Allen Hazen at the Lawrence Experiment Station. His investigations revealed that sewage could not filter through sand satisfactorily with a grease content sufficient to clog the filters. This reason for grease control is still as sound as it was at that time, but in modern sewage works other reasons for grease removal have developed. Primary considerations presently involved are the prevention of clogging of sewage conduits, whether they be gravity lines or pump discharge lines; prevention of deposition on tank walls and channels of sewage treatment plants; reduction of odors from scum on sedimentation tanks; prevention of interference in oxidation processes; and elimination of sleek formation at outfalls.

For many years it has been general city plumbing regulation practice to require installation of grease traps at recognized sources of this material. While the prevention of grease entrance to sewer lines is not assured by the installation of such traps, this is the starting point. In all cases regular servicing and cleaning of the traps must be done to assure the desired result. Installation of these traps should be as near as possible to the source of the grease and yet in a location that is accessible for cleaning. Proper sizing of grease interceptors or traps is an essential consideration and for proper sizing Professor F. M. Dawson of the University of Iowa has suggested a limit of one tenth of a foot per second velocity through the interceptor based on the maximum rate of flow from the combination of fixtures tributary to the interceptor.

The Army's experience has been based largely on municipal practice of recent years plus additional Army research made necessary by the higher grease content of sewage originating at Army posts. The result has been to intensify grease removal problems and, therefore, much valuable information as indicated by Major McCaskey's paper is resulting from Army experiences.

Salvage and resale of grease is an intriguing phase which usually arises in grease removal practices where considerable quantities may be separated. Recently Mr. Wellington Donaldson of New York exhibited cakes of soap which had been made from reclaimed sewage skimmings at New York. This was not done in promotion of the idea that soap should be reclaimed from this source, but rather that reclamation is possible to this extent.

For many years some communities have salvaged grease at times when conditions were favorable for it. Grease balls forming in the general area of ocean outfalls served as an early attraction to grease as a salvage material. Bradford, England, is a long recorded city which has been successful financially in the process of grease salvage. American cities with sewage of lower grease content do not find the salvaging process economical as a continuing practice. In recent years the Annapolis plant has salvaged and sold skimmings to such a degree that it was definitely profitable. At the present time such reclamation would probably be more attractive if no price ceiling existed on the sale of grease. During World War I the price of grease advanced to approximately fourteen cents per pound, while the current ceiling in effect is seven cents per pound.

A development that would be of inestimable value in the future in the whole problem of grease removal would be a more rigid standardization of grease content measurement. The current standard method still allows the use of three solvents for extraction and, therefore, no result is complete without stating the solvent and making mental allowances for the general relation between the results obtained by the different solvents. Before much progress can be made in the development of a standard test for grease it will be necessary to define the term more definitely. That is, to decide which substances are to be included under the term "grease." Until this is done it seems a logical step to choose chloroform as the single solvent as it generally gives the highest result. The value of a higher result is not to falsely magnify the import of the grease problem but to give a more exact result when proportions of removal are considered. Where physical means are used for grease removal, a standardized grease determination would give a fair picture of plant efficiency. When using the grease test for measuring efficiencies in biological treatment devices, it must be remembered that the starting material may be entirely worked over and the final product might still be soluble in the fat solvent. Thus, while the grease reduction might be only 60 per cent, the process might be 100 per cent complete. With this limitation in mind, a standardized grease test can give valuable information on the efficiency of a biological treatment device.

The effect of recent interest in the problem has given rise not only to single choice of solvents, but also to several other methods that have been advanced as suitable for grease determination. It should be an immediate undertaking of those concerned with the problem to make a choice at the earliest possible time so that the great variations in results now being obtained will be clarified and knowledge on the subject may be advanced. Meetings of this nature make consideration of such methods easy and, through the Federation of Sewage Works Associations, national standards may be fixed.

Sewage Works Planning

METHODS OF FINANCING SEWERAGE CONSTRUCTION IN FLORIDA *

By Wylie W. Gillespie

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Sanitary sewerage facilities may be defined as a system of collection and disposal of domestic, industrial, and commercial wastes. It sometimes becomes necessary for private enterprise to provide these facilities, but usually it devolves upon some governmental body to provide this type of utility. In Florida the local governmental group, i.e., the town, village, or city, is faced with the problem of providing sanitary sewerage and even those towns which adequately recognize the need for this type of public works, are frequently at a loss as to how sewerage works may be financed.

The reasons why the citizenry of a particular locality may demand that their public officials provide sewerage facilities are many and varied. Quite frequently, public health considerations are the determining factor. The possibility of polluting potential water supplies and the possible creation of disease hazards which may lead to epidemics, are usually recognizable public health risks which, when called to public attention, may create a demand for sanitary sewerage improvements.

If Florida is to maintain its tremendous tourist influx, she should be able to advertise that she not only provides adequate sanitary sewerage facilities in all communities, but keeps the streams and lakes clean for bathing and fishing. Unless Florida cleans up her rivers and bays in front of the principal cities and her lakes about which her smaller cities are built, the great tourist business will go to Cuba, Southern Texas and California in search of communities providing esthetic and sanitary surroundings necessary to those who have the time and funds to provide for their desires.

In those areas in the State where high ground-water tables are to be found, individual septic tanks are frequently unsatisfactory and a source of constant expense to their owners for maintenance and upkeep. Such a situation on a large scale may lead to a popular demand for municipal sewerage facilities. In such an instance, the demand may be created wholly from a selfish viewpoint of personal economy.

Regardless of the reasons why sanitary sewer improvements are desired in a particular area, and also regardless of the justification which creates such desire, the problem of financing frequently seems to be almost insurmountable.

* Presented at Third Annual Meeting, Florida Sewage Works Association, Daytona Beach, May 19, 1944.

Sewerage improvements may be divided into several general groups. These are: (1) the construction of municipal sewerage facilities in communities which have previously been served only by privies or individual septic tanks; (2) improvements to and extensions of existing sanitary sewerage lines in communities in which a part of the area is now served (adequately or inadequately); (3) the reconstruction of existing old sewers which were laid in years past with improper materials or under improper designs; and, in each of the foregoing stated instances, (4) the provision of adequate and complete treatment and disposal facilities.

Not infrequently it may be found that the developer of a particular area or subdivision adjacent to or incorporated in a community may, in order to facilitate sale of the lots of his development, provide sanitary sewer facilities. In such instances the cost of these facilities is naturally reflected in the sales price paid by the purchasers of the property in the development. Although the systems after construction usually become a part of the local municipal system, the community is not faced with the problem of financing the cost of building these improvements. This paper, therefore, deals primarily with the various methods which a community may employ to finance the construction of sewerage works which are demanded by the local populace. These methods may be divided into several different groups:

1. General obligation bond issues in which all real property of the community is subject to taxation for amortization of bonds which are sold to provide funds for the construction of the desired improvement.
2. Special assessment or the so-called ''Baby Bond'' issues, in which the property abutting the particular improvement is assessed for the retirement of bonds issued to finance the sewer construction.
3. Incidental sewer construction, usually short extensions, which is financed by budgetary appropriations for maintenance in which the funds are made available from existing sources of revenue such as ad valorem levies and revenues from other utilities such as water, electricity, etc.
4. The sale of revenue certificates secured by the revenues from a sewer service or sewage disposal charge levied against users of the sanitary sewer system. Such a revenue certificate does not create a lien on any real property or on any other income of the city other than the income derived from the charge made for sewer service.

In Case No. 1 just mentioned, i.e., general obligation bonds, it is necessary that a bond election be held. All qualified freeholders are eligible to vote in such election and it is necessary that a majority of the qualified freeholders participate in the election in order for the election to be valid. A majority of those participating in the election must vote in favor of the proposed bond issue if the issue is to be made and validated. In other words, if 49 per cent of the qualified citizens who own real property vote in a bond election and the vote is unanimously in favor of the bond issue, the election is lost and the bonds cannot be validated and sold. More than 50 per cent of the qualified freeholders must vote in the election and more than half of those voting must be in favor of the proposed issue in order for the bonds to be validated and sold. This provision is further modified by local charters in some instances.

From a practical viewpoint and in consideration of the many general obligation bond issues which were made in Florida during the boom period of the 1920's and for which real property is now paying ad valorem levies, it is becoming more and more difficult for any community to carry successfully a general obligation bond election. Not infrequently, Florida communities have already reached their legal limit of general obligation debt. Since the passage of the Homestead Exemption Amendment no homestead can be liable for debt service not incurred prior to the passage of the amendment, unless the assessed valuation of the homestead is in excess of the $5,000 exempted by said Amendment. Since any municipality is primarily a group of homes and homesteads, it follows that a large part of the assessed valuation of the community is not liable for general obligation bond issue assessment. Thus, the potential financing capacity of the community from this method is usually very limited. Without further discussion, it is felt that except in particular instances this method of financing holds little hope for providing funds for the needed sanitary sewerage improvements which are expected in the immediate postwar period in Florida.

Special assessment or ''baby'' bonds are issued under provisions contained in most municipal charters. Usually these provisions require that all (or a large majority) of the affected freeholders request the improvement by petition to the city government. Since it is very difficult to secure such unanimity of public opinion and action, and since it is customary for the city government to participate in such a program from general revenues, this plan is seldom feasible for major improvements. This plan is followed with considerable success in some Florida cities to secure extensions of sewer laterals for local service.

Sewerage improvements which can be financed by existing revenues from budgetary sources are necessarily extremely limited and it is a very unusual Florida community which is able to finance a major sanitary sewerage improvement from this source.

It therefore becomes apparent that the most likely source of financing sewerage construction is the issuance of revenue certificates based upon a sewer service charge made by the municipality.

In 1935, the Legislature of Florida enacted into law a bill, the title of which in part states that it is ''An act to promote the public health, safety and welfare by authorizing the municipalities of the State of Florida to construct, extend, operate and maintain . . . sewerage systems, sewerage treatment works . . . to provide for municipal or private ownership and to provide for the granting of franchises in the event of private ownership, to provide *for the fixing of rates or charges for the use of utilities described herein. . . .*''

Under this law, it is legally possible, providing that provisions of the local charter do not conflict therewith, for Florida municipalities to pass resolutions or ordinances and avail themselves of the provisions of this Act. Under this Act a community is authorized to clean and improve street channels and other bodies of water for sanitary purposes; to provide means for the regulation of the flow of streams for sanitary purposes; . . . or to provide for the collection and disposal of sewage and other liquid wastes; . . . and incidental to such purposes and to enable the accomplishment of same to construct reservoirs, sewerage systems, trunk sewers, intercepting sewers, pumping stations, wells, siphons, intakes, pipe lines, distribution systems, purification works, collection systems, treatment and disposal works.

This law provides that all such construction is declared to be a public utility and that any municipality which acquires, constructs or extends such a public utility may issue mortgage revenue certificates or debentures without regard to the limitations of municipal indebtedness. The law further provides that such mortgage revenue certificates or debentures shall not impose any tax liability upon any real or personal property in such municipality nor constitute a debt against the municipality but shall be a lien only against or upon the property and revenues of such utility. The law further provides that such indebtedness or the franchise under which such an indebtedness is operated shall not extend longer than thirty years from the date of sale and that such certificates or debentures shall be sold for at least 95 per cent of par value and shall bear interest not to exceed 6 per cent per annum.

This law further permits any municipality which constructs works authorized by this Act to permit another municipality or the owners of property outside of the city limits or within the limits of another municipality to connect with or use the sewerage utilities upon such terms and conditions as may be agreed upon.

Chapter 17118, Acts of 1935, further provides that a municipality may proceed under this law and create a zone or area by ordinance and require all persons within said area to connect with any sewerage system constructed, provided that such zone or area does not include property within another incorporated city or village and further provided that such area or zone does not extend more than five miles from the corporate limits of such municipality.

This general statute provides a workable means for many Florida communities to finance sorely needed sanitary sewerage improvements. The method is successful and has been demonstrated by actual use. A number of Florida communities are now operating under this program. A number of others are contemplating postwar improvements which will be financed by this method. Two Florida communities which have highly successful histories under such a program are our Capitol City of Tallahassee and the city of Clearwater. The operation of this program has been successful in every community which has preceeded under this plan.

The monthly charges are graduated. Small individual house connections are charged at a nominal rate and larger buildings and large water users pay at a higher rate. Some communities favor a charge based on water consumption in which the user pays at an established rate per thousand gallons of water consumed each month.

In order to determine whether or not a particular community can finance sanitary sewerage improvements by revenue certificates, several factual determinations must be made. It is necessary to prepare, first, an estimate of the probable cost of the contemplated improvement; second, an estimate of the gross revenues which will be received when the monthly sewer charge is put into effect; third, an estimate of the operating costs involved in maintaining the sewerage system. The net revenues are, obviously, the remainder of the gross revenue after operating costs have been deducted. It is necessary that a reasonable "cushion" or margin be provided to take care adequately of unexpected expenditures or unanticipated decrease in revenues, and the net revenues which are available after providing such a cushion may be safely used for the retirement of the debt incurred from the sale of revenue certificates.

It seems quite apparent, therefore, that the potential net revenue from such a system is fundamentally a function of density of population. Communities which have a small population spread out over a large area require a sewerage system which will be expensive to construct and which will produce a comparatively small amount of revenue. Communities which have a large population confined in a small area will produce a much larger revenue per dollar of construction cost.

At the present time, private capital is very much interested in acquiring revenue certificates which have a sound basis and very attractive offers can now be secured at low interest rates.

In this connection, it is well to point out that the private purchaser of sewer certificates is usually desirous that the city issuing the certificates also own the local water system. This desire is not created because the purchaser wishes that water revenues should also be pledged for the retirement of the sewer certificate, but because municipal ownership of the water utilities provides the most practical method of billing and enforcing collection of the sewer charge. In some places where the water utility is privately owned, satisfactory arrangements have been effected for the private utility to collect the sewer rental charge in conjunction with the water billing. Such an arrangement is, of course, dependent upon local conditions and the willingness of the private utility company to co-operate with the city.

A recent issue of "Engineering News-Record" carried a story headed "Philadelphia Adopts a Sewer Rental Ordinance." This article states that the City of Philadelphia adopted a sewer rental ordinance on April 21 and that the revenue from these sewer rentals will provide funds for a forty million dollar sewer and sewage treatment program. It is anticipated that these sewer charges will not only support the forty million dollar program, but will also make it possible to finance an existing fifty-five million dollar sewer debt which is now a part of the general city debt.

In conclusion, it appears that many Florida communities will be faced with the necessity and desirability of providing adequate sanitary sewerage works. In planning such financing, the issuance of revenue certificates based upon a monthly sewer rental charge seems to hold the most hope for many communities. In order to determine whether or not this method is feasible in a particular community, the city will be required to make an analysis of its needs and potential revenues, and it is the writer's recommendation that all Florida communities proceed to investigate carefully this method of financing and to take prompt steps to determine whether or not such a method is applicable.

Sewage Works Design

DESIGN OF SLUDGE HANDLING FACILITIES *

By Paul E. Langdon

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The recognized purpose of sewage treatment is the reduction of pollution of waterways and the elimination of health hazards. Various processes carry out this purpose in degree relative to the necessity of the stream or receiving waterway. Depending on the requirements, the treatment may involve only the removal of visible pollution by fine screening or sedimentation, or may carry the treatment into biological action to accomplish more complete removal of solid and dissolved impurities.

In any treatment plant the prime objective is the removal of impurities from the sewage to permit its discharge without nuisance. The solids removed are a by-product of the process and as such must be disposed of effectively. It is interesting that this by-product, in its various forms, represents one of the most troublesome phases of sewage treatment plant operation.

The solids in sewage are removed as trash, skimmings, grit, sludge from preliminary treatment, grease and scum, and sludge from biological or secondary treatment. Each of these processes of solids removal introduces its own problems of handling the material and of accomplishing efficient removal under a reasonable operating and maintenance program. The removal and handling of trash, screenings and grit is almost entirely mechanical, and in general relatively easy to accomplish. The handling of grease and scum is more difficult and involves greater problems as these materials are waterborne and must be removed and handled in a liquid condition.

The problem of disposal of sludge has been attacked from a number of angles. Raw sludge from both preliminary and final treatment has been incinerated, as at Minneapolis-St. Paul and Detroit. Fertilizer has been produced from raw primary, and more particularly, waste activated sludge, as at Chicago, Milwaukee and elsewhere. Along the east coast sludge is often barged to sea, as at New York and Elizabeth Joint Meeting, New Jersey. The Wards Island plant in New York handles raw sludge in this manner whereas the more recent New York plants have included digestion tanks as an economy in reducing the amount of solids and moisture content of the sludge to be handled as well as to provide for the recovery of power from sludge gas.

* Presented at 17th Annual Meeting of the Central States Sewage Works Association, Oshkosh, Wis., June 22–24, 1944.

The design of the Hunts Point sewage treatment works for postwar construction at New York includes preliminary sedimentation, activated sludge secondary treatment, and sludge digestion with provision for barging digested sludge to sea. It also provides for recovery of gas and its utilization for aeration and power generation. An attempt is being made in this design to overcome some of the difficulties encountered in operation of this type of plant. A general description of some of the devices and methods under consideration may be of interest.

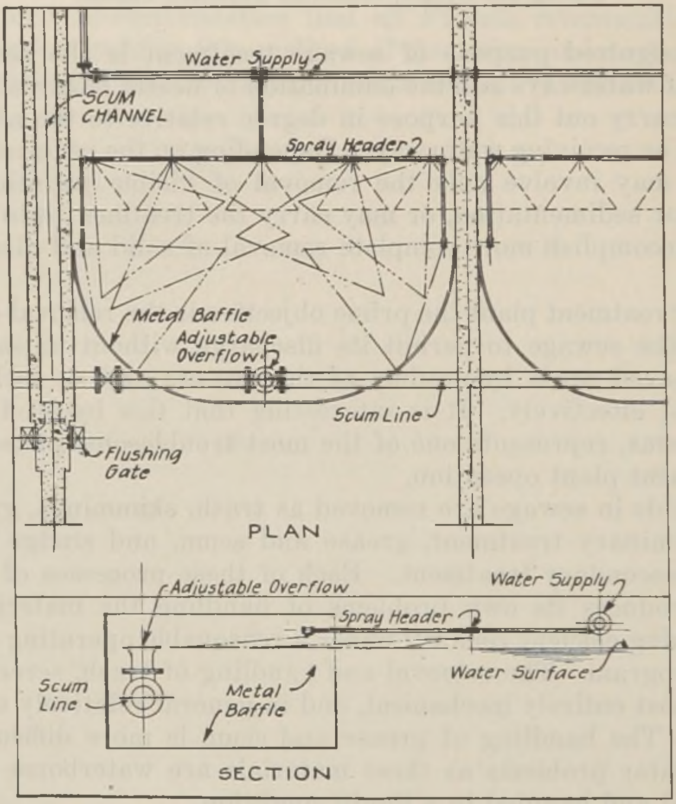


FIG. 1.—Scum removal device.

It is proposed to remove the preliminary sludge in conventional sedimentation tanks of the conveyor type. The sludge must be pumped from these tanks into the digestion tanks which will be located at some distance from the sedimentation tanks, perhaps requiring a force main 1000 feet or more in length. The type, capacity and characteristics of pump to be used are being given careful consideration. One of the difficulties almost always encountered in pumping preliminary sludge is the clogging and reduction in capacity of the sludge lines that result from the fibrous material and larger solids which always seem to get by the screens. With such a long force main, the pumping head varies over a considerable range with variations in rate of pumping. Although operators seem to prefer the centrifugal pump where it can be used, the wide variation in head conditions makes the plunger type more adaptable. Similarly, the periodic clogging or plugging of the force main can sometimes be broken up by increasing pressure. To this end, consideration is being given to providing pumps with pressure capabilities considerably in excess of the requirements. For example, three of the four pumps would be powered so that they could discharge against a pressure of 50 pounds per square inch and one of them against 100 pounds per square inch, although the computed maximum operating head condition is about 20 pounds per square inch. This accomplishes two purposes: first, to permit a high pressure to be built up

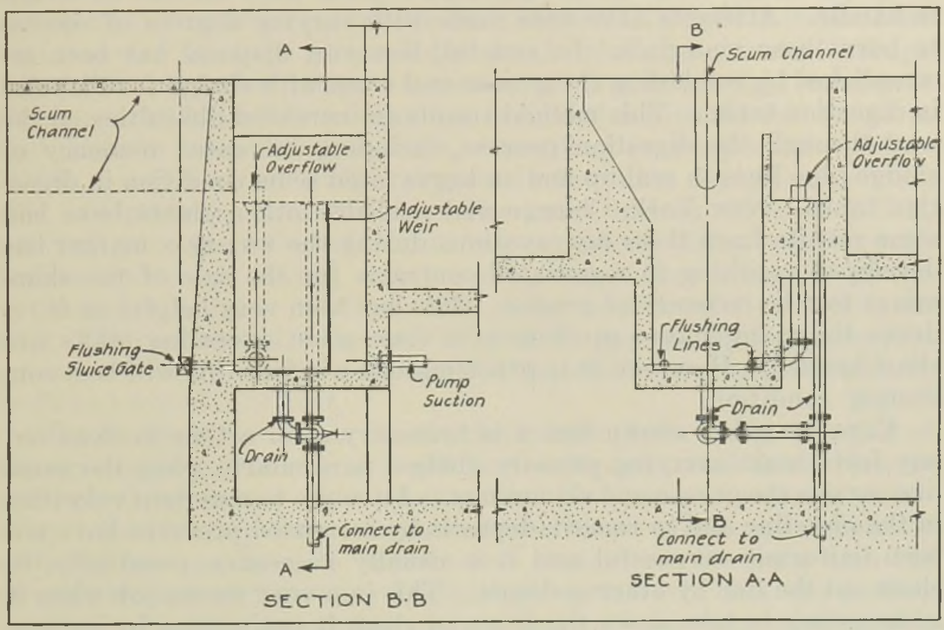


FIG. 2.—Scum separation box.

to remove a plug in the line, and second, to obtain sturdy equipment that will operate without the annoying breakdowns that have often occurred.

Many devices have been developed and used for removing scum from preliminary tanks, most of which are of the mechanical type. They have met with varying degrees of success and approval by operators. Several attempts have been made to remove scum and grease by means of water jets, notably at Los Angeles and San Francisco. One of the principal difficulties of mechanical equipment in cold climates is the formation of ice on the mechanism and the maintenance required to keep them in operation during cold weather. An arrangement is under consideration for water jet removal comprising a series of jets starting at the end of the skimming action of the flights, which will move the grease and scum along a semi-circular baffle to a depressed weir (Fig. 1). As each settling tank will comprise six channels, it was considered desirable to provide for the removal from all parts of one tank simultaneously. To accomplish this the entire series of jets for the six channels is controlled with one valve and the outlet from the six depressed weirs is similarly controlled by one operation. Thus the surface of an entire tank can be cleaned by manual manipulation of two valves. The scum and grease so removed is conveyed to a separating box where the floated material is connected to a pump suction and the overflow or water is returned to the sewage flow (Fig. 2). This method of separation has been in use at Buffalo for some time and has resulted in some concentration of the grease and scum.

Grease and skimmings comprise two of the most difficult materials to handle. Attempts have been made with varying degrees of success to burn these materials. In general, however, disposal has been accomplished by combining the grease and scum with sludge for disposal in digestion tanks. This method results in increased difficulties on the way through the digestion process, including increased tendency of sludge pipe lines to seal up and an aggravated scum condition in digestion tanks. New York, Chicago and probably other plants have had some respite from these aggravations during the war as a market has developed resulting in negotiated contracts for the sale of the skimmings for the recovery of grease. This has been very helpful as it relieves the maintenance problem at a time when operating staffs are short-handed. However, it is problematical whether this will be a continuing condition.

Experience has shown that it is necessary after a time to clean out any force main carrying primary sludge, particularly when the same line carries the grease and skimmings. Attempts to maintain velocities in the pipe line and to remove deposits by increased pressure have not been uniformly successful and it is usually necessary, eventually, to clean out the line by other methods. This is a very messy job when it is necessary to take down the line and clean it out section by section. Buffalo has had considerable success in removing congealed grease from such a pipe line by means of heat. This can be accomplished either by introducing hot water or steam and gradually increasing the temperature to about 180 degrees, which seems to be sufficient to liquify and remove practically all of the material. In providing for such a cleaning program, it is necessary to recognize the temperature differences in the pipe line and to provide for expansion by proper joints and anchorage. The use of welded steel pipe is being considered for this reason.

In a complete treatment plant of the activated sludge type, roughly one-half of the solids to be handled in digestion tanks are removed by preliminary processes and one-half by secondary treatment. Sludge as removed from final sedimentation tanks has a high moisture content which must be recognized in proportioning the digestion tanks. In order to decrease the amount of water to be handled, thickening tanks are under consideration. Many experiments have been carried out on sludge thickening and a number of units on a plant scale have been constructed and operated. However, the data from this experience are somewhat inconclusive as to the results that can be expected. As an overall average, however, it is expected that sludge concentration will be increased from perhaps one per cent to 2½ per cent solids which will decrease the volume to be handled in digestion tanks by about 40 per cent, still perhaps twice the volume of primary sludge. Little difficulty has been encountered in either pumps or pipe lines with this type of material.

It has been general practice in most plants where digestion tanks are included to use the heat from the sludge gas in maintaining optimum temperatures in the tanks. In a good many cases the gas has been used in engines for power generation and the waste heat from the engine jackets and exhaust recovered for this purpose. In most instances, the heat transfer has been accomplished by circulating hot water through coils in the digestion tanks. A review of data from eight treatment plants operating in this manner has indicated a considerable range in heat transfer rate from the coils, depending on temperature differentials, consistency of sludge, activity in the tank, depositions on the coils and probably other factors. The range is from 10 to 30 B.T.U. per hour per square foot of coil surface per degree differential between heating water and sludge, with some assurance that a rate of 20 can be maintained with a relatively thin sludge and circulation within the tank. This is twice the figure of 10 B.T.U. per hour per square foot per degree differential commonly used but still represents a relatively inefficient transfer of heat.

The design of the Hunts Point plant contemplates the installation of four gas engines, two of which will be directly connected to air blowers and two of which may be used either for air blowers or power generation. Preliminary estimates indicate that there will be approximately sufficient gas produced to operate two engines continuously with the possibility that a third may be operated part time, and the further possibility that during certain periods and under certain conditions of operation, particularly in the early periods of operation, probably only one engine can be operated. It is further estimated that the heat recovered from two engines will be more than sufficient to provide the necessary heat for the digestion tanks leaving some available for building heating. Thus it is necessary to provide another source of heat, such as boilers, for making up the building heating requirement and for use in heating the tanks when the plant is being started.

In addition to being relatively inefficient, heating coils in digestion tanks are inaccessible and are subject to interruptions in operation. A number of cases have been reported where the coils have broken, requiring that the tank be taken out of service to permit their repair.

A scheme is under consideration for the Hunts Point plant to eliminate the heating coils within the tanks and to accomplish all necessary heating in accessible locations. Both the preliminary sludge and waste activated sludge force mains are to be carried in a service tunnel located directly adjacent to the gas engines and boiler room (Fig. 3). Preliminary computations indicate that sufficient heat can be transferred in about 1000 feet of heat exchanger to maintain an optimum temperature in the digestion tanks. The scheme under consideration would provide four interconnected units. Under normal operation, one of these would be used for preliminary sludge and two for waste activated sludge, with the fourth as a standby, or for use under maximum conditions. Each unit would comprise about 350 feet of 6-inch copper tube enclosed in an 8-inch steel pipe with the sludge passing through the copper tube and the heating water circulated in the space

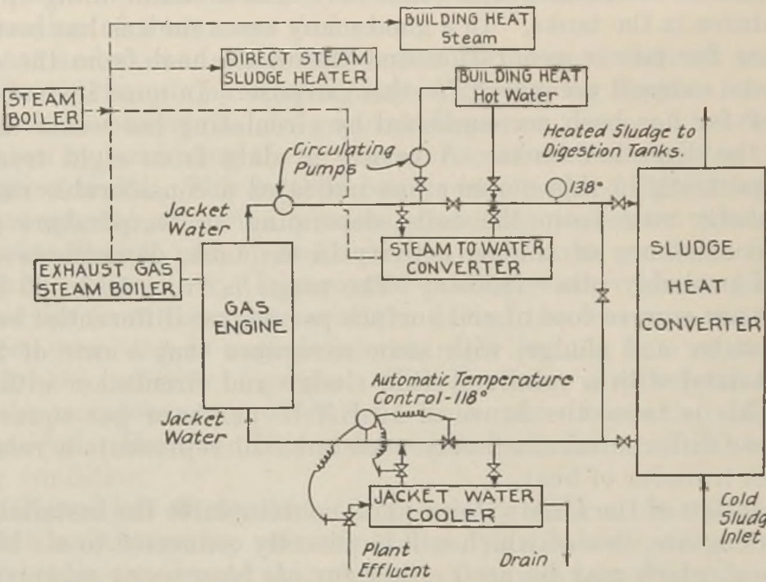


FIG. 3.—Diagram of heating equipment.

between the two pipes (Fig. 4). By maintaining velocities both in the sludge lines and in the heating water, it is expected that a heat transfer of 200 to 500 B.T.U. per hour per square foot of surface per degree differential can be expected. Such an installation, comprising a total length of exchanger of about 1400 feet, would take the place of and accomplish the same heating result as about 22,500 feet of 3-inch pipe coils that would be required in the four 115-foot diameter digestion tanks. Preliminary computations indicate that radiation losses from the digestion tanks under most severe conditions would amount to about 25 per cent of the total heat required to be added to the sludge. On this basis it is estimated that the sludge would have to be heated to about 97 degrees in the exchangers in order to maintain a temperature of 85 degrees in the tanks. As the exchangers would be located approximately midway between the sludge pumps and the digestion tanks, a further advantage is anticipated in avoiding in some measure the clogging of the pipe lines with congealed grease.

In normal operation it is anticipated that gas production will be relatively constant, which will permit the practically continuous operation of one or more of the engines at a relatively constant rate, which in turn will result in an even production of waste heat for use in the heating of sludge. Similarly, it is anticipated that a schedule of pumping primary sludge can be arranged to work in conjunction with a constant production of waste activated sludge to use the heat as produced by the engines. Minor variations in the temperature of the sludge passing to the digestion tanks would be of little consequence as

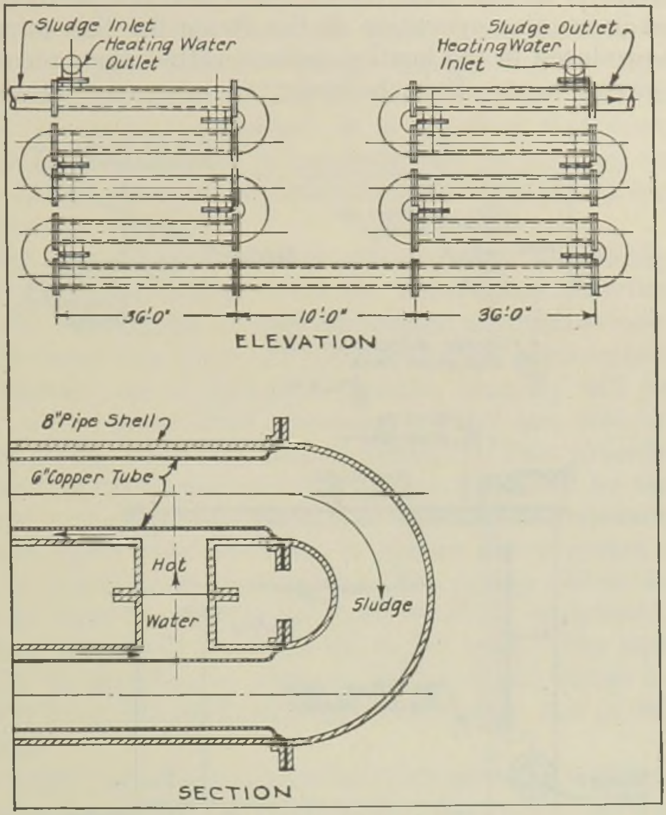


Fig. 4.—Sludge heater.

it would take considerable time to change the temperature of the tank contents to any extent. The critical control of heat must be on the temperature of the water returned to the engine jackets. Automatic devices would be provided to limit the maximum return temperature, which would require, under some conditions, the use of a system of cooling water. When the engines are not producing sufficient heat to maintain proper temperatures in the tanks, the deficiency would be made up by the boilers which would be started and controlled manually.

It is conceivable that emergencies may develop whereby the temperature in the tanks would drop sufficiently below the optimum that it would be difficult to make it up by means of the exchanger. Similarly, it might be possible that a number of exchangers would have to be taken out of service for a time for maintenance and repairs, thereby decreasing the heat transfer capacity. An emergency arrangement is under consideration for direct steam heating. Sludge has been successfully heated by direct steam application before it is introduced into the digestion tanks at Los Angeles. The emergency provisions contemplated include a relatively small tank in the sludge control building through which the contents of the digestion tanks can be circulated and in which steam can be introduced under low pressure through submerged heaters (Fig. 5). It is not expected that this method of heating will be used in regular operation as the steam for this purpose would have to be produced in the heating boilers rather than recovered from the waste engine heat. It is, however, an insurance against unusual

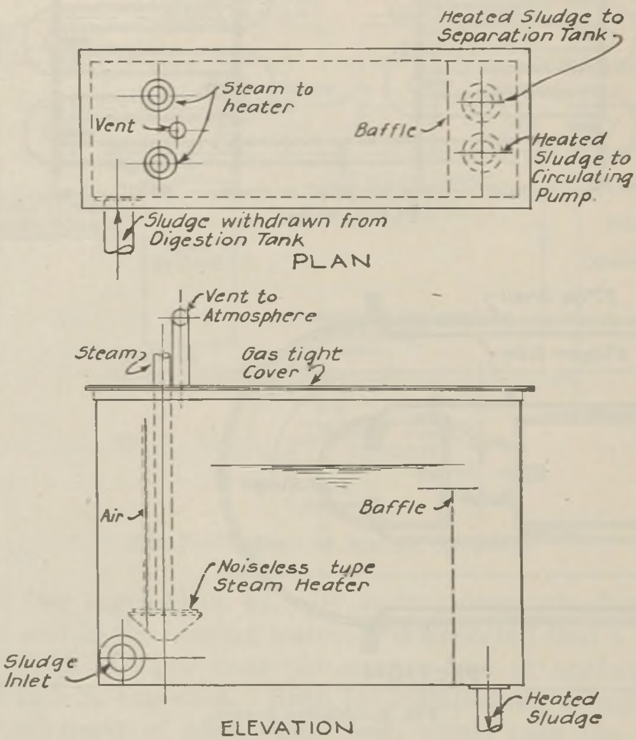


FIG. 5.—Direct steam sludge heater.

conditions which might result in a lowering of the temperature within one of the tanks, which could be fortified with heat by this means.

The installation of sludge tanks contemplated at the Hunts Point plant comprises a total of eight units, each 115 feet in diameter and with an average depth of about 35 feet. Four of these units are designated as digestion tanks equipped with fixed concrete covers. In the proposed scheme of operation it is intended that the contents of these digestion tanks will be maintained as nearly a homogeneous mixture as possible by means of circulation. Centrifugal pumps, one for each tank, are being provided with sufficient capacity to displace the contents of the tank in 24 hours, and it is intended that they will be operated continuously. Interconnections between the pumps will permit intermittent operation between two tanks in case a pumping unit is out of service. These circulating pumps will ordinarily take their suction from the bottom of the tank near the center and discharge near the top of the tank at any selected one of five distribution points. Four of the distribution points are located at the side of the tank and one at the center. Thus the operation of the circulating pumps should accomplish reasonably good mixing and displacement of the tank contents. Application of raw sludge from the preliminary sedimentation tank pumps and the waste activated sludge pumps will be through these same distribution points providing for mixing of the raw sludge being applied and the circulated sludge. It is expected that most complete displacement and mixing will be accomplished by rotating the application of raw sludge between the several distribution points and between the four digestion tanks.

In normal operation, circulation will probably be entirely within a tank, withdrawing the sludge from the bottom and distributing it at the top of the same tank. Some advantage may be gained by intercirculation between two tanks and connections are contemplated for this purpose. Another set of pumps of smaller capacity will provide for dewatering of the tanks when necessary. They can also be used for transferring sludge from one tank to another. This procedure should be especially helpful in maintaining proper condition by seeding.

With fixed cover digestion tanks it is desirable to maintain a reasonably constant liquid level in order to assure gas pressure under the covers and to avoid explosion hazards. The piping will be arranged to remove sludge from the tank at the same rate it is introduced by means of an overflow which will maintain the liquid level. The circulation of sludge within the tank has no effect on the level, and sludge is therefore removed only from the tank receiving raw sludge and in the quantity of application.

The gas piping is interconnected between all tanks so that a constant pressure should exist at all times under the covers to take care of extremely unusual conditions which may develop. Each of the tanks is to be provided with a pressure relief and vacuum breaking valve for the protection of the roof. Additional overflow piping will provide relief in case of plugging of the sludge withdrawal connections.

There is some evidence that continuous circulation and the maintenance of a homogeneous mixture in the tank will reduce the scum problem which has been serious in quite a number of plants. Circulation has been quite effective in this regard on somewhat smaller tanks and at a somewhat lesser rate of circulation at Peoria. Provisions are contemplated, however, for handling of scum which may form. This is in the nature of a bell mouth pipe connection located about four feet below the average liquid level of the tank at the center under the gas dome and connected to a plunger type pump. Any considerable accumulation of scum can be drawn off gradually through this pump for other disposal.

Based on average rates of sludge production and moisture content, the displacement time in the four digestion tanks will be about 20 days. In this period, under the circulating homogeneous mixture operation, it is expected that perhaps 85 per cent of the digestion will take place.

The other four sludge tanks are of about the same dimensions and are designated as "separation tanks." The sludge withdrawn from the digestion tanks is conveyed through a closed pipe line to the second group and is introduced in rotation to one of the four separation tanks. These are maintained in as quiescent a condition as possible to allow for consolidation of the digested sludge and the formation and removal of a good sludge supernatant liquor. In operation it is probable that the rotation of application of the solids to the digestion tanks might be quite frequent, perhaps a complete cycle between the four tanks in 24 hours. It would probably be desirable to apply digested sludge to the separation tanks on a much longer cycle, perhaps allowing a three-day period between applications, or even longer.

In order to cause the least disturbance within the separation tanks it is proposed to remove digested and separated sludge at almost a constant rate from all tanks. In general, this will be made possible by the storage tank which will receive discharge from these pumps. It will have a capacity of about 110,000 cubic feet which is the equivalent of the capacity of two sludge vessels. By maintaining a reasonable schedule of removal to sea, sufficient capacity should be available to allow reasonably constant removal from the separation tanks.

Many methods have been employed at different times for the removal of sludge liquor. With the scheme of operation contemplated it seems desirable to remove the liquor at a relatively constant rate in order to avoid disturbances which result from rapid removal of large quantities of material. The supernatant selector developed by Pacific Flush Tank Company, together with flow regulating equipment, has these design characteristics and this equipment is being considered.

The art of sewage treatment and the corollary of handling and disposing of removed solids has seen a great development in recent years. The use of new processes and equipment has resulted in more effective handling and disposal. There is ample room for additional improvements and it is hoped that some of the ideas developed and suggested here may result in less trouble in operation and more efficient processing.

JOINT STATEMENT OF POLICY INVOLVING PROJECTS FOR SEWAGE TREATMENT PLANTS IN WHICH CERTAIN HIGH-RATE FILTERS ARE USED

January 31, 1944

To supersede previous Joint Statement of Policy of Wisconsin, Minnesota and Iowa Health Departments †

The following tentative standards, which are based on observations and tests at demonstration plants, should be followed in preparing plans for review by these departments. These standards apply to plants treating domestic sewage, which may include limited amounts of industrial wastes amenable to biological treatment.

Type A

Sewage filters may be designed for rates from a minimum of ten million gallons per acre per 24 hours to a maximum of thirty million gallons per acre per 24 hours when used with conventional primary settling tanks and sludge digestion units where effluents of not less than 30 parts per million five-day biochemical oxygen demand are required. In comparing effluents from high-rate filters with effluents from conventional filters, all available oxygen including nitrite-nitrate oxygen shall be considered. Well nitrified effluents from conventional filters with B.O.D. in the magnitude of 50 to 60 p.p.m. may be considered equivalent to effluents from a high rate filter with 30 p.p.m. B.O.D.

1. The settling tank preceding the filter should be designed with an overflow rate not in excess of 1,200 gallons per square foot of surface area per 24 hours for the period of maximum dry weather flow of one hour duration.

2. A controlled recirculation system should be provided:

   a. To maintain continuous dosing at a rate always equal to or in excess of ten million gallons per acre per 24 hours.

   b. To supply sufficient dilution to the settled sewage so that the five-day biochemical oxygen demand of the influent to the filter, recirculation included, shall not exceed three times the five-day B.O.D. of the required effluent, providing that, in no event, shall the loading, recirculation included, exceed three-fourths pound five-day B.O.D. per square foot of filter surface per 24 hours.

3. The distribution system should provide continuous discharge onto the filter, and the rest period during which any unit area receives no

† Adopted by Board of State Health Commissioners, Upper Mississippi River Basin Sanitation Agreement.

sewage should not be in excess of 8 seconds. The distributor should be designed to meet the following requirements:

	Flow		
	Average	Maximum	Minimum
Minimum Coefficient of Area * (1)	0.96	0.96	0.96
Maximum Coefficient of Distribution * (2)	1.65	2.0	2.0
Maximum Dosing Ratio * (3)	2.0	2.0	2.0

* Definitions Appended.

4. The filter media in place should be clean, hard, durable crushed rock, gravel or its equivalent. Where stone is used, it should be so graded that none will pass a two-inch screen, and none will be retained on a four-inch screen. To that extent the stone should have all three diametrical axes approximately the same length. The minimum depth of filter media should be six feet.

5. The filter underdrainage system should be of such capacity:

a. That when carrying maximum discharge, the flow will not occupy more than one-third of its vertical cross-section area;
b. That the minimum total unsubmerged outlet area should be equal to at least five per cent of that of the filter surface.

6. The settling tanks following the filter should be so designed that the overflow rate per square foot of water surface per 24 hours does not exceed 600 gallons at the maximum flow into the tank.

7. Facilities for conditioning and digesting sludge should be designed with special attention to the quantity and characteristics of the sludge produced.

8. All five-day B.O.D. determinations specified herein are to be made on samples collected at not greater than hourly intervals, and composited volumetrically in proportion to the flow. Sampling should start in the early morning before strong sewage or waste arrives at the plant, and be continued for 24 hours.

9. Devices should be provided to permit measurement of:

a. Flow of raw sewage or plant effluent;
b. Flow to filter, or recirculated effluent, whenever recirculation is used.

10. Tests of distribution of flows onto the filter should be made by a series of adjacent pans consisting of water-tight compartments 6 inches by 12 inches in plan. These pans should be placed along an entire radius of the filter, with the 12-inch length perpendicular to that radius. The flow discharged against the 12-inch section of the filter wall should be drained into the end pan. With armed distributors, the duration of the test shall be any whole number of revolutions. Where disc distributors are used, tests should be made along two radii approximately

TABLE 1.—*Effect of Recirculation Ratio and Strength of Settled Raw Sewage on High-Rate Filter Plant Effluent*

Average Dosing	Daily Rate	Recirculation	Average B.O.D. of Settled Raw Sewage								
Total m.g.a.d.	Raw Sewage m.g.a.d.	Ratio	p.p.m. 100	p.p.m. 150	p.p.m. 200	p.p.m. 250	p.p.m. 300	p.p.m. 350	p.p.m. 400	p.p.m. 450	p.p.m 500
10	10.0	0.0	44	62	79	95	112	129	147	164	181
	6.67	0.5	37	50	63	76	89	101	113	126	139
	5.0	1.0	33	43	53	64	74	84	94	105	115
	4.0	1.5	30	39	47	56	64	73	82	90	99
	3.33	2.0	—	35	43	50	57	65	72	80	87
	2.86	2.5	—	33	40	46	52	59	65	72	78
	2.50	3.0	—	31	37	43	48	54	60	67	74
15	15.0	0.0	41	58	75	92	109	128	158	201	248
	10.0	0.5	32	46	59	72	85	98	111	124	145
	7.5	1.0	—	39	49	60	70	80	91	101	111
	6.0	1.5	—	35	43	52	60	69	77	85	94
	5.0	2.0	—	31	38	45	53	60	68	75	82
	4.29	2.5	—	—	35	42	48	55	61	67	73
	3.75	3.0	—	—	32	38	44	50	55	61	66
20	20.0	0.0	39	56	73	90	119	162	210	257	305
	13.33	0.5	32	44	57	70	83	97	125	167	214
	10.0	1.0	—	37	47	58	68	78	88	104	131
	8.0	1.5	—	32	41	49	58	67	76	84	93
	6.67	2.0	—	—	36	43	51	58	65	72	79
	5.72	2.5	—	—	32	39	46	52	58	65	71
	5.0	3.0	—	—	30	36	42	48	53	59	64
25	25.0	0.0	38	55	72	103	148	196	244	—	—
	16.67	0.5	30	42	56	69	87	125	171	218	—
	12.5	1.0	—	36	46	57	67	79	105	147	193
	10.0	1.5	—	31	40	49	57	66	75	91	125
	8.33	2.0	—	—	36	42	50	57	64	72	83
	7.15	2.5	—	—	31	38	44	51	57	63	70
	6.25	3.0	—	—	—	35	40	46	51	57	63

Note:

For design purposes first estimate the reduction in B.O.D. of the raw sewage through the primary clarifier, then apply data from above table.

Generally speaking, the formula shall not be applied to loadings or recirculation ratios in excess of those included in the above table.

Example:

Assumed B.O.D. of raw sewage = 300 p.p.m.
Reduction in primary clarifier (33% assumed) = 100 p.p.m.

Strength of settled raw sewage = 200 p.p.m.

The following are solutions from the above table:

(1) For dosing rate of 15 m.g.a.d. and 0.0 recirculation, the plant effluent is estimated to have a strength of 75 p.p.m.
(2) For dosing rate of 15 m.g.a.d. and recirculation ratio of 2.0, the plant effluent is estimated to have a strength of 38 p.p.m.
(3) To obtain a plant effluent of 30 p.p.m., it is necessary to use a recirculation ratio of 3.0 and a dosing rate of at least 20 m.g.a.d.

90 degrees apart. Where feasible, the tops of the pans should be flush with the surface of the filter media.

TYPE B

Filter installations used after fine screens with undigested sludge disposal.

1. Unless otherwise demonstrated, the reduction in five-day B.O.D. accomplished by fine screens should not be considered to exceed 10 per cent.

2. The solids removed by the screen and by the final settling tank should be disposed of in such manner as to be inoffensive, and safe from a public health standpoint.

3. The five-day B.O.D. of the filter influent, recirculation included, should not exceed three and one-third times the five-day B.O.D. of the required effluent.

4. In all other matters, the requirements for Type A apply.

Type C

Sewage filters (roughing filters) designed for pre-treatment of unusually strong sewage capable of treatment by biological methods.

1. The settling tank preceding the filter should be designed with an overflow rate not in excess of 1,200 gallons per square foot of surface area per 24 hours for maximum dry weather flow of one hour duration.

2. Filter loadings in excess of three-fourths pound five-day B.O.D. per square foot of filter surface per 24 hours may be used. The reduction in five-day B.O.D. by filtration and subsequent settling may be assumed to be 64 per cent, provided that no reduction in excess of 0.7 pounds per square foot of filter surface per 24 hours should be assumed.

3. The intermediate settling tank should be designed to have an overflow rate not greater than 1,200 gallons per square foot of water surface per 24 hours.

4. Forced draft ventilation should be used to provide one cubic foot of air per minute per square foot of filter surface whenever filter loading exceeds three-fourths pound five-day B.O.D. per square foot per 24 hours.

5. In all other matters, the requirements for Type A apply.

Definitions

*(1) *Coefficient of Area*—The Coefficient of Area is the ratio of that filter surface receiving sewage to the total filter surface area.

*(2) *Coefficient of Distribution*—The Coefficient of Distribution is the sum of those filter areas, expressed in per cent of the filter surface receiving sewage, on which the flow deviates from the average dosing rate by 100 per cent or more, 75 per cent or more, 50 per cent or more, 25 per cent or more, and 0 per cent or more, this sum divided by 100.

*(3) *Dosing Ratio*—The Dosing Ratio is the maximum dosing rate on any unit area of the filter, divided by the average dosing rate on that area of the filter receiving sewage.

Sewage Research

THE EFFECT OF TEMPERATURE AND ORGANIC LOADING UPON ACTIVATED SLUDGE PLANT OPERATION *

By Don E. Bloodgood

Associate Professor of Sanitary Engineering, Purdue University

The application of the natural biologic functions of decomposition and oxidation when speeded up through concentration of the biologic masses has resulted in the magnification of the problems of the activated sludge process of sewage treatment.

It is generally believed that temperature affects rates of biological activity and the speed of most chemical reactions. The effect of temperature upon activated sludge plant operation has, perhaps, been more generally discussed in relation to activated sludge bulking in the summer months when the temperature of the sewage is the highest, than it has in relation to the activity of the organisms. It is, however, definitely known and has been pointed out by various workers that the biologic activity of organisms such as bacteria or other small plants and animals increases materially with a rise in temperature. The operation records of the Indianapolis plant have for many years indicated that a lower temperature in an aerator necessitated a longer detention time if other conditions were maintained more or less the same.

Not enough emphasis has been placed upon the actual poundage of B.O.D. loading upon a given aeration tank volume. It is true that the terms "pounds of B.O.D. removed per 1,000 cubic feet of aerator capacity," and "pounds of B.O.D. removed per million cubic feet of air" have been used to some extent. One still hears the terms "cubic feet of air per gallon of sewage" and "hours detention period" with no correlation made between them and the strength of the sewage, measured by the B.O.D. and the temperature of the sewage being treated.

Realizing a need for a more rational method of rating activated sludge plants, the writer has developed a method from operation data of the Indianapolis plant.

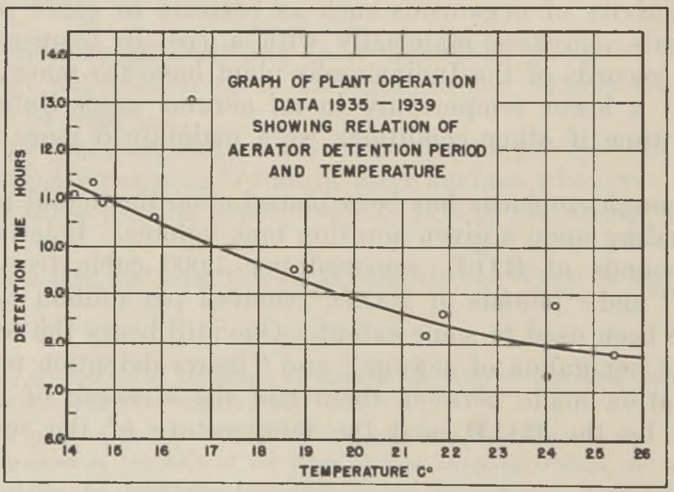
Since 1935, with the aid of the Biometer readings and utilization of the plain aeration process of sewage treatment, it has been possible to keep the activated sludge of the Indianapolis plant loaded to the optimum at all times so that the detention periods obtained would be the minimum for the existing conditions. The definite effect of temper-

* Presented at 17th Annual Meeting, Central States Sewage Works Assn., Oshkosh, Wis., June 22–24, 1944.

ature and B.O.D. loading upon activated sludge plant operation was first noted when the data for the period 1935 to 1939 were compiled. These data, as given in Table I and Graph I, indicate very definitely that temperature affects rate of treatment. It is true that the B.O.D. concentration of the sewage for the several periods here presented is not

TABLE I.—*Average Data for the Period 1935 to 1939*
Indianapolis, Indiana

Month	Temp. of Aerator, C. Degrees	Detention Time, Hours	B.O.D. of Sewage Treated (p.p.m.)
January	14.51	11.31	198
February	14.10	11.10	192
March	14.72	10.92	197
April	15.79	10.60	165
May	18.71	9.53	182
June	21.48	8.17	174
July	24.01	7.32	166
August	25.43	7.72	180
September	24.23	8.79	201
October	21.87	8.61	212
November	19.04	9.65	226
December	16.59	13.11	226



GRAPH I

the same, but in Graph I it is not apparent what the separate effects of B.O.D. concentration and temperature had upon the rate of treatment in the plant.

It is readily seen from the data above tabulated that the highest B.O.D. is 36.2 per cent greater than the lowest. These rather large variations in B.O.D. and temperature certainly must have an effect upon the operation of the plant.

These data did not seem at all conclusive to the writer, who decided to investigate further. In an article in the *Proceedings* of the Am. Soc. C. E., November, 1939, Robert T. Regester pointed out "needed study and research on activated sludge," and mentioned specifically the need for "improvement to the operational technique of process control through continuation of research relating to the fundamental phenomena and theories involved in the process."

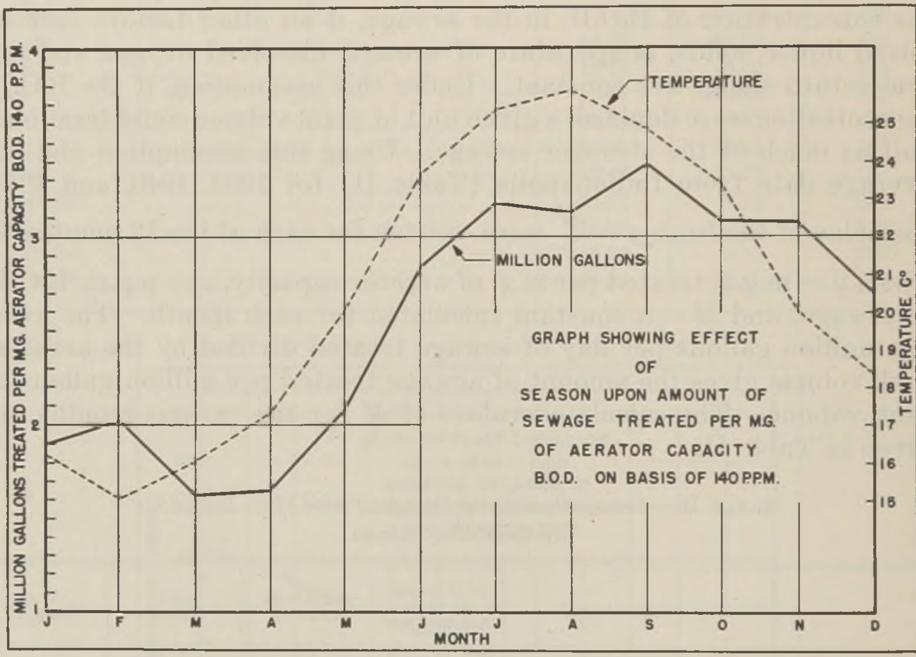
The first step in the study of this problem was to try to separate the data available in a manner so that the effects of temperature or season and concentration of B.O.D. could be examined separately. It seemed reasonable at this point to make the assumption that the amount of sewage that can be treated in an aerator is directly dependent upon the concentration of B.O.D. in the sewage, if all other factors such as mixed liquor solids, temperature of sewage, dissolved oxygen and per cent return sludge are constant. Under this assumption, if the B.O.D. concentration were doubled, a given unit of plant volume could treat only half as much of the stronger sewage. Using this assumption and the average data from Indianapolis (Table II) for 1939, 1940, and 1941, formulae of the form $y = \frac{M}{x}$ were written for each of the 12 months, in which y = m.g.d. treated per m.g. of aerator capacity, x = p.p.m. B.O.D. in sewage, and M = a constant calculated for each month. The average million gallons per day of sewage treated divided by the aeration tank volume gives the amount of sewage treated per million gallons of tank volume. The calculated values of M for the various months are given in Table II.

TABLE II.—*Average Operational Data for Period 1939, 1940, 1941*
Indianapolis, Indiana

	M.G.D. per (y) M.G. Aerator Cap.	B.O.D. (x) (p.p.m.)	(M) Values	Ave. Temp. C°
January	1.05	253	265.65	16.25
February	1.19	238	283.22	15.08
March	0.88	258	227.04	16.08
April	1.02	226	230.52	17.35
May	1.26	231	291.06	20.08
June	1.86	214	398.04	23.65
July	2.10	212	445.20	25.35
August	2.06	213	438.78	25.91
September	1.93	246	474.78	24.91
October	1.77	245	433.65	23.41
November	1.68	257	431.76	20.08
December	1.41	268	377.88	18.41

Table III has been prepared using the M values calculated for each month. It gives the calculated rates of treatment per million gallons of aerator capacity for sewage concentrations varying from 50 p.p.m. to 300 p.p.m. From the data in Table III the B.O.D. concentration of

140 p.p.m. was selected as representative, thus eliminating the variation caused by fluctuations in B.O.D. concentration. Graph II was then prepared, which shows quite definitely the seasonal effect upon the capacity of an activated sludge plant treating sewage of constant strength. In general, this graph shows that the capacity is directly affected by the temperature of the sewage. After completing Graph II it was noted that if the temperature curve was shifted ahead a month or the capacity curve shifted back a month, the two curves on appropriate scales almost coincide. This seems to be rather convincing evidence that, all other things being equal, the rate of treatment in an activated sludge plant is directly related to the temperature.



Graph II

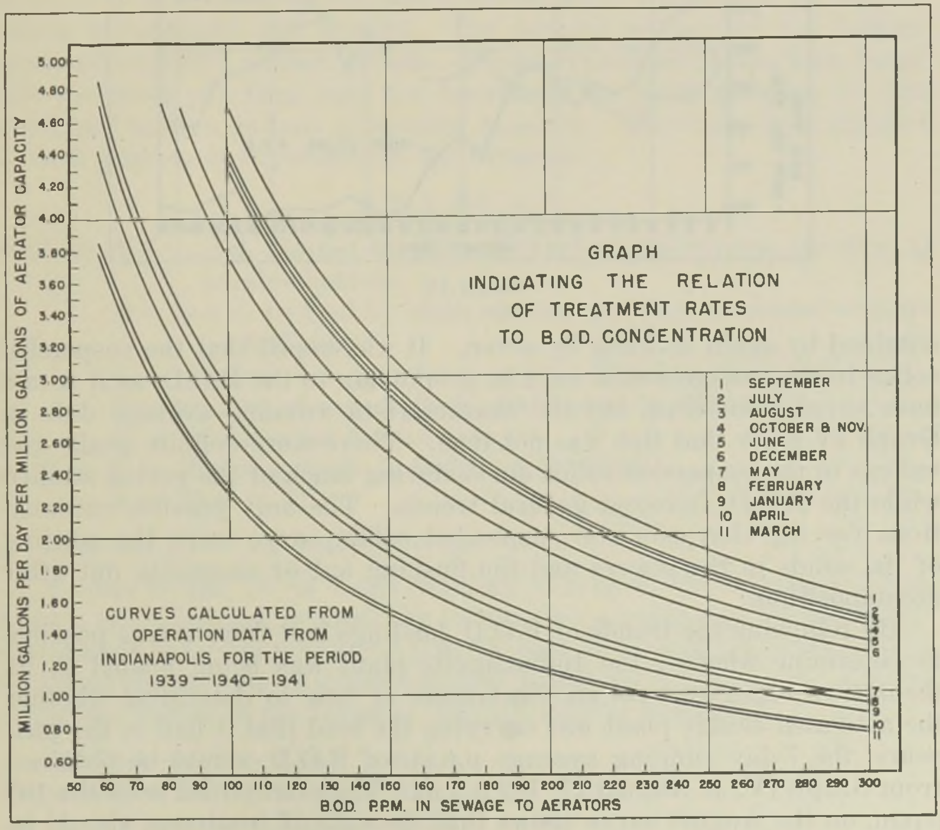
The data from Table III have been plotted on Graph III in order to obtain a picture of the effect on B.O.D. loadings on plant operation and to make it possible to use a graph in determining permissible loadings upon the Indianapolis activated sludge plant units for each month. This graph, based upon the theory presented, shows that a plant of one million gallons aerator capacity can treat 2.02 million gallons per day of a sewage with a B.O.D. concentration of 220 p.p.m. If, however, the B.O.D. concentration was 160 p.p.m. the same plant could treat 2.78 million gallons per day.

The determination of plant loadings from the B.O.D. test is so delayed by the incubation period required that the data cannot be used for plant control. It was further found useless to try to use the daily B.O.D. figures for purposes of determining the load and capacity because of the great daily fluctuations in both flow and B.O.D. It was

TABLE III.—*Calculated Rates of Treatment Per Million Gallons of Aerator Capacity and Varying B.O.D. Concentrations*

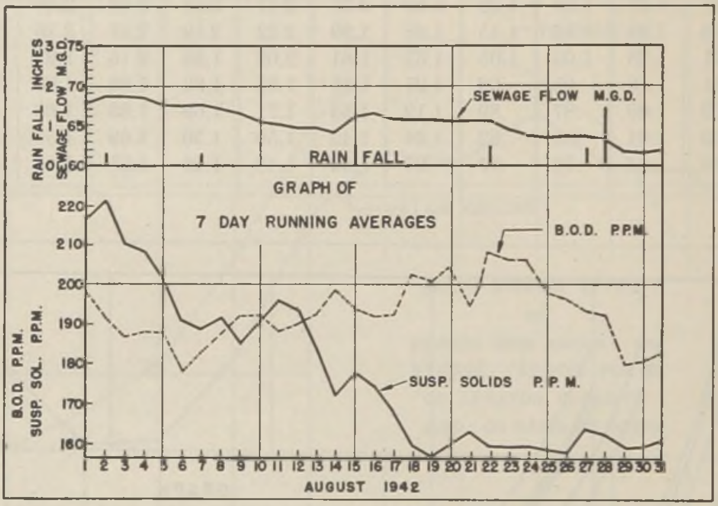
Basic Data from Indianapolis Operation

B.O.D. (p.p.m.)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
50	5.31	5.66	4.54	4.61	5.82	7.96	8.90	8.76	9.49	8.65	8.61	7.55
60	4.42	4.71	3.78	3.84	4.85	6.64	7.41	7.30	7.90	7.21	7.18	6.29
70	3.79	4.04	3.24	3.30	4.16	5.69	6.35	6.25	6.78	6.18	6.15	5.40
80	3.32	3.54	2.84	2.88	3.64	4.97	5.56	5.48	5.93	5.41	5.39	4.72
100	2.66	2.83	2.27	2.31	2.91	3.98	4.45	4.39	4.75	4.34	4.32	3.78
120	2.21	2.36	1.89	1.92	2.42	3.32	3.71	3.65	3.95	3.60	3.59	3.14
140	1.90	2.02	1.62	1.65	2.08	2.84	3.18	3.13	3.39	3.09	3.08	2.70
160	1.66	1.77	1.42	1.44	1.82	2.49	2.78	2.74	2.96	2.70	2.70	2.36
180	1.47	1.57	1.26	1.28	1.62	2.21	2.47	2.44	2.64	2.40	2.40	2.10
200	1.33	1.41	1.13	1.15	1.46	1.99	2.22	2.19	2.37	2.16	2.16	1.89
220	1.21	1.28	1.03	1.05	1.32	1.81	2.02	1.99	2.16	1.97	1.96	1.72
240	1.11	1.18	.95	.96	1.21	1.66	1.85	1.83	1.98	1.80	1.80	1.57
260	1.02	1.09	.87	.89	1.12	1.53	1.71	1.69	1.83	1.66	1.66	1.45
280	.95	1.01	.81	.82	1.04	1.42	1.59	1.56	1.69	1.55	1.54	1.35
300	.88	.94	.76	.77	.97	1.33	1.48	1.46	1.58	1.44	1.44	1.26



GRAPH III

thought necessary to devise some manner of analyzing the plant operation data at hand so that trends in B.O.D. concentrations and flows could be observed and used to explain fluctuations in rates of treatment indicated necessary by plant control methods in use. To follow these trends the seven-day running average was used, it being fully realized that the seven-day effect would not be exerted upon the activated sludge plant on any one day. A much shorter period would have been used had there been a cycle within that period as there is in the seven-day period. The seven-day running average is obtained by adding the results for seven days and dividing by seven then as each new day's results are obtained, the first day is subtracted from the original total and the new seventh day is added on and the new average



Graph IV

obtained by again dividing by seven. It was hoped that the suspended solids in the sewage would vary in proportion to the B.O.D. as it would have saved some time, but the characteristic running average data in Graph IV show that this was not true. There were definite peaks and valleys in the suspended solids curve during much of the period studied while the B.O.D. followed general trends. The only possible explanations for the characteristic suspended solids curve were the settling of the solids in the sewers and the flushing out or sloughing out after decomposition.

By following the trends of B.O.D. loadings and flows it was possible to determine whether the Indianapolis plant was being loaded to its theoretical capacity. As an illustration of how to determine whether the activated sludge plant was carrying the load that it had in the past years, the 7-day running average p.p.m. of B.O.D. would be obtained from Graph IV, as August 17, 192 p.p.m. Then Graph III with the 192 p.p.m. on the August curve shows that the rate of treatment should be 2.28 million gallons per day per million gallons of aerator capacity.

The 1942 operation data are compared in Table IV with the calculated results that should have been expected.

TABLE IV.—*Rates of Treatment**

	Calculated Rate	Actual Rate	Per Cent Actual of Calculated
July 1942	2.41	2.32	96.3
August	2.30	2.33	101.2
September	2.21	2.12	95.9
October	1.78	2.02	113.6

* Million gallons per day per million gallons of aerator capacity.

From this it would seem that the 1942 summer operation followed very closely the curves established by previous years of operation.

At Indianapolis, however, the problem of loading was complicated by the fact that the secondary treatment plant was not large enough to give complete treatment to the entire flow of sewage. The best removal could be obtained by treating the maximum amount possible with activated sludge and all of the balance by plain aeration. The amounts to be treated by the two methods were determined by the following calculations and graphs. The aerator volume of the Indianapolis plant is 23.5 million gallons. From experience it has been found that the most practical rate for treatment by plain aeration is 4.46 m.g.d. per million gallons of aerator capacity. The ratio to be treated by each process is expressed in the formula:

$$AX + BY = C$$

in which A = m.g.d. treated by the activated sludge process per m.g. of aerator volume,

B = m.g.d. treated by plain aeration per m.g. of aerator volume = 4.46 m.g.d.,

X = number of m.g. units in activated sludge treatment,

Y = number of m.g. units in plain aeration treatment,

C = total sewage flow in m.g.,

$X + Y$ = 23.5 m.g. units in Indianapolis Plant,

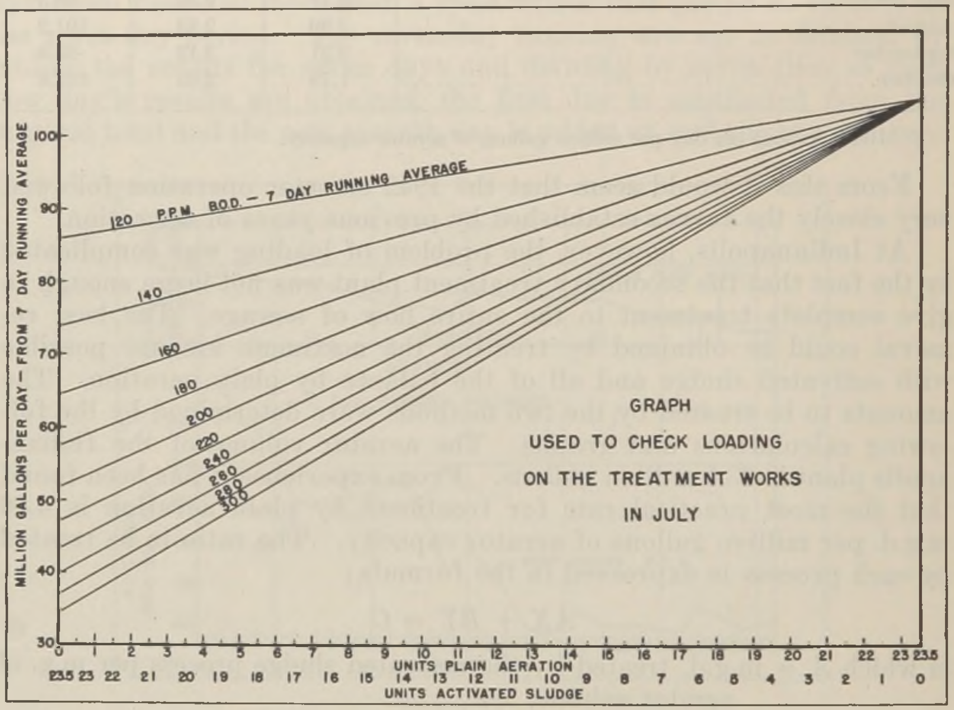
$X = 23.5 - Y$.

Then $A(23.5 - Y) + 4.46Y = C$.

If from Graph IV of 7-day running averages, the sewage flow for August 8th, 67 m.g.d. is used, the value of C is obtained. If the corresponding B.O.D. value of 188 p.p.m. is used on Graph III to obtain the activated sludge rate of treatment, it is found to be 2.34 m.g.d. Substituting the values in the formula the following is obtained:

$$2.34(23.5 - Y) + 4.46Y = 67$$
$$54.99 - 2.34Y + 4.46Y = 67$$
$$2.12Y = 12.01$$
$$Y = 5.66 \text{ units needed for plain aeration}$$
$$X = 17.84 \text{ units needed for activated sludge}$$

Graph V, based upon July treatment rates, is here presented and this type of graph was found helpful in determining the plant operating proportions necessary for the most efficient operation when using the two methods of treatment. On this basis, if all units were using activated sludge, the maximum rate that could be treated would be 54.99 m.g.d., and 12.01 m.g.d. of primary treated sewage would have had to be by-passed.



Graph V

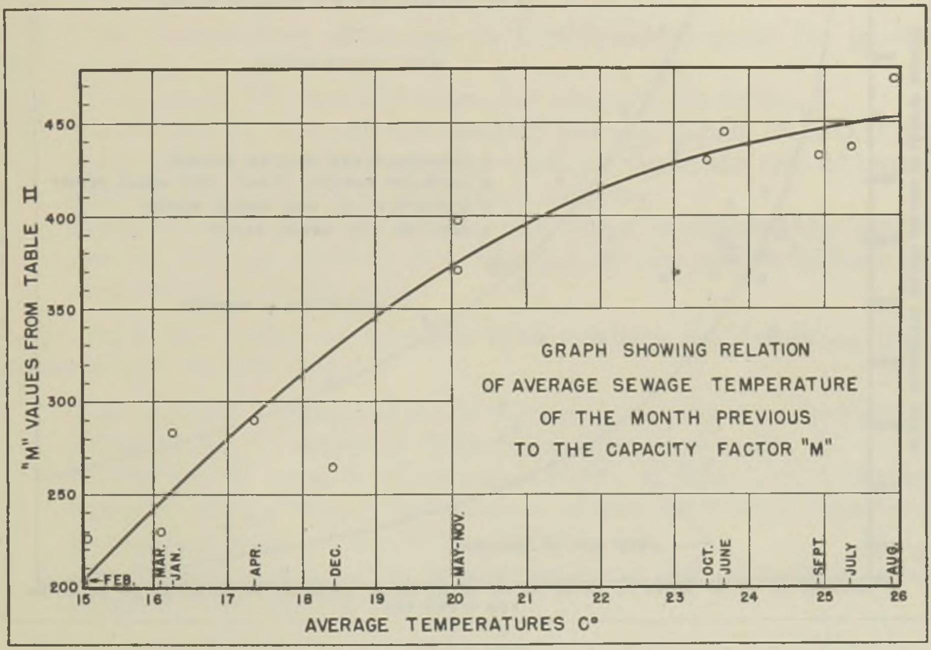
It would seem that this information on temperature and B.O.D. loadings might be of use to the consulting engineer in determining the needed aeration tank volumes if the sewage strength and flow of sewage were quite accurately known. If the designing engineer knew the average B.O.D. strength and would take from Graph III the m.g.d. per m.g. of aerator volume for the minimum month corresponding to the average B.O.D. and divide it into the total sewage flow, the aeration tank volume needed would be the result. The rate of treatment per million gallons of aerator capacity can be calculated from

$$Y = \frac{M}{x}$$

$$Y = \frac{227.04}{x}$$

where: Y = million gallons treated per million gallons of aerator capacity,
X = B.O.D. in p.p.m. of sewage going to aeration units.

From present day knowledge this would be a very conservative design as it would give a detention period of 8.0 hours for a sewage of 100 p.p.m. of B.O.D., with 33 per cent return sludge under winter conditions. If, however, the plant must be designed to do its maximum work during the critical summer months of, say, June, July, August, and September, then the constant *M* in the above formula becomes about 430 and the detention period can be taken at about 6.3 hours for a B.O.D. concentration of 150 p.p.m. and 33 per cent return sludge or 4.2 hours detention for a B.O.D. of 100 p.p.m. The factor *M*, as has been pointed out before, is dependent upon the temperature of the sewage,

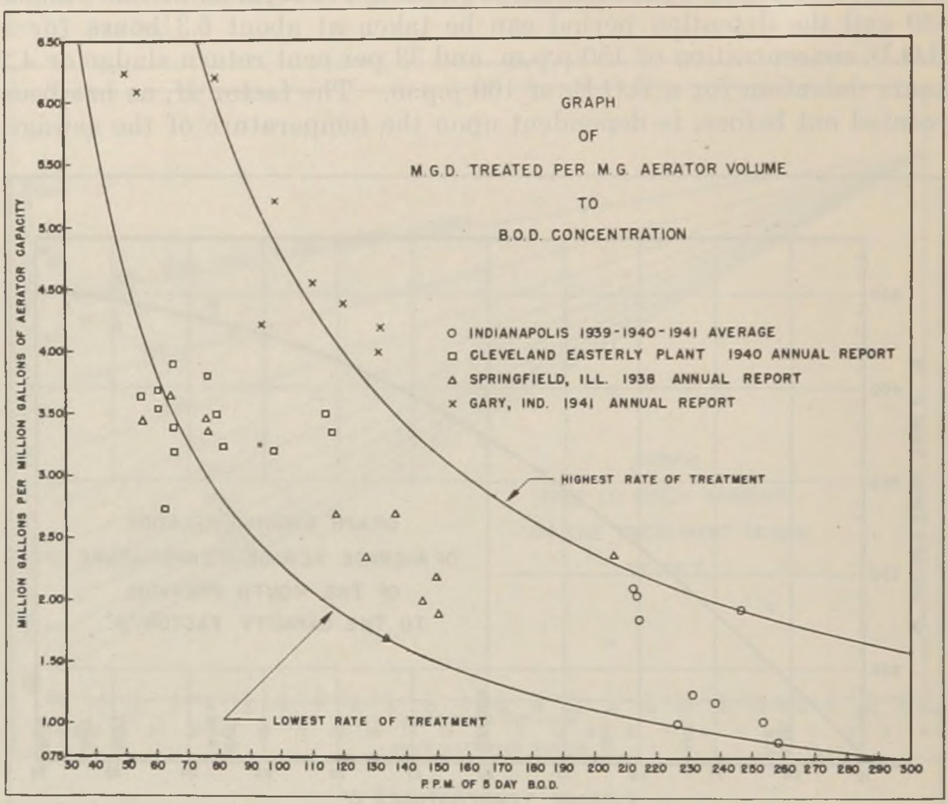


Graph VI

and in analyzing the data it was observed that the *M* values obtained from plant operation data varied in quite a definite relation with the average temperature of the month previous. This is not strange when one considers that there may be some lag or carry-over effect of temperature from one period to the next on which the capacity data were considered.

The *M* values for the several months have been plotted against the temperatures of each previous month, Graph VI. In general there seems to be a definite relation between these two sets of values. It is fully realized that the data as compiled on temperatures do not follow the (sketched in) curve exactly but it is firmly believed that the effects of temperature and B.O.D. loadings on an activated sludge plant are expressed in a general way by the relationships that are herein shown.

The development of the theories and beliefs so far expressed in this paper has been based upon data from the Indianapolis plant. How they fit the data from other treatment plants can best be seen in Graph VII where the B.O.D. concentration has been plotted against the rates of treatment for the Cleveland, Ohio Easterly Plant; Lima, Ohio;



GRAPH VII

Springfield, Illinois; Gary, Indiana; and Indianapolis, Indiana. It can be seen that, in general, the rates of treatment of these several plants fall between the maximum and minimum curves which were based upon the assumption that the rates of treatment decreased one-half with the doubling of the B.O.D. strength. No attempt was made to make temperature adjustments to the data from other cities in view of the fact

TABLE V.—*Operation Data at Indianapolis*

Year	Mixed Liquor Solids, p.p.m.	Return Sludge Solids, %	Cu. Ft. Air per Gal.
1939	2,900	0.89	1.51
1940	2,000	0.79	1.69
1941	2,500	0.80	1.67
Average	2,466	0.83	1.62

that it is doubtful whether the plants listed would of necessity have to operate at the maximum capacity of their units for all months in the year. The great seasonal variation in the rated capacity of the Indianapolis plant was accentuated because the units were loaded to their maximum capacity with but little variation in mixed liquor solids concentration, return sludge concentration, or amount of air applied, as can be seen from Table V.

The approximate range of mixed liquor solids, return sludge concentration, and amount of air used can be seen from these data.

To check the rates of treatment of an activated sludge plant it is suggested that the following procedure be followed:

1. Take temperature of sewage in Centigrade degrees for month previous.
2. From Graph VI obtain *M* value for temperature in No. 1.
3. Divide this *M* value by the monthly average p.p.m. of B.O.D. in the sewage going to the aeration units, to obtain the rate of treatment in m.g.d. per m.g. of aerator capacity.
4. Compare No. 3 with the actual rate which is obtained by dividing the average monthly flow in m.g.d. by the million gallons of aeration space being used.

To check the design of aeration tank volumes the following procedure might be followed:

1. Take minimum temperature of sewage in Centigrade degrees.
2. From Graph VI obtain *M* value for temperature in No. 1.
3. Divide this *M* value by the average p.p.m. of B.O.D., that can be expected after primary treatment, to obtain the rate of treatment in m.g.d. per m.g. of aerator capacity.
4. The estimated m.g.d. flow divided by No. 3 will give the m.g. of aeration tank volume required.

It is to be noted that no allowance has been made in this discussion for appreciable changes in mixed liquor concentrations. This is a matter that should be kept in mind when making comparisons.

Conclusions

1. The capacity of an activated sludge plant for any month is dependent upon the concentration of B.O.D. in the sewage.

2. Temperature of the sewage definitely plays an important part in determining the capacity of an activated sludge plant.

3. The data analyzed here indicate that the full effect of minimum and maximum temperatures is not indicated in the rates of treatment until the month following.

4. The method of 7-day running averages is quite satisfactory in detecting trends in sewage flows and B.O.D. loadings.

5. The data indicate the fallacy in giving the rated capacity of an activated sludge plant in million gallons per day with no stipulation as to the concentration of B.O.D. or temperatures.

6. The required detention time in an aerator is directly dependent upon the B.O.D. concentration and temperature of the sewage.

7. The assumptions and theories herein given are substantiated by the data obtained from other activated sludge plants in the country.

8. It is proposed that the rated capacity of activated sludge plants be based upon the m.g.d. of sewage of stated B.O.D. strength and specified temperature.

9. It is fully realized that this work is not complete in every detail. Further study should be made which will undoubtedly modify the assumptions that have been made. It is presented here, however, as a possible contribution to the general solution of activated sludge plant operation problems.

BIOLOGICAL ENGINEERING IN SEWAGE TREATMENT

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Biological engineering in sewage treatment may be considered to encompass those methods of treatment which accomplish under artificial conditions and at accelerated rates those biologically induced changes which naturally occur in polluted streams, or such methods of treatment as those which control natural purification processes to limit the development of nuisance conditions. This paper will briefly review the advances made in the art of sewage treatment which have a biological basis, recent developments, and some possible future developments.

Historical

The disposal of human wastes by water carried systems did not become an important practice until the industrial revolution (factory system introduced 1750–1800) was well developed. The concentrations of populations which it brought about, with attendant sanitation problems, caused relaxation of laws governing the use of storm sewers and the construction of sanitary sewers, beginning early in the 19th century. The pollution of rivers, streams and harbors was immediate, and most critical in England where the industrial revolution was most advanced. Thus, it is only natural that early developments in sewage treatment originated in that country.

Filtration

Sand Filters.—The use of sand filters for treatment of sewage was investigated in the middle of the 19th century and recommendations for their use were made by Sir Edward Frankland (1), as reported in 1870. This practice was, undoubtedly, borrowed from the waterworks field as sand filtration of surface supplies had become quite widespread in European cities in the period 1829 to 1865. It is questionable whether the proponents of sand filtration of sewage were aware of the biological aspects of this method of treatment as the sciences of microbiology and bacteriology were very poorly developed at that time. This method of treatment was the sole biological method employed until about 1890. Sand filtration of sewage was extensively studied at the Lawrence Experiment Station in the years following 1886. These studies (2) established the significance of biological forms as the active agents in sand filters and discovered the basic information for understanding the mechanism of all biological treatment processes.

Contact Beds.—The first contact beds or filters were developed by Didbin in London in 1892 (3) and were the result of his attempt to overcome some of the shortcomings of intermittent sand filtration and to reproduce and accelerate under controlled conditions the biological changes, naturally occurring in streams, which are produced by biological films on rocks, etc. The use of contact beds was of short duration as they were soon shown to be inferior to trickling filters.

Trickling Filters.—Trickling filters were developed almost simultaneously with contact beds or filters and the reasons for their development were the same. The pioneering work on this method of treatment was done by Corbett at Salford, England, in 1893 (4). The use of trickling filters constitutes the first real milestone in the biological treatment of sewage. This method has withstood the many tests of time and is held in high regard to this day.

High Capacity Rock Filters.—By 1930 a knowledge of the biological flora and fauna flourishing in standard low rate filters and of the stratification of various forms in the filters was well established. Also certain disadvantages such as poor distribution of the heavy momentary application of sewage over the filter medium surfaces were appreciated. The latter consideration, in conjunction with the theory that bacteria thrive best when fed continuously, led Dr. Halvorson of Minnesota to develop the "Aerofilter" (5).

Meanwhile Jenks was developing the "Biofilter" (6) which was designed with shallow filters to eliminate the portions of the ordinary filter which are involved in nitrification. In addition, recirculation of filter effluent was incorporated to reduce the strength of the sewage applied and through constant seeding, with filter sloughings, maintain quite uniform biological life from top to bottom of the filter. High rate filters, therefore, operate with a minimum amount of oxidation, act to a considerable degree as biological flocculators and depend upon sedimentation of the flocculated material for removal of the greater part of the pollutional load. Nitrification is negligible in a filter operating near capacity load.

Activated Sludge Process

The development of activated sludge treatment marks the second important milestone in the field of biological engineering in sewage treatment. Clark and Gage at the Lawrence Experiment Station (7) and Ardern and Lockett at Manchester, England (8) were largely responsible for the pioneering work on this method of treatment, which took advantage of the floc forming organisms naturally present in domestic wastes and created conditions favorable for their growth and preservation.

The high degree of stability given to sewage treated by the activated sludge process was soon found to be the result of nearly complete removal of organic matter and considerable oxidation of the nitrogenous matter. The latter has been, in many cases, considered as unnecessary, and, because of the large amounts of oxygen consumed in nitrification, attempts have been made to eliminate this phase of the treatment process by limiting the air supply and shortening the aeration period. Such control has been most successful at large plants, notably Chicago (9) and New York (10).

Some other developments which have been offered recently to improve the operation or economy of the activated sludge process, which remain in the experimental stage are: 1. Incremental feeding or stepped aeration as reported by Fair and McKee (11) and practiced at the Tallmans Island and Bowery Bay plants in New York City (12), 2. Stage addition of return sludge as proposed by Sawyer and Rohlich (13), and 3. Mallory Process of control which attempts to correlate optimum biological conditions with physical limitations of plant facilities.

Hays Process

The Hays Process is a compromise between the activated sludge method and the contact bed method with provisions for eliminating some of the disadvantages of each (14). The process includes two stages of treatment which provide for segregation of those organisms largely responsible for stabilization of carbonaceous wastes in the first stage and those organisms concerned with completing the carbonaceous stabilization and oxidizing the nitrogenous matter in the second stage.

Sludge Digestion

The use of digestion tanks to accomplish stabilization of settleable solids under anaerobic conditions and relieve streams of part of their oxygen demanding load constituted the first step in biological engineering in this field of sewage treatment. The use of heated digestion tanks to speed the process of anaerobic stabilization and render it independent of climatic conditions constituted the second important step (15) and the development of two stage digestion (16) the third.

Of recent date, it has been reported that the addition of nitrogenous compounds (17) will control scum formations and speed the digestion where nitrogen may be deficient. This proposal would appear most applicable to the field of industrial waste disposal or with domestic wastes containing large amounts of garbage and grease.

Modified Sewage Aeration

Attempts at stabilizing sewage by aeration have been made ever since man first became concerned with the problem of sewage treatment (1). No degree of success was attained, however, until the use of activated sludge was practiced.

Recently, Setter (18) and Setter and Edwards (19) have reported on studies of sewage aeration using extremely low concentrations of aeration solids, 150–500 p.p.m., and aeration periods of 1.5 to 3.0 hours. The degree of treatment attained ranged from 30 to 85 per cent removal of B.O.D. and suspended solids, depending upon the method of operation. Thus, all degrees of treatment between plain settling and activated sludge can be accomplished. A relatively dense, unstable sludge was produced, ranging from 4 to 5 per cent solids. These studies would indicate that sewage aeration with controlled aeration solids is as flexible as high capacity filters in meeting requirements for a high or medium quality effluent. It is the author's conception that actual practice in the field of modified sewage aeration has been developed to a high degree of perfection at the Rockville Center, L. I., N. Y. plant, under the able guidance of C. Geo. Andersen (20).

Removal of Fertilizing Elements from Sewage

There are at least four reasons why those people concerned with sewage treatment and stream pollution control are interested in the removal of fertilizing elements from sewage or sewage plant effluents. They are as follows:

1. *Riparian Rights.*—The law assures each riparian land owner that he is entitled to use water from a surface supply as long as the water is returned to the supply in undiminished quantity and unimpaired in quality. The data in Table I will serve to illustrate that cities using a river water for domestic supply do not meet the last requirement, even though the waste waters of the community may be well treated by biological methods.

Table I.—*Comparison of Normal River Waters and Biologically Treated Domestic Sewage*

	Total Phosphorus (p.p.m.)	Ammonia Nitrogen (p.p.m.)	Nitrate Nitrogen (p.p.m.)
River Water	0.15	0.20	0.50
Treated Sewage	3.00	10.00	5.00
Number Fold Increase	20	50	10

2. *Stimulation of Algal Growths.*—Recent stream pollution surveys, notably those conducted by the U. S. Public Health Service, have shown that streams and lakes enriched with sewage or sewage plant effluents develop zones of intense biological activity, frequently characterized by heavy algal growths during certain periods of the year. Such growths have been of considerable concern to cities using surface water for domestic supplies and may also create general nuisance conditions when accumulations occur. The latter is of special significance in lakes, and often results in a marked depression of lake shore property values. The solution to this problem, or some degree of relief, appears, at present, to be related to the removal of the fertilizing elements nitrogen and/or phosphorus from the sewage or sewage plant effluent.

3. *Possible Control of Deoxygenation Rates in Polluted Streams.*—The removal of nitrogen and/or phosphorus from sewage or sewage plant effluents may be important from the viewpoint of stream pollution control. The studies of Lea and Nichols (21, 22), Lea (23), and Martin and Miller (24) have shown that the rate of biological stabilization of organic wastes is markedly influenced by the presence or absence of

suitable amounts of nitrogen and phosphorus. This means that the value for "k" in the modified Phelps' equation, $y = L(1 - 10^{-kt})$, the expression commonly used to represent the rate of deoxygenation by waste matters under natural conditions, is largely affected and controlled by these nutrient elements, at a given temperature. That considerable variation exists in the rate at which certain industrial wastes are stabilized in different river waters was demonstrated by Martin and Miller (24) and shown to be related to some extent to the phosphorus contents of the waters. The author's conception of the significance of phosphorus in controlling biological activity or oxygen demand is shown in Fig. 1. This conception is based largely upon the experi-

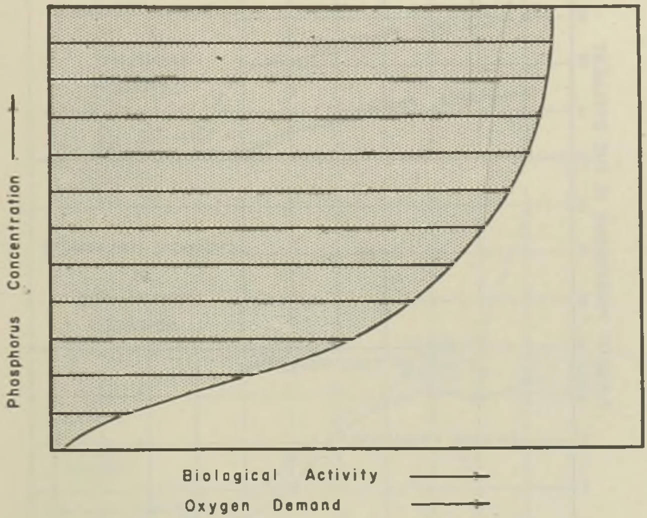

FIG. 1.—Present conception of the influence of phosphorus concentration on biological activity or rate of deoxygenation.

mental data of Lea (23) and upon personal experiences. Values for phosphorus concentration have not been established definitely, but Lea has shown that in the absence of organic sources of phosphorus the soluble phosphorus concentration must be from 0.08 to 0.11 p.p.m. to produce maximum activity. With both forms of phosphorus present, the total concentration necessary would be in excess of these values, possibly in the range of 0.15 to 0.25 p.p.m.

Since domestic sewage is such a potent source of phosphorus, preventing its admittance (without treatment to remove the phosphorus) to certain streams may markedly control the rate of biological activity in such streams and prevent the development of undesirable conditions. Such control would seem to have its greatest application in situations where industrial wastes containing limited amounts of phosphorus are involved, such as waste sulfite liquor, and could afford the industries involved an opportunity to contribute something toward stream pollution control until such time as they have developed economical means of removing the pollutional matters from their wastes.

4. *Conservation of Fertilizing Elements.*—Further discussion of this factor does not seem pertinent at this time.

Methods of Removing Fertilizing Elements from Sewage

Phosphorus Removal

The removal of phosphorus from sewage can be readily accomplished by treatment of sewage with one of the common trivalent coagulants, such as ferric chloride, as demonstrated by Sawyer and Romer (25). The effectiveness of such treatment is illustrated in Fig. 2,

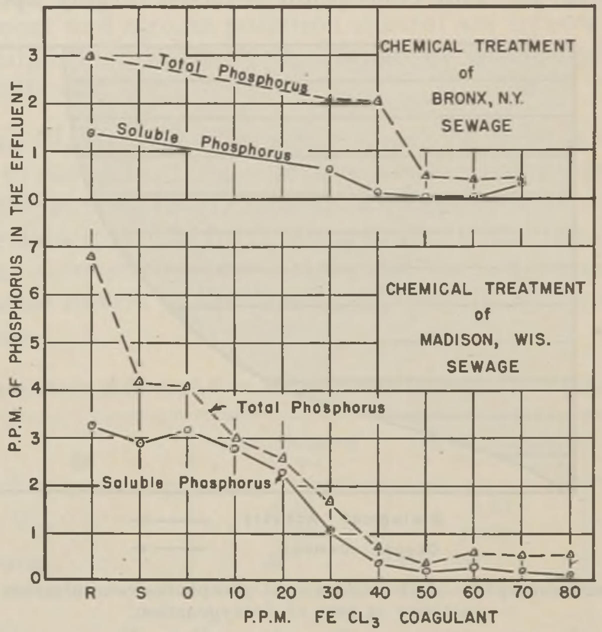

FIG. 2.—Phosphorus removal from domestic sewage by ferric chloride coagulation.

which shows that total phosphorus concentrations can be reduced to approximately 0.50 p.p.m. and soluble phosphorus concentrations can be reduced to values as low as 0.01 p.p.m. with doses of 50 p.p.m. (3 grains per gal.) of ferric chloride. Studies on effluents from activated sludge and from trickling filter treatment plants have shown the coagulant demand to be somewhat higher, 60 to 70 p.p.m., but the removal of phosphorus is more complete. Effluents containing less than 0.05 p.p.m. soluble and 0.20 p.p.m. total phosphorus are readily obtainable.

Nitrogen and Phosphorus Removal

Domestic sewages are abundantly rich in nitrogen and phosphorus with respect to the amount of carbonaceous matter they contain, and the biological stabilization of such wastes results in the production of effluents which are rich in phosphorus, nitrogen, potassium, etc., the plant fertilizers. Activated sludge treatment of domestic sewage may be illustrated diagrammatically as shown in Fig. 3. Such treatment may result in the conversion of some inorganic nitrogen and phosphorus to organic forms contained in the new activated sludge which has been formed. The effluent, however, contains the unconverted portions of these important fertilizing elements.

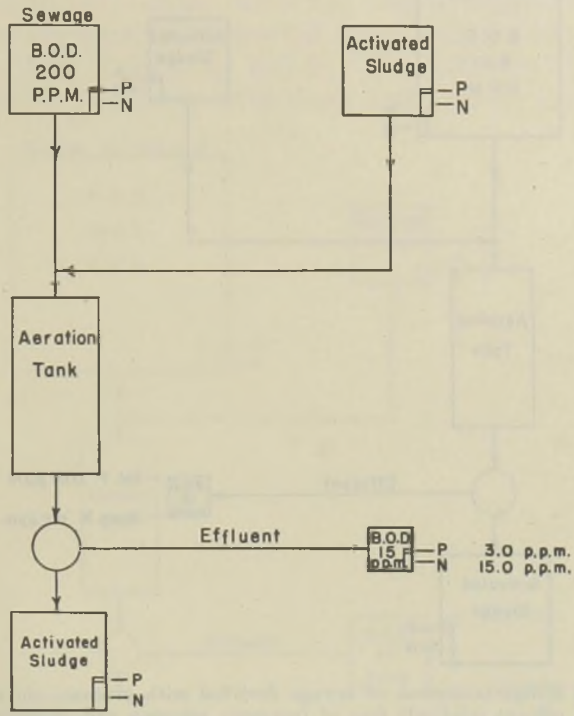

FIG. 3.—Activated sludge treatment of sewage—showing production of final effluent containing normal amounts of inorganic nitrogen and phosphorus.

The addition of carbonaceous matter to domestic sewage will result in the production of increased amounts of activated sludge when such mixtures are treated by that process and a direct result is the conversion of more inorganic nitrogen and phosphorus to organic forms. With the use of the proper amount of carbonaceous matter, glucose for example, practically all the nitrogen and phosphorus can be tied up in

TABLE II.—*Characteristics of Effluents Produced by Activated Sludge Treatment of Sewage Fortified with Glucose*

Feed Mixture	Inorganic Phosphorus (p.p.m.)	Ammonia Nitrogen (p.p.m.)	Nitrite Nitrogen (p.p.m.)	Nitrate Nitrogen (p.p.m.)
Sewage	2.68	0.35	0.01	20.0
Sewage + Glucose 200*	0.57	0.28	0.50	12.0
Sewage + Glucose 400*	0.00	0.28	0.02	4.0
Sewage + Glucose 600*	0.00	0.28	0.00	0.0

* Enough glucose added to raise the B.O.D. of the sewage 200, 400 and 600 p.p.m.

the sludge, and effluents relatively free of inorganic forms of these elements can be produced. Fig. 4 illustrates graphically what can be accomplished and the data in Table II show some actual results obtained in the laboratory.

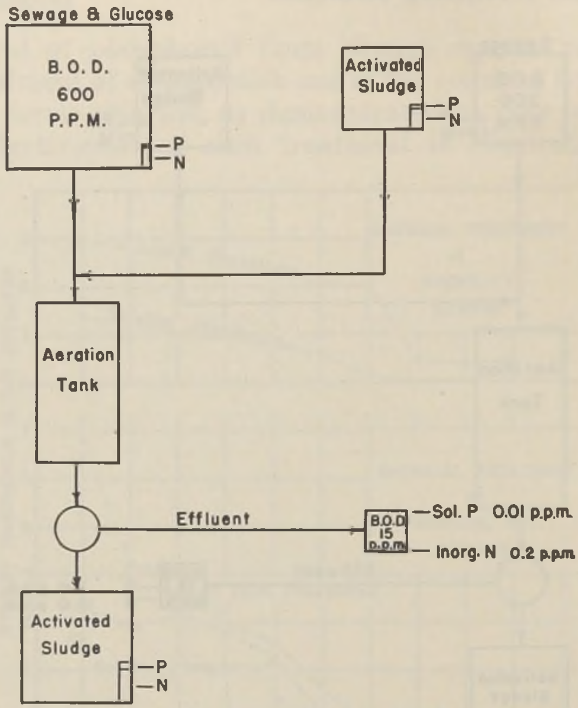

FIG. 4.—Activated sludge treatment of sewage fortified with glucose—showing production of final effluent relatively free of inorganic nitrogen and phosphorus.

These data illustrate what can be accomplished in the field of nitrogen and phosphorus removal by fortifying sewage with carbohydrate matter. At the same time, more activated sludge is produced as shown in Table III.

The nitrogen content of the sludges produced is increased by glucose additions as long as excess nitrogen appears in the effluent. When ex-

TABLE III.—*Quantity and Quality of Activated Sludge Produced on Sewage Fortified with Glucose*

Feed Mixture	Yield of Dry Sludge† (Mgms.)	Composition of Sludges		
		Phosphorus (Per Cent)	Nitrogen (Per Cent)	Ash (Per Cent)
Sewage	1220	1.72	7.25	21.8
Sewage + Glucose 200*	2620	1.72	8.31	14.1
Sewage + Glucose 400*	3880	1.18	7.72	9.9
Sewage + Glucose 600*	5800	0.80	5.75	7.1

* Enough glucose added to raise the B.O.D. of the sewage 200, 400 and 600 p.p.m.

† Amount of sludge wasted to maintain starting concentration of sludge, during 13 feedings over a period of 3 days.

cess glucose is added, the content of nitrogen in the sludge drops sharply. Studies on the increased growth of the sludge showed that with once, twice, and thrice daily feedings the conversion of glucose to sludge varied from 36 to 63 per cent, increasing as the number of feedings per day increased. The oxygen necessary for stabilization of glucose by activated sludge, when fed with sewage, was found to be 17.1 per cent of the theoretical amount required for complete oxidation, or about 26 per cent of its 5-day B.O.D. The value for oxygen requirements corresponds favorably with those reported by Ruchhoft, Kach-

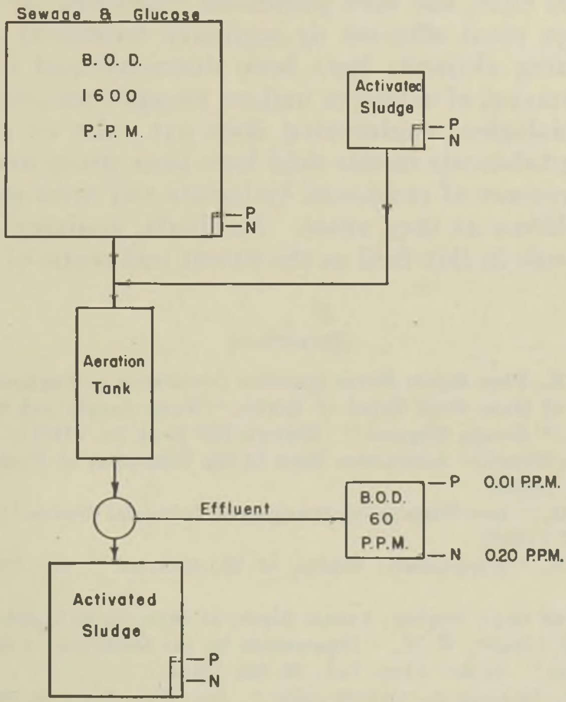

FIG. 5.—Activated sludge treatment of sewage fortified with excess glucose—showing production of final effluent relatively free of inorganic nitrogen and phosphorus, but high in residual B.O.D.

mar and Placak (26), but the values for the conversion of glucose to sludge are lower than they reported.

It is appreciated that the use of glucose or other refined carbohydrates for removal of nitrogen and phosphorus from sewage would not be economically feasible. However, the use of certain industrial wastes of a carbohydrate nature may be. Waste sulfite liquor has been demonstrated to accomplish similar results, but it possesses certain unfavorable characteristics, notably its ability to cause foaming during the aeration process. The production of highly colored effluents when waste sulfite liquor is used may be a serious deterrent to its use in certain locations.

Careful control of the amount of carbohydrate matter added to sewage with respect to its ammonia nitrogen content must be practiced if successful results are to be obtained. Overtreatment with carbohydrate matter generally results in the production of unsatisfactory effluents having a high B.O.D., as shown in Fig. 5. Although a greater quantity of sludge is produced, its content of nitrogen and phosphorus is much lower and such sludges often have much poorer settling characteristics.

Summary

A brief review of advances in the art of sewage treatment which have had a biological basis has been presented. Reasons for further treatment of sewage plant effluents or auxiliary treatment of sewages to remove fertilizing elements have been discussed and methods of accomplishing removal of nitrogen and/or phosphorus presented.

Although biological engineering does not exist as a distinct profession, accomplishments in this field have been many and the result of bringing the pressure of engineers, biologists and chemists to bear upon particular problems as they arose. No doubt, sanitary engineers will increase their role in this field as the extent and scope of their training expands.

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Industrial Wastes

THE DISPOSAL OF LIQUID WASTE FROM THE VIEWPOINT OF ONE IN THE PETROLEUM INDUSTRY *

By Walter Humphreys

Superintendent, Santa Fe Springs Waste Water Disposal Company

We hear and read a great deal about waste paper, waste tin cans and waste scrap of all kinds which the Government wants very much. Now we will hear about waste water which the governing agencies do not want at all.

These remarks may be divided into three parts:

1. Petroleum liquid industrial waste disposal methods.
2. Oil company's viewpoint on disposal.
3. The sewage works association as a factor in the disposal of industrial waste.

It might be well to review briefly some of the factors regarding the disposal of liquid petroleum industrial waste. It is derived from two main sources, oil fields and refineries. In California, the quantities of waste to be handled are roughly 40 m.g.d. from the oil fields and 100 m.g.d. from the refineries. There are more than 300 installations embracing the primary, secondary or tertiary stages of waste water treatment. The cost of these treating plants, including disposal facilities and operation, varies from $10 per m.g. to $300 per m.g. The total amount of capital invested approaches 20 million dollars.

There are fundamentally six methods of disposal:

1. Imponding for evaporation. In California, where such methods are economically possible, experience shows that 4,000 gal. of brine per day per acre can be dissipated by that method. It costs approximately $4,000 per acre to prepare land properly for evaporation ponds.
2. Controlled diversion into surface streams.
3. Injection into subsurface sand formation in the oil strata. This method has a possible double aim, *i.e.*, disposal of brine waste and secondary recovery of oil. Returning of the brine into the subsurface oil strata has been attempted for a number of years but the process is still experimental. Pennsylvania, Kansas, Texas, Oklahoma and now California are carrying on this type of disposal. Steps involved in the treatment require complete

* Presented at 17th Annual Meeting, California Sewage Works Association, Fresno, June 22–25, 1944.

removal of oil, iron and bacterial growth together with water stabilization. This method is not too attractive when viewed from the brine disposal standpoint.
4. Disposal into waste alkali land or sand areas.
5. Disposal into salt marshes or ocean.
6. Disposal into sanitary sewers and storm drains. Sanitary sewers offer the most satisfactory means of final disposal when sewers are available.

These disposal methods require various degrees of treatment. All treatments must accomplish one thing in common, i.e., removal of the hydrocarbons or oils to say 50 p.p.m. or less. However, some ordinances permit disposal of wastes containing as high as 400 p.p.m. of oil into the sanitary sewers.

The treatment of oil field waste water might be divided into physical and chemical methods. The physical method may embrace gravity separators which are settling or subsidence ponds. These are designed on a base of low velocity (one foot per minute) and long retention time varying from a few hours to many days. Practically all plants use this method of treatment. The efficiency of this method varies greatly and is dependent upon the character of the influent rather than on the design of the separator. Velocity and retention are important factors where oil removal is desired. Long retention may produce sulfide difficulties. The chemical treatment method has unlimited possibilities, seemingly without regard to the character of the influent. For complete treatment, filtration seems necessary.

Refinery wastes are quite complex and are becoming more so as new processes and methods of refining are developed. As the demand for a greater variety of hydrocarbon products develops, liquid industrial waste treatment becomes more difficult.

Insofar as petroleum industrial waste is concerned, there seem to be no health problems when viewed from a pathological standpoint. There is, of course, the nuisance value from the aesthetic standpoint and as it affects the olfactory nerves. These factors deal too much with the human equation to be correctly valued. Recreational authorities are concerned with the nuisance due to oil, odor and general appearance. The fish and game authorities are interested in protection of wild life and fish, largely from a toxicity standpoint.

The problems encountered in handling waste water in the petroleum industry are numerous. In the oil fields they embrace overcoming reversed oil emulsions, eliminating calcium carbonate and other deposits in pipe lines and on structures, controlling sulfides, corrosion, etc. The raw refinery liquid waste problems deal with disposal of sodium plumbate or "doctor treatment," caustic washes, acid sludge, naphthonic and saponic acids and of brines carrying complex hydrocarbon compounds and mercaptans.

As to the oil company's point of view on liquid waste disposal, the writer cannot speak for all of the oil industry, especially for the refineries. It can be emphatically stated, however, that the industry will and has co-operated with the public and its agencies in effecting suitable disposal of its wastes insofar as it understands the problem.

The disposal of clean brine waste is a continually increasing problem. The necessity for a co-operative, intelligent study of the factors involved by the governmental agencies and the petroleum industry is essential. There should be a greater effort to improve the mutual understanding between these authorities and the industry.

The industry feels that its value to a community entitles it to a reasonable use of the existing common carriers handling liquid waste. It feels that duplication of facilities is extravagant and unnecessary.

It is the writer's opinion that the oil industry will agree with any plan embracing the use of public facilities which includes the principal of credit given for taxes paid, with a normal charge for excess quantities. The waste should be pretreated in such a manner that it will not be an undue expense to the sanitary district, but this does not necessarily mean meeting domestic sewage standards.

The industry objects to the policy of including the oil company's assessed value when creating sanitary districts for the purpose of financing and then prohibiting the use of the sewer facilities. It must be recognized that the oil industry, like other industries, has liquid waste for disposal. It is generally desirable, from the standpoint of the public and industry, that the sewerage system be available for disposal of liquid industrial wastes. It is not generally desirable from the standpoint of the sewerage departments.

Most of us resent criticism, particularly when it is not constructive. Municipalities dislike authorities to say that their domestic effluent is bad or injurious. Industry does not like to have it said that its waste discharge is bad, even though in both cases the accusation may be true.

It seems possible that disposal areas can be set aside and so designated. These areas could receive liquid waste, the overall nature of which would have no objectionable features. These areas could be arid ground purchased by industry or government agencies, or they might be disposal points in sloughs, marshes or the ocean. The character of the effluent specified and the charge for use can be set according to the needs.

Finally, what part should the sewage works association take in industrial liquid waste disposal policies? This part of my story starts back about 15 years ago when, in endeavoring to secure more practical information, I associated myself more or less with water works and sanitary groups for the purpose of obtaining some viewpoints, facts and information on industrial waste practice. I was particularly attracted to the sewage works association because, as you are aware, this group is organized for "advancement of fundamental and practical knowledge concerning the nature, collection, treatment and disposal of sewage and industrial waste." I think the industrial waste phase has been sadly neglected.*

I feel that there should be a greater encouragement to include industrial participation in your affairs. I believe that there is a large and very diversified field in industrial waste treatment and that a great deal can be accomplished for the good of all. There has been a lack of understanding between the sewage works group and the industrial waste group. There are two possible reasons for this: (*a*) the sewage works group specialized for years in their problems and go to a great deal of time and trouble to disseminate their common information, however, their schooling and experience in industrial waste treatment is limited and (*b*) the industrial waste group is not particularly interested in domestic sewage or industrial waste unless the industrial waste contains valuable by-products. There is little if any attempt to diffuse the knowledge on hand. This association could correct these difficulties, for example, by broadening the scope of its meetings to attract the attention of industrial representatives.

At present there is not much of a place in the sewage works association for industrial men. There has been too much opposition to liquid industrial waste in sewage to encourage industrial interest in this association. It is becoming more and more a community problem and it cannot be solved successfully by legislating against it.

I believe a great deal of benefit can be derived by the sanitary engineers and industrial waste engineers through a mutual association. That association should be this one. The California Sewage Works Association is to be complimented for its step in attempting to bring the minds of domestic and industrial groups together.

* *Editor's note*: In an effort to correct any past deficiency in this respect, the Federation Board of Control authorized the appointment of an Industrial Wastes Committee in October, 1943. This committee, headed by Dr. F. W. Mohlman as Chairman, is now actively engaged in arranging an industrial waste symposium for inclusion in the program of the Fifth Annual Meeting of the Federation, which will be held at Pittsburgh on October 12–14. There is certain to be an increased interest and recognition of industrial waste problems in the future.

WASTE DISPOSAL PROBLEMS AT A SOUTHERN CALIFORNIA FRUIT AND VEGETABLE CANNERY *

By Charles W. Froehlich

Plant Superintendent, Hunt Brothers Packing Company, Fullerton, Calif.

The purpose of this report is to outline the difficulties we have gradually run into in this cannery during the last few years, the steps we have taken to overcome these difficulties, and the degree of success we have had.

The Hunt Brothers cannery at Fullerton is a comparatively large one, even for California, handling in normal years a pack of 5,000 tons of spinach, 3,500 tons of apricots, 15,000 tons of cling peaches, 20,000 tons of tomatoes and several smaller packs to fill in the idle months. These smaller packs include pork and beans, hominy and citrus juices. During the peaks of the spinach and peach packs, the flow of water to the city sewer has reached an average of 1,000 gallons per minute for short periods of time. Like a number of other California canneries, however, the growth of this plant has been rapid, and an examination of the packs for the past few years will reveal that ten years ago this was a small cannery with no waste disposal problems. During the last five years this problem has grown rapidly and a number of solutions have been attempted; certainly, a great deal of progress has been made.

It was during the 1940–1941–1942 packing seasons that the real trouble first developed, and the first solution attempted was the installation of a rotating screen 10 ft. long and 5 ft. in diameter, with a settling basin or sump immediately ahead of the screen. The purpose of this basin was to settle out sand, from such packs as spinach, and to insure removal of stones and hard objects that might injure the screen. While this installation aided a great deal, it was soon apparent that the screening plant was too small. So it was moved to a new location and a second screen added. This gave additional space for the settling sump and, of course, the second unit added to the screening capacity. These rotating drums were covered with a 12-mesh wire screen, and a screw conveyor was installed through the center of each to remove solids as they were raised out of the water by cleats on the inside of the drums.

The first real difficulty with this screening plant developed as the screens rapidly became clogged with solids and lime deposits from the water. It was found that a fair cleaning job could be done by spraying the screen with a high pressure water and steam spray as the drum rotated, but this did not help the lime deposits. Various attempts

* Presented at 17th Annual Meeting, California Sewage Works Association, Fresno, June 22–25, 1944.

at removing this deposit resulted in mechanical injury to the screen, which in turn resulted in a temporary shutdown of the cannery while the screen was repaired.

By this date the volume of water delivered to the city sewer by the cannery was up to and, during certain hours, exceeding the capacity of the sewer so that even clear water could not have been handled at that capacity. To meet this emergency, it was necessary to pump the water north of the cannery to hastily constructed lagoons where the water was held and allowed to percolate into the soil. The usual problems met in disposing of sewage in lagoons, such as mosquitoes and objectionable odors, were met and properly disposed of, but it soon became apparent that this extra water fed into the soil traveled down underground channels in the direction of the natural fall of the surrounding country and effected continuous irrigation of the orange groves for an amazing distance from our lagoons. To get around this problem, a tract of land about two miles from the cannery, in an old river bed, was purchased, and plans laid for a pipe line to this gravel soil where lagoons, or settling basins, would be constructed. This plan was soon blocked, however, as the residents of this area petitioned the local health authorities (who had approved the plan) to prohibit the construction of such a waste disposal plant in the vicinity, and stated they would have the district incorporated, if necessary, to stop the project. We concluded, therefore, that, regardless of the success of any screening or filtering plant we might install, the flow of water from the cannery was to be limited by the capacity of the city sewer, even if clear water were delivered.

Starting our 1943 season, we were faced with the problem of eliminating the mechanical difficulties experienced with the screening plant, and reducing the flow of water to the city sewer, or, it might be said, reducing the flow of water from the cannery. The rather fragile, quickly clogging, woven wire screens were removed from the rotating drums, and heavy sheet metal screens with punched holes were substituted. The first drum was equipped with screens having 1/4-inch holes to remove large particles, and the second drum with 1/16-inch holes to finish the job. The screws originally in the center of these drums were removed, transverse baffles installed, and the ends of the drums effectively sealed so the only way water could enter the sewer was to pass through the holes in the screens. There was no possibility of overflowing drums delivering raw waste to the sewer. As a result of these changes, cleaning of the screens was made possible and a continuous, consistent job of screening of the sewage accomplished.

It was apparent that the only way to reduce the flow of water to the city sewer was to reduce the consumption of water in the various processes in the cannery. Without affecting the efficiency of the peeling, washing and cooking processes, this was possible only by reusing some of the water. In our cannery, a great volume of water is consumed in the process of cooling cans after cooking. This water is clean, since the cans to be cooled have just been through a water cook of at least one-half hour, and can be used very satisfactorily for many cannery operations such as the first wash of peaches following the lye peeling, washing grit from spinach, washing equipment and floors, and many such operations which, added together, total a considerable quantity of water. A 15,000-gallon tank was set up in the plant and all clean cooling water was piped to it, to be pumped as needed in the various operations mentioned above.

A third step in our 1943 program to relieve the load on the sewer was the change in certain types of equipment in the plant. A rotary-spray spinach blancher, which used an excessive amount of water and discharged spinach waste to the sewer, was replaced by a draper-immersion type. A single lye peeling line, used for peaches, was augmented by a second line. This added line reduced the strength of lye necessary in the peeler and the quantity of water necessary for washing after peeling because of increased efficiency in the washer. The water at the discharge ends of these washers is comparatively clean, so it was pumped back to wash the peaches as they were discharged from the lye peeler.

The fourth step was a very careful survey of the cannery to close all open drains at which fruit could be swept directly into the sewer, and installation of filtering screens at the discharge of all machines which usually discharge fruit and vegetable waste to the sewer. This last precaution may sound rather elementary, but a very careful survey of most plants will reveal many places where so-called "garbage" is sent directly from a processing machine (or the floor) to the sewer system. Likewise, it might be well to call attention again to the sump in the sewer line ahead of the first screen. This sump is large enough to allow the flow of cannery waste to slow down enough so that heavy suspended matter like sand will settle and be shoveled out during a lull in packing operations. The tonnage of solids taken from this sump was so heavy that it was necessary to install a mechanical elevator to remove it successfully. This was during the spinach packing season.

As a direct result of the projects outlined above, the flow of water from the cannery was reduced to such a level that the city sewer was able to take it away, even during the longest peaks. The cannery consumption of water was reduced almost 50 per cent. Likewise, there was never a complaint that anything other than soluble solids and very small particles of suspended matter were discharged to the sewers. For some washing operations in the cannery, we had always reduced the use of water to a minimum, but with reclaimed water we were able to use as much as the washing operation justified.

While it should be remembered that there was no economy in reclaiming this cooling water, since the construction and installation of the reclaiming system, added to the cost of operation, would show a cost for water in excess of that for fresh water purchased or pumped, the installation of this system did reduce the flow of water to the sewer to the point where the sewer could handle it. An entirely unexpected advantage was gained in that the flow of water to the sewer was evened out, or levelled off. Since a large part of cooking and cooling is done in closed retorts, the flow of this cooling water is not uniform. Even with carefully regulated cooks, it is very difficult to avoid emptying two or even three retorts at the same time. Of course, with no reclaiming system, which means with no holding system, this cooling water rushes out to the sewer and overloads it during these periods. This smoothing out of the load to the screening plant was a very distinct advantage and should not be underestimated.

While a great deal of progress had undoubtedly been made in this cannery toward successful handling of the plant wastes, the problem has by no means been solved. The final treatment of the solids in suspension and solution in the sewage from this cannery is placing an added load on the municipal sewer system and treatment plant, which has not been entirely satisfactory. However, a great deal of progress has been made. Probably no one would contend that any industry should be allowed to discharge "garbage" into a municipal sewer system, but, when the many complex problems that present themselves in successful sewage treatment are considered, it seems that an organization trained especially to meet such problems should be utilized. In the interest of efficiency, one plant should be set up to meet and solve the sewage problems of the community. If one industry in that community utilizes more than its share of the benefits from the treatment plant, some means of properly and justly charging that industry for the service should be devised, but in my opinion the general plan of waste disposal should be the same.

DISPOSAL OF WASTES FROM FRUIT AND VEGETABLE CANNERIES *

By W. S. Everts

Asst. Secretary, Canners League of California

The subject assigned to me is disposal of waste from food canneries, from the viewpoint of the food canning industry. This subject is not quite so broad as might be assumed as our organization, the Canners League of California, has to do only with canned fruits and vegetables and, at that, is confined to operations north of the Tehachapi. In passing, it might be well to state that the canning of meats, soups and other specialty items is not of great moment here in California as compared with fruit and vegetable canning.

The fruit and vegetable canners, like other manufacturers having waste materials, located in the early days primarily in the San Jose and Bay area districts. At that time many of the fruits and vegetables for canning were grown in Alameda and Santa Clara Counties, and, of course, we had not reached the large production which now exists in some of the tree fruits, such as pears and cling peaches, which are grown principally in the great central valleys. Nor had we increased, in other sections of the State, products requiring development of more acreage, such as tomatoes. The tomato crop for canning is expected to reach 1,000,000 tons this year, which will probably produce one-third of the pack of tomatoes and tomato products in the United States.

Some of the wastes up to a few years ago were sluiced into the rivers or the Bay and some of the canners located in the interior used the local sewer systems or hauled the material to convenient dumping grounds which, because of the small population, did not cause any trouble from a nuisance and health standpoint. With the growth of the canning industry and the increase in population, the matter of disposal of wastes became of more importance. In certain cities, such as Palo Alto, Stockton and Sacramento, the sewer systems could not accommodate the wastes from canneries, and in some instances where tomato packing was extensive, the disposal systems were affected by the acidity, small seeds and other factors inherent in the product. Even in hauling wastes from the canneries, difficulties have been encountered, because, as cities grew, convenient places for disposal could not be found.

Another factor that has affected the disposal of waste has been the growth of the individual canning plant. Only a few years ago canneries ran but one shift and most of the operations were performed by hand, especially in preparing cling peaches, apricots and pears for canning. Today all of these operations are mechanized and it is doubt-

* Presented at 17th Annual Meeting, California Sewage Works Association, Fresno, June 22–25, 1944.

ful if the general public realizes the advances that have taken place in the development of new machinery and the streamlining of operations in the preparation and canning of fruits and vegetables. It is a matter of steady flow utilizing machines and conveyors. Many of the larger concerns have abandoned smaller units during the past few years, have enlarged some of their other units, equipped them with all the latest mechanical devices and have run these units on a two or three shift basis. When a cannery operates on a twenty or twenty-four hour basis for a long period of time, the disposal of waste becomes a problem within the cannery itself and it must be streamlined and mechanized to keep pace with the constant increase in tonnage of raw materials handled.

A few years ago, the Fish and Game Commission brought to the attention of the industry the fact that canneries make arrangements for the screening out of all insoluble solids. Probably one of the factors that brought the dumping of waste forcibly before the public was the practice along the Sacramento and San Joaquin Rivers of dumping asparagus butts into the river and, in the case of the fresh shipping houses, other waste material such as that from celery, asparagus and other products. With the growth of bass fishing and other recreational uses of the rivers, people naturally did not like to have this material floating past them, and in some instances when the water was low, the material, through the action of the river, would gather at certain spots and cause obnoxious odors.

The Fish and Game Commission approached this industry with the idea of removing all insoluble solids. While their position was probably influenced somewhat by the general sporting public, especially fishermen, it had been found that in certain places around the Bay this material was affecting fish life along the shallow shore primarily from the standpoint of utilizing the oxygen in the water and causing the death of the smaller fish; also because of the effect this decaying material had on the crustacean and other small organisms upon which the smaller fish feed.

A year or two before the war the Canners League of California employed Mr. Cedric Macabee, Consulting Engineer, to make a survey and otherwise endeavor to work out some uniform methods whereby this waste disposal problem could be solved. In addition, the Western Regional Research Laboratory at Albany conducted experiments on asparagus waste with the view of utilizing this waste in the manufacture of by-products, such as feed, paper and other products. While these can be manufactured, it was found that the cost was prohibitive. Right now experiments are being conducted on the extraction of juice from the asparagus butts by reducing the juice to a syrupy form. Certain pharmaceutical concerns have become interested in this juice as a medium for growing various molds, such as Penicillin. At this time one cannery is operating on this project and expects to manufacture a supply, which will give the pharmaceutical houses a chance to ascertain the uses and cost of the material.

Canners were well on their way in designing and otherwise perfecting various screens, conveyors, bins, etc., which would enable them to handle waste materials. However, at the outbreak of the war it became impossible to procure such equipment so a great deal of this work has been held in abeyance. It will, however, be pushed along at a rapid pace at the conclusion of the war. As pointed out above, it is no small problem to screen out the material and dispose of it. Because of the large operations, this material must be brought to one point, screened and transferred to another point, such as a large bin where it can be carried away by specially built trucks. We are hoping, of course, that after the war some of the cities—especially Oakland, San José and other canning centers—will develop a system of sewage and waste disposal that will be able to take care of this material. This will take time and must be done on a large scale.

During the last two years some of the distillers have utilized the pear and peach wastes. We are hoping that this will continue, although cling peaches do not contain a very high percentage of sugar, the principal ingredient of value.

To date we have not been forced to consider the matter of soluble solids as canners in the East have, where waste disposal plants must often be operated in connection with the cannery itself. These are located primarily where operations are concerned with the canning of corn and peas, containing appreciable amounts of proteins and starches, and where both the solids and the solution must receive treatment.

The canning industry realizes that the disposal of these wastes is highly desirable from both a sanitary and esthetic standpoint. This industry has now reached an annual production of about 50,000,000 cases per year, utilizing approximately two million tons of raw material. We do not think that screening and disposing of waste material by truck at isolated points is the answer. All of this work of gathering and screening may result at some future time in profitable utilization of waste to the extent that the material will have some value, although in the case of fruits the possibility of by-product utilization seems very remote. These by-products are more cheaply and efficiently made by other products. It is, of course, our hope, especially in the larger cities, that sewage plants will be designed and built that will materially simplify handling of this material. The large increases in population in some areas will require much of this type of construction to care for increased domestic sewage flows. There is no question but that engineers interested in sewage works are giving very close attention to this type of construction, not only as a solution to the disposal of factory waste but as a means of giving postwar employment. Unless such wastes as cannery waste can be utilized efficiently and economically in the form of useful products, it would seem in the public interest to handle them through sewage disposal plants, by the cities and/or districts in which these plants are located.

DISPOSAL OF LIQUID WASTE FROM FISH CANNERIES, FROM THE VIEWPOINT OF THE FISH-CANNING INDUSTRY *

By Herbert C. Davis

Pres., Terminal Island Sea Foods, Ltd., Los Angeles, Calif.

Ever since the beginning of the industry in California, the disposal of wastes from fish-processing plants has been a major problem to the industry and to communities in which such plants are located. These liquid wastes run into very large volumes, and for many years merely ran into the bay or ocean waters immediately adjacent to the canneries. Many years ago this practice was prohibited by legislation, as the extremely high percentage of organic solids contained in these wastes presented a problem in pollution of public waters that was serious. This legal restriction caused all of the wastes, particularly in the Los Angeles harbor district, to be diverted into the municipal sewer system, putting an unusually heavy burden on that system.

In order to understand thoroughly the character of these cannery wastes, it is best that we segregate them into three groups and define them; at the same time, reference will be made to the volumes and nature of each.

In Group 1 is placed all of the water used in the cannery for unloading, fluming, transporting, and handling the fish through the cannery, together with the water used for cleaning up after the day's pack is finished. This is the group of wastes presenting the largest volume, and averages approximately 2,000 gallons per ton of sardines received at the plant. The water is substantially all salt water, which in itself is an added difficulty in any process for treatment or disposal. These wastes will contain approximately one-half per cent by weight of organic solids, both in suspension and in solution. The solids consist of blood, small particles of fish flesh, and small quantities of oil and fat. This amount of organic solids obviously produces a very high biochemical oxygen demand, and the presence of substantial quantities of oil and fat complicates any method of waste disposal which might be applied. In the course of a normal day in the Los Angeles harbor district, where 4,000 tons of sardines may be received and processed, there is a liquid waste from this one source of 8 million gallons.

In Group 2 is placed the bilge water from the fishing boats. This water should not be confused with the normal bilge water of oil tankers, cargo vessels, or other types of vessels, because of the peculiar construction and bilge usage of a fishing vessel. These waters consist primarily of salt water, which is added to the cargo in the hold for purposes of unloading, and contain chiefly small particles of fish, fish blood, fat, and sometimes substantial quantities of fish oil, as well as

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small amounts of lubricating and fuel oils. Formerly, these bilge waters were pumped from the boat into the harbor at the time of unloading. Recent regulations for the purpose of controlling pollution now require that these waters be pumped into the cannery sewer system and become part of the liquid waste disposal problem. The volume here approximates 400 gallons per ton of fish unloaded, adding another 1.6 million gallons to a normal day's load on the sewer system. These bilge waters will run as high as one per cent of organic solids, the bulk of which is soluble and not removable by screening.

In Group 3 is the material commonly referred to as "stickwater," but which is in fact the press liquors remaining after the oil has been separated from the liquors obtained through pressing the cooked fish for the purpose of producing oil and meal. Each ton of sardines produces approximately 1,000 pounds of press liquor, or 133 gallons. The average reduction plant in the fish industry handles about 10 tons of fish per hour, and the total amount of press liquor produced in an ordinary day by all of the canneries in Los Angeles harbor is at least 300,000 gallons. These liquors are extremely potent in that they average about six per cent solids, being almost entirely soluble and insoluble proteins; there is very little oil left in these liquors.

These three groups of waste, therefore, present a problem of disposal in volume and B.O.D. that is probably equivalent to the total sewage load of a community of several hundred thousand people. But this should not be of particular concern from your standpoint because, fortunately, the industry is making tremendous strides in converting the solids in this liquid waste into by-products, and in due time will leave only a large volume of practically clear water, which can be returned to the bays and harbors without further treatment. Thus, they will be removed entirely from the municipal sewerage system.

At Monterey and Los Angeles harbor practically all of the stickwater is being piped to a central plant, where it is treated for the recovery of the proteins and the extremely valuable vitamins which it contains. Today, therefore, in the main, stickwater or press liquors have been removed from the waste disposal problem.

Considerable research is under way at the moment, designed to perfect a method of coagulating and recovering all of the materials contained in the bilge waters and cannery wastes described under Groups 1 and 2. War conditions, which have interfered with obtaining the necessary materials, are preventing the installation, in practically every cannery, of the equipment necessary to recover as valuable by-products the bulk of the solids, oils, and fats contained in these waters. You may, therefore, look forward to a day shortly after the war when the effluents from the fish canneries will consist only of mixtures of fresh and salt water containing no suspended matter and only small quantities of soluble organic solids which will have such a low B.O.D. that they can be handled easily through any municipal plant or diverted directly to the waters of the State without presenting any problem of pollution.

DISPOSAL OF WASTE FROM BRANDY AND MOLASSES DISTILLERIES FROM THE VIEWPOINT OF THE INDUSTRY *

By E. M. Brown

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The problem of slop and waste disposal from wineries and distilleries has again developed into one of major importance to the industry. This problem has been further aggravated by the increase of slop beyond the usual distilling operations connected with the wineries due to the increased wartime fermentation and distillation of molasses and fruits and may be further increased by the processing and distillation of grains and potatoes.

For those not familiar with distilleries, the word "slop" designates the residue left after the alcohol has been distilled from alcoholic bearing liquids in the process of distillation. The slop from wine contains, besides traces of various alcohols, from 0.7 to 2.5 per cent of solids, of which 0.45 to 2.0 per cent are organic solids and about 0.2 per cent are suspended solids. The pH of such slop is from 3.7 to 4.0 and the oxygen consumed from 11,000 p.p.m. to 32,000 p.p.m. or even higher. "Winery waste" is a combination of tank washing and condenser waters plus lees and other residues combined with still slop and is six or seven times the volume of the still slop alone.

During 1933 and also in 1935–6 the State Bureau of Sanitary Engineering conducted a series of winery inspections in San Joaquin County covering the production and disposal of winery waste. From their investigations, they determined the population equivalent per ton of grapes crushed and converted to sweet wine to be 130, where 0.4 ton was utilized to produce brandy for fortification. At that time, over 110,000 tons of grapes were crushed in the Lodi District. This tonnage has increased since then. At that time most of the winery wastes were dumped into the Mokelumne River with the result that dilution by the river was inadequate and oxygen demand values rose in places in the river up to 17.2 parts per million.

In March, 1937, the Fish and Game Commission issued a report prepared by Paul A. Shaw containing the combined data of the Bureau of Sanitary Engineering, San Joaquin Co. Local Health District, which report showed the deleterious effect of stream pollution from winery wastes dumped into the Mokelumne River from adjacent wineries. As a result, wineries using the river for slop disposal were prohibited from doing so. This put a problem up to the wineries as to what to do with the slop. The most feasible and simple method under these emergency conditions was to dispose of the slop upon adjacent land,

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recognizing that this method of disposal was only a stop-gap until better methods of control could be brought about. A number of meetings were held at this time, attended by members of the Fish and Game Commission, University of California representatives and winery executives.

Realizing the extent of the problem, the representatives of the Fish and Game Commission agreed to await the results of a pilot plant which was to be operated co-operatively by the various wineries concerned. The various agencies interested, including representatives from the Davis Branch of the University of California, agreed to act in an advisory capacity, and it was hoped that the problem would be solved for the good of the industry. Unfortunately, due to certain influences, all work along this line was dropped, so the problem is now back in the hands of the wineries where it lies, practically unsolved.

When you realize that waste disposal in the Lodi District represents a load equal at times to a population equivalent calculated at 130,000 to 384,000 persons for a 90-day season, it can be realized that disposal may eventually be an expensive one for the distilleries.

The one favorable feature, especially under present conditions of high wartime prices, is that the still slop from wine distillation contains from 0.3 to 0.5 per cent of cream of tartar, a large portion of which can be recovered in the form of calcium tartrate. The recovery of this calcium tartrate along with the precipitation of a certain amount of organic substances reduces the oxygen consumed by a large amount, thereby simplifying, to a certain extent, our disposal problem.

There are apparently three main avenues of approach to the problem of waste disposal. They are:

(1) Land disposal, which is at present used by almost all the distilleries in California. If land disposal is preceded by the precipitation of tartrates as calcium tartrate, the O.C. may be lowered to as low as 5,000 p.p.m. in some instances but probably in most cases to around 10,000 p.p.m. In any case, untreated distillery slop deposited upon land tends to putrify after ten days or so, creating a very offensive odor. Such odor nuisance may cause depreciation of land values, making the winery liable. Also, there is a grave possibility of the slop percolating downwards into the subterranean water strata, causing it to become toxic and destroying adjacent vines or trees.

(2) Biological plus chemical treatment. During 1937 and again in 1939 the author and Dale Mills did considerable preliminary work on slop disposal. This work was published in mimeograph form by the Wine Institute. In the light of present knowledge, the processes in which lime was used to raise the pH to 7.5 or 8.0 should probably be preceded by the use of lime and calcium chloride to bring the pH to about 5.2 to 5.5 in order to precipitate the tartrates after which the solution could be raised to a pH of 7.5 or 8.0 to cause precipitation of a greater amount of organic solids. This would give us an effluent which our experiments indicate could successfully be handled bio-

logically on a trickling filter. At the present price of tartrates, such a process would pay its way.

(3) Evaporation. Most distilleries producing whiskey or grain alcohol use evaporators to dispose of their distillery slops. They are somewhat fortunate in that the residue from their still slops, which includes spent grains, has turned out to be an excellent live-stock food and returned interest on the investment, even though installation of such evaporators costs in the neighborhood of $100,000.

When it is considered that the average sweet wine winery crushing 10,000 to 12,000 tons annually will produce about 50,000 gallons of distillery slop daily, the erection of evaporators becomes a costly proposition. However, the results are positive. The waste problem is eliminated. In the erection of evaporators we have the experience of the whiskey distilleries to guide us and work done on this problem by the research department of one of the larger whiskey distilleries would indicate that similar machinery, with changes incorporated to recover the tartrates and the combining of the thickened slop with pomace as a stock or chicken-feed, will return interest on the investment. This evaporation setup runs into a greater financial structure than the smaller winery probably can afford and throws the whole problem of waste disposal, as far as the smaller wineries are concerned, into the realm of industrial economics.

THE VIEWPOINT OF THE CALIFORNIA DIVISION OF FISH AND GAME WITH RESPECT TO THE DISPOSAL OF INDUSTRIAL WASTES *

By Paul A. Shaw

Toxicologist, State Division of Fish and Game

The viewpoint of the Division of Fish and Game with respect to the disposal of liquid industrial wastes is, in a narrow sense, predetermined and fixed by our Fish and Game Code. This publication, familiar to many of you for information on seasons, districts, bag limits, etc., covers statutes passed by the State Legislature and signed by the Governor which relate to the conservation and preservation of fish and game. The activities of the Division must come within the provisions of this code and are fundamentally law enforcement.

It follows then that, as public servants, we are only enforcing the statutes given to us and are not in a position to modify or alter their provisions to suit the taste of sportsmen, industry or ourselves. If some of the laws are archaic, which we recognize, and do not meet the best interests of modern times, it is the responsibility of you and other people of the state to see that suitable changes are brought before the legislators.

Section 481, the only fish and game statute pertaining to the general problem of industrial waste disposal, should be considered with the above statement in mind. Many of you are acquainted with its provisions, but for the benefit of those who may not be, it reads as follows:

> Sec. 481, Fish and Game Code: "It is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this State, any petroleum, acid, coal or oil tar, lamp black, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material, or substance, or any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill or factory of any kind, or any sawdust, shavings, slabs, edgings, or any factory refuse, or any lime, any cocculus indicus,† or any slag, or any substance or material deleterious to fish, plant life or bird life."

It is evident from the above that these early legislators intended the Fish and Game viewpoint on pollution to be restricted to controlling all discharge to State waters, either directly or indirectly, of substances deleterious to fish, plant life or bird life. The most obnoxious odor, the severest menace to health, or the loss of a farmer's livestock from polluted water is not our concern. However, these damages are often coincidental to concurrent violations of the provisions of the above section.

Now, while the basis of Division activity is established by law, the purpose and policy as defined in Section 21.4 of our code is to conserve fish and game resources. To accomplish this goal of conservation

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† The berries of an East Indies plant very poisonous to fish life. Why this substance should be included in the law at all, particularly inserted between lime and slag, is indeed a mystery.

the enforcement action may take many forms other than court procedure. Applying this policy to Section 481 on pollution, the correction or prevention of a deleterious condition becomes of prime importance, while the imposition of a fine following court conviction is only important should it prove to be the best way to secure a correction or prevent a repetition of the violation. In this connection, the viewpoint of our Division is to place a much broader interpretation on the word "deleterious" than the actual killing of fish. We deem it to include any change in aquatic environment that will weaken or break a link in the chain of normal aquatic life. This thought is nothing more than insistence on a suitable standard of living for fish, bird or plant life so that an area remains suitable for the spawning, hatching, rearing and adult life of fish or birds and their food supply. With fish life in particular, it is important that an area be kept sufficiently attractive so that the better species do not migrate away and less desirable scavengers and rough fish move in to replace them. It becomes evident, then, that the basic policy of the Division of Fish and Game with respect to disposal of wastes is to prevent the occurrence or secure the correction of conditions inimical to aquatic life. Notwithstanding the desirability of minimizing bacterial contamination, this factor alone is of minor consequence in safeguarding fish life, but areas quarantined because of sewage pollution may concern us and require action where sludge beds, oxygen depletion or other deleterious factors are evident.

Health departments are charged with the obligation of enforcing the provisions of their codes, the objective being to protect public health. This objective, in contrast to that of Fish and Game, creates certain distinctions in interest, among these being the quarantine procedure. While the quarantine of a contaminated beach against swimming, or of designated areas against the sale of shellfish, may provide a reasonable degree of public health safety, it often fails to satisfy our requirements for wild life protection.

Applied to the protection of fish life, the quarantine method is obviously absurd. Can you imagine posting underwater signs such as:

"THIS STREAM POLLUTED BY CANNING AND DISTILLERY WASTES. MIGRATING SALMON PLEASE DETOUR TO SPAWNING GROUNDS ON SILVER CREEK, 15 MILES SOUTH."

Returning now to our subject of industrial wastes, it may be stated that the principal efforts of the Division of Fish and Game have dealt with control and proper disposal of industrial wastes due to their high concentration, toxicity and potential damage to fish or bird life. To accomplish our stated objective of maintaining clean waters that provide a normal aquatic environment, we believe that permanent and satisfactory corrections are best secured by co-operating with and maintaining the good will of industries. At the same time, it is essential to establish in the minds of industrial officials the necessity of control measures. To expand this idea, let me enumerate a few factors that are felt to create on the part of industry the dual attitude of a co-operative spirit combined with an active remedial program.

1. An industrial concern knows that good will is of utmost importance and that reputation, standing and sales volume are injured if they are publicly under fire through complaints and newspaper articles for creating an obnoxious condition. The enforcing agency, by stressing the value of maintaining public good will, can often gain more ground than by assuming a police attitude that invites antagonism. In this connection, there is a tendency for industry to minimize the value of recreational assets and they should bear in mind that some half a million residents purchase annual licenses with the expectation that suitable water conditions will be maintained for their favorite sports of fishing or hunting aquatic birds.

2. In some instances an industrial effluent contains material that offers possibilities to recover a by-product that will reduce waste disposal costs, and such a suggestion on the part of the enforcing agency is a duty as well as an effective weapon in promoting action.

3. The presentation of factual data on volume, concentration, toxicity and damaging effect of an industrial waste adds great weight to requests for improvement. Unless the deleterious character of a waste has been well established in the minds of the public and the industry, the need for remedial requests may be taken lightly. For this reason, unless requests are supported by factual data, industry has justification for assuming that we are just "throwing the book" at them. The added policy of being secretive with evidence when court action is contemplated also discourages good will and remedial action. For this reason it has been the Fish and Game policy to discuss the evidence with the defendant's attorneys before presentation in court.

4. The ability to make economical and practical suggestions relative to the probable type of treatment that may prove effective in giving adequate improvement in the effluent quality will further aid in securing industrial co-operation and action. However, it should be clearly brought out that the responsibility for correction and the final decision on method to be used lie entirely with the industry. Our statutes do not provide for a permit system or an organization for approving or assisting in the actual design of treatment works. In this connection, it is our viewpoint that an industry should secure adequate outside engineering advice unless they have competent men on their staff, and if desired, we will furnish the names of various concerns or persons who may be of help on their particular problems.

5. While preferring to work on a basis of co-operation and good will, we believe that an industry should never be allowed to forget that compliance with the law is essential—the essence of our position being fairness with firmness. If permitted, an industry will quickly assume the idea that correction can be ignored if the installations do not also result in a profitable by-product, or they seek to defer action indefinitely on the pretext of research and experimental studies looking toward a 100 per cent answer while practically ignoring already available procedures of lesser efficiency that are suitable for the situation. The enforcing agency must be on guard to combat these lines of thought.

6. Since co-operative efforts toward technically sound solution of disposal problems do not always dispel an antagonistic viewpoint and may fail to initiate remedial action, it is essential to have a trained and efficient enforcement staff to collect evidence necessary for proper court action. This group must also continue active enforcement by prosecution of types of violations where previous efforts have fully acquainted the public and the industry with a policy of strict enforcement. The ancient story that corrective measures will force the business to close its doors is well known, but the history and facts do not support this contention in any way. The loudest wailer is most often the one who subsequently points with pride to a successful corrective installation and emphasizes the contingent values and benefits that have accrued from it.

7. The continuation of routine patrol and inspection by both enforcement officers and technically trained personnel is of particular importance. Otherwise, operating employees, foremen and even managing officials may slip back into careless ways, permitting dangerous conditions to recur and adversely reflect on the efficiency of installations which should be satisfactory.

Now as to treatment procedures, in a broad sense the two terms "separation" and "exclusion" may be used to cover the majority of controls so far effected through the effort of our Pollution Detail. This would include principally the visible pollutants such as oil, mining silt, fruit, vegetable and fish plant solids, and certain others which contain floating or sludge producing material susceptible to separation and exclusion by one or more of the common procedures of land disposal, impounding, skimming, screening, settling, etc. This type of material must logically be removed as the first step in waste treatment and is further justified for first attention due to the damage caused and to the weight of public opinion in condemning its discharge to public waters. There have been, of course, many instances when wastes of a less visible character including acids, alkalis, metal salts, winery still slop, whey, etc., have created conditions necessitating immediate action.

The writer has intentionally refrained from any detailed discussion of methods of treatment applicable to different industrial wastes. The consulting engineers, equipment men and representatives from industry are able to discuss this subject adequately.

In conclusion, it is altogether possible that industry feels we have been somewhat overbalanced on the enforcement side, but it must be recognized that our Division is fundamentally one of law enforcement. In this connection, there have been, within our own organization, many struggles to secure an adequate technical staff and laboratory facilities. Undoubtedly, as control over the visible wastes becomes more complete, public opinion more demanding, and legislation more restrictive, a more concentrated program will be initiated to reduce the load of soluble organic wastes reaching state waters. When this time arrives the emphasis and need for a technical staff to further aid industry and our police force in promoting our policy of correction as opposed to imposition of fines, will become more evident.

DISPOSAL OF LIQUID INDUSTRIAL WASTES FROM THE VIEWPOINT OF THE BUREAU OF SANITARY ENGINEERING OF THE CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH—A LOOK TO THE FUTURE *

By C. G. Gillespie

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In objective, which is to escape complaints, rather than in technique, there is not much difference between disposal of sanitary sewage and industrial waste, and the words may be used interchangeably in this talk. The reason for now looking ahead in these disposal problems takes me back to World War I. As that war drew to a close, and for several years thereafter, there was a great upsurge in the people's way of living. New levels of pleasures, environment, sanitation and culture affected everybody.

Even out in the country people wanted water-flushed plumbing and cities wanted sewers. At once they all asked what should be done with the sanitary sewage and what the standards were for the State, just as you now ask with respect to disposal of industrial wastes. On the whole, the Bureau tended to avoid laying down arbitrary procedures and standards and preferred to see each case met on what might be considered good practice in that instance. But, to a certain degree, there were policies and sign posts by which to guide ourselves and others. For instance, streams were roughly classified as to the protection to be afforded them. Lake Tahoe was declared out of bounds for sewage disposal purposes. Sewer farm cropping was clearly defined and the Bureau had bases by which to judge plant designs. These and other simple policies naturally were adapted to still other conditions and they aided the planning a great deal. For this reason, and the receptiveness of California to good sanitation, the people have come a long way in improving sewage disposal. The curve has been rising and is still rising. But it must be admitted that many of the things done represented compromises and sometimes inadvisable concessions. So dissatisfaction over the results still prevails in many instances. This is especially noticeable amongst the sportsmen, but it will be found to some degree in almost every neighborhood in which sewage disposal is carried on.

Now that people are thinking of the end of World War II, even greater agitation for greater change should be expected than followed the previous war. Therefore, it is not too soon to gaze into the crystal ball for what lies ahead in the field of sewage disposal. What it seems clearly to tell is that people are more particular than in the past. In

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more concrete form, it is that people do not want to be offended or bothered by sewage or waste. That means that those who plan to operate sewage and waste disposal plants must be studiously conscious of what has been called the aesthetics of sewage disposal, but what more accurately amounts to the psychological reactions of people to it, and cities must learn to spend money where needed to avoid creating resentment.

The goal for a long time was simply bacterial removal and health protection. It was, and still is, a perfectly good objective, but the basis was not broad enough. People also protested the odors of sewage decay, while fishermen and recreationists began to deplore and then denounce stream pollution generally. The public became aware that such things were not really necessary and complaints mounted rapidly. In California, this led to new disposal areas and to various kinds of works to treat the sewage more completely than previously. Also, many cities went in for ornateness and architectural appeal in their sewage works. Parks and gardens were planted, or sometimes the place was merely screened with trees. All this was a wholesome thing to do. Though ornamentation did not actually lessen the odors, or improve the effluent, yet it showed that cities with sewage to dispose of were considerate of those who might otherwise be offended. Clearly it helped to ease one of the causes of resentment. When you think of it, it was really an admission that people wanted to escape from the thought of a sewage disposal neighborhood. That, I think, is the important new specification to realize in the disposal of sewage and industrial waste of the future. This change in the state of mind of the people is, of course, not unique in the matter of sewage disposal. People want clean air in their factories, clear water, clean restaurants and food establishments, no mosquitoes nor flies nor other insects, cleaner environment generally and less of everything that interferes with the comfort of their living. It behooves planners to take these manifestations into account.

Sewage disposal in the future must not only be right, it must look right and it must not offend any of the senses of the people, or it will miss its purpose. Planners, operators and all who are responsible must be more sensitive to the psychological side of sewage disposal. It is a study in itself in which few are naturally proficient. Health officers and engineers who make a life study of sewage disposal, and operators too, learn the psychology of people toward sewage disposal largely through the complaint route. Their advice and opinion should be sought.

Before long, it will undoubtedly be pertinent for the State Board of Public Health to try to give expression to such new objectives, not only as a matter of good leadership in the broad field of health protection, but because it is directly pertinent to do so in the exercise of the permit system for State control of sewage and industrial waste disposal. Such objectives must, of course, contain a good deal of elasticity, but this need not lessen their value as aids to technical workers who understand.

Today we might touch on a few concrete illustrations of the use of the principle that sewage disposal must be right, look right and not offend, or it will fail to give satisfaction. Take the very first item a city or an industry encounters—location and isolation of the sewage works or disposal area. There is a strong tendency nowadays to improve sewage treatment and lessen the need of the zone to buffer complaints around the area. Unfortunately, there is also the tendency to over-extol the perfection of the processes in this respect and, in consequence, sewage works are frequently placed where they encroach on an unwitting and, ultimately, an unwilling neighborhood. It is always right to improve sewage disposal so as to reduce its radius of damage and the land needs for plant isolation, but it is the unwise approach to take chances with complaints from the neighborhood. Industry, particularly, is aware that it costs money to live down a bad reputation. The better course is to acquire a site and choose a type of works that will rate well in that neighborhood. Even then, choose safe isolation, letting the encroachment, if there be any, come from the other direction—from the neighbors. The size of the site should be what is necessary to avoid offense to others who may work or live on the adjoining property. It is not an easy thing to decide. There is something about sewage disposal that makes it unpopular, even in a dairy country. That is an example of a reputation that must be lived down.

In the matter of clarity of effluent, it is a fact that the great volume of sewage and waste is merely settled or screened. To the layman, those effluents still resemble sewage, and they do not really satisfy the present-day public idea of sewage and waste treatment. This statement does not mean that there are not neighborhoods and problems which safely permit of so simple a treatment, but they are dwindling in number. It does mean that there are many other cases where failure to carry the treatment far enough still leaves dissatisfied the people who are concerned. This may even include the townspeople and their officers as well. Perhaps this latter observation is true even more often than we realize.

Undoubtedly, the future will see more use of the higher processes, not just for nuisance control, but for the cleaner and clearer looking effluents they produce. Even oxidized effluents will, in some cases in the future, as in the past, still not possess sufficient clarity to send to some waterways. Final clarifiers, and in fact the entire works, will undoubtedly need to be designed more conservatively. Often, only a little more extra effort and outlay would have hit the bull's eye. I believe that, increasingly, a real polished effluent and use of sand filters or equivalent will be needed to meet expectations fully.

No one nowadays thinks of putting raw sewage on sewer farms. That day went out long ago. But we have not made much progress in the use of higher pretreatment to improve land disposal. Many sewer farms still degrade the neighborhood because of the ugly conditions, the odors, and the unsavory reputation they spread over hundreds and sometimes thousands of acres. I predict that for sewer farm disposal, wastes will be processed more highly so that the farm will rate no differently from any other farm in that locality. When this is accomplished, it will put a fresh impetus on land disposal in the West and this change will still further improve our stream conditions.

Throughout the country, use of streams for drainage has almost axiomatically seemed a natural one to the great mass of people. But it is inconceivable that conditions such as prevail on the rivers at Stockton, Sacramento, Modesto, Redding and a few other places that might be mentioned will be tolerated, once the harbors of the State are cleaned up. If it be true that the generation ahead simply will not want to be reminded of sewage or pollution, or for that matter of ugliness generally, and will pay for cleanliness and sanitation, then it should be plain that the State cannot figure sewage disposal or use of streams for the purpose on the close margin of the past. The words "pollution" and "contamination" are assuming a more sinister and revolting sound to people all the time.

Take the little creeks or intermittent flow arroyos that drain through countrysides that are now growing up. Already, people along their banks are complaining about the sewage and the sludge in them. It might be well to recognize in the policy of the State that, if such waterways be used, the sewage must be fully oxidized, clarified and even filtered through fine sand.

Then, there are broad stretches where recreation and sewage disposal conflict. A prominent instance right now is the shoreline of Santa Monica Bay. It is not enough to remove the bacterial hazard or even the disgusting solids and grease that strand on such beaches. Neither the sand, the surf, nor the air should so much as draw the shore fun-lover to the thought of sewage. Recently, consulting engineers have reported on a $20,000,000 project to meet the situation. It is noteworthy that the plans provide for a certain degree of activated sludge treatment, largely I think to meet the rather inarticulate but real feelings of the people that the sewage works simply should not offend. Huge as is this sum, it will pay big dividends in the extension of seashore recreation to millions of people.

For a long time the State Board of Public Health has taken a broad view of its obligations to the people affected by sewage and waste disposal, and has been unwilling to grant permits over reasonable protests. The Board has felt that, in so doing, it is serving the interests, not merely of the neighborhood, but of its cities and industries as well, because a disposal works that goes in under such conditions has one strike against it before the start of operations. That such a policy is statesmanlike is evidenced from the fact that almost never do sewage disposal griefs appear in the courts, and almost never do cities or industrial plants forfeit their plant investments. It is well that cities have sustained the reputation of the Board for fair play in these matters.

The Health and Safety Code under which sewage disposal is regulated by the State requires that it be "necessary" to dispose of the sewage in the way proposed. This implies a broad legislative intent which will become more pertinent as the State grows. For just as we all foresee an industrial era in the west, so will wide areas now sparsely settled fill with cities. Already this process is going on in the Los Angeles metropolitan area and around San Francisco Bay. The idea of local disposal of the sewage of each community means increasing multiplicity of the sewage disposal woes of the region, and it puts greater value on handling the sewage not on local, but on regional lines. Thus, in such an area, the comparison between local and regional projects must be made carefully and realistically. The drawbacks against the individual city plant in that kind of a region are such that the necessity for it must be abundantly justified or it should not be adopted or allowed. In such a comparison of projects, values must be put upon many items that are highly intangible, not the least of which is good will. This is a study that clearly calls for talent intimately familiar with local levels of sanitation and aspirations and with this matter of psychological reaction to sewage disposal.

To those of you who may now be struggling with difficult problems in your plants, this paper may sound like the discussion of a policy that will multiply your troubles. Really, its end result is the opposite, for there are things that even the operator can do to lessen or avoid offense to the people in his neighborhood if he will study his plant and his people. Moreover, there are those who must plan the new works of the future and they must know where they are headed, if they are to avoid a greater multiplicity of waste problems.

I have barely touched on a subject germane to sewage and waste disposal, for, in some form or other, people's lives and modes of living will change rapidly after the war, and this will include their want for sewers and good waste disposal. With respect to standards of the future, the idea that sewage disposal must not offend, attuned to the psychological needs in each case, will be accepted and become the basis for engineering practice. This need not necessarily mean that practices will suddenly change and costs skyrocket. The trend however, will be for more costly sewage disposal, just as it is the trend with everything that makes for cultural and material improvement. More and more we shall have to have better sewage disposal to preserve the values, real and otherwise, in the people of the city and in the countryside concerned. As many an industrialist knows, it is far better to be somewhat ahead of the demands than to spend huge sums to recover from a bad reputation.

Discussion

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In general, industrial wastes may be disposed of separately or jointly with domestic sewage. The fundamental principles are the same in either case. Public interests are usually properly protected when no public nuisance or menace to health is created by the disposal.

It follows that the same reasoning should be applied to disposal of industrial waste as that used for domestic sewage disposal. The plant site should be selected to avoid or minimize offense to neighbors and the public. Treatment should be provided to the extent required by the effluent disposal whether to land or to a stream or body of water.

Some industrial wastes may be characterized by presence of toxic or poisonous substances, others may be heavily contaminated with disease organisms and still others may be offensive to sight or smell.

The Bureau always recommends a careful study of the industrial process to learn if liquid wastes can be reduced in quantities, reused in the process or otherwise controlled to limit the quantity and strength of the material reaching the sewers. The net cost of changes within the plant plus disposal may be less than the cost of construction and operation of treatment works for uncontrolled waste.

In any given case the disposal of industrial waste separately or combined with domestic sewage should be studied with an open mind. The municipal authorities and industrial plant officials should then analyze their respective problems and attempt to work out a solution.

No formula can be set up nor can a universal panacea for all the ills of industrial waste disposal be provided. With careful engineering study, common sense and good business judgement, it should be possible to solve most of our present day problems to the satisfaction of all parties concerned.

ORGANIZATION AND ACTIVITIES OF THE NATIONAL COUNCIL FOR STREAM IMPROVEMENT (OF THE PULP, PAPER AND PAPERBOARD INDUSTRIES), INC.

During the past twenty years the United States pulp, paper and paperboard industries have spent millions of dollars in improving the quality of effluents and wastes discharged into the surface waters of the country. Despite the expenditures of such vast sums of money, the industry's problem is still far from a solution. This unsatisfactory condition results from the fact that the attempts to solve the problem have been largely on an individual mill basis, in which the program has been developed primarily to meet local conditions and in most cases the experience of the individual mill has not been available to the industry at large. There is little doubt that a fractional part of the amount of money expended by the mills of the country in connection with the stream improvement problem during the past ten years would have been sufficient to set up a permanent organization to deal with the problem collectively on both an experimental and practical basis. Through elimination of duplicated effort and the development of a co-ordinated program the problem would have been much closer to a solution than is at present the case.

Recovery and utilization of material now generally wasted also presents an opportunity to the industry. The importance of this is indicated by the fact that, according to the Bureau of the Census, 6 per cent of the wood pulp, 14 per cent of waste fibre and 43 per cent of non-fibrous materials used in paper manufacture of 1939 were lost during processing. This phase of research alone justifies the institution of a co-operative broad-scale program.

The rapid technological advances in many fields of industry have resulted from just such co-ordinated research and development programs. Great progress in papermaking itself has come about through this procedure. Economy alone indicates the logic of such a proposal as duplication of effort is minimized and research on a sufficiently broad scale to achieve results is possible through this means of attack. To be considered also is the co-ordination of the multiplicity of factors involved in waste treatment, recovery and utilization. Not many single companies would care to undertake a properly integrated program of this nature as probably the main emphasis of their technological research would most advantageously be devoted to the development of their product. These and many other reasons indicate the advisability of the co-operative approach to research in connection with the industry's waste disposal and utilization problem.

Type of Organization, Officers, Executive Control

On April 22, 1943, an organizing committee met in New York and completed plans for formal organization of the National Council for

Stream Improvement (of the Pulp, Paper and Paperboard Industries), Inc. These plans were unanimously approved at the first meeting of the Council's Board of Governors on May 14, 1943, and the Council was set up as a nonprofit-making corporation, incorporated in the State of Delaware. Under the By-laws, executive control is vested in a Board of Governors elected annually by the membership with representation proportional to the dollar value of dues paid in by members manufacturing various products. An Executive Committee exercises the functions of the Board of Governors between meetings of the Board of Governors, subject however to the Board's control. A Technical Planning and Budget Committee, meeting at regular intervals, considers and acts upon matters requiring decision relating to budget control, technical research, and general business matters, all, however, subject to review and approval by the Executive Committee and Board of Governors. In all matters relating to direction of research the Technical Planning and Budget Committee's decisions will be made after due consideration of recommendations submitted by regional committees appointed from the membership. A schematic diagram of the organization is presented on the following page.

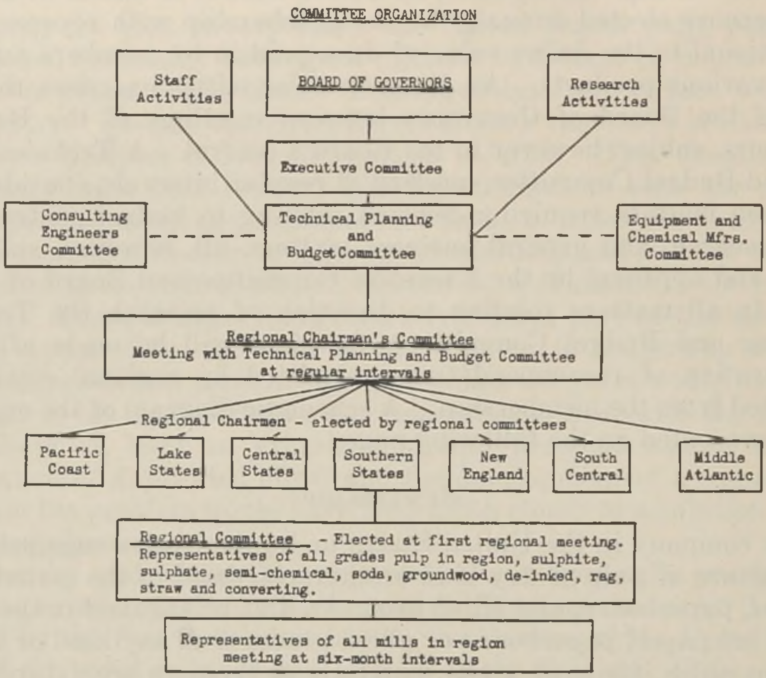
Membership

Any company in the United States or its territories engaged in the manufacture of pulp of any kind or character used in the manufacture of paper, paperboard, and allied products, and/or engaged in the manufacture of paper, paperboard or allied products of any kind or character from pulps, fibers or waste materials or from an admixture of the same, shall be eligible for membership in this corporation. Applications for membership obligates the applicant to pay such dues or assessments as may from time to time and for stated periods be fixed by the Board of Governors, and upon such conditions as the Board of Governors may from time to time prescribe, and shall state that the applicant agrees to abide by all of the provisions of the Certificate of Incorporation and of the By-laws of the corporation. Upon receipt of such application and the acceptance thereof by the Board of Governors or by such Committee as from time to time the Board of Governors may designate for such purpose the applicant shall become a member of the corporation

Executive Staff

Mr. Russell L. Winget, who has had a wide experience in the paper industry both in industry and in association fields, has been appointed Executive Secretary and will devote all of his time to National Council affairs.

Dr. Harry W. Gehm has been appointed Technical Advisor and will devote his entire time to Council matters with headquarters at the executive offices in New York. Dr. Gehm has had wide experience in the sanitary engineering and industrial waste treatment field. Previous to his connection with the National Council he was Research Associate in the Department of Water and Sewage Research of the New Jersey Experiment Station, New Brunswick, New Jersey, at the same time acting as Assistant Professor in formal courses in sanitary engineering at Rutgers University, New Brunswick. Dr. Gehm is well known to



technical personnel in the sanitary engineering field through his work in this connection, his membership in chemical and sanitary engineering organizations, and through publication of numerous technical articles on sewage and industrial waste treatment.

Activities

Arrangements have been completed with the Mellon Institute at Pittsburgh for an active and extensive research program concerning waste treatment recovery and utilization. All types of waste from the manufacture of the various products of the pulp, paper and paperboard industries will be included in the investigational plan. The Council's program provides for a number of projects at selected universities and other institutions as well as the work at Mellon. Institutions chosen for additional projects will be selected on the basis of their record of achievement and facilities available for attacking the specific problems at hand. As the plan encompasses both basic and applied research and development, institutions of proximity to the industries involved will be selected in most cases.

The Council's policy is to obtain the best possible scientific personnel to carry on this work. With this thought in mind men of post-doctorate and graduate engineering calibre will be assigned to the various problems. Dr. G. D. Beal of the Mellon Institute will direct the research and Dr. Harry W. Gehm will represent the Council's Technical Planning and Budget Committee in research activities. It is planned that advice and assistance in guiding the research program will be provided by consultants who will meet together with the Technical Planning and Budget Committee, the chairmen of the district committees, the Council's staff and representatives of Mellon Institute and will be called in on specific problems as needed. These will be men expert in the fields of waste treatment, water quality and any special subjects relating to waste utilization as may appear promising.

Close integration of research with the industry is a basic requirement for success of any broad-scale program. Such integration will be obtained by the Council through contact with committees representing the paper, pulp and paperboard mills in various regions of the country in which they are centered. Problems involving the individual mills will be discussed by their respective committees with the Technical Planning and Budget Committee and research staffs for submission to the research institutions. In this manner the individual mills will exert a balancing influence on the research program which should enhance its ultimate value to them. They will also be kept up to date on research developments by this direct contact with the Council's staff, and assistance will be given them by the staff in application of such of the research findings as may be suitable and acceptable to them.

Considerable knowledge has been accumulated concerning waste treatment by research and development work sponsored in the past by individual companies which are now members of the Council. Many of these firms feel that the interests of the industry in general will best be served if such data were made available for the use of all. Concurring with this thought they have opened their files on the subject to the Council so the staff and research institutions can examine and assemble the data and make them available to member mills interested in applying similar techniques. The Council will, therefore, through its Technical Advisor supply information to the mills, evaluate and report on such processes and developments which are of interest to groups of the industry and consult with them concerning its application as requested.

Help in selecting, applying and developing equipment and chemicals suitable for waste treatment will be provided in co-operation with companies employed by the mills. Through close contact with all aspects of the waste problem the Council will endeavor to be of as great a service to the industry as possible which will ultimately result in improvement of stream conditions and surface water quality.

Another of the Council's activities is to keep in touch with all agencies of similar interest for the purpose of exchanging information and following the progress of stream improvement efforts. The staff is agreeable to discussing problems and means for their solution with regulatory agencies. All inquiries and requests for technical information should be addressed to the Council's executive offices at 271 Madison Avenue, New York City.

Stream Pollution

A REVIEW OF PROPOSED NATIONAL WATER POLLUTION CONTROL LEGISLATION *

A number of factors have combined to mark the past decade as one of unusual activity in the field of water pollution control. Despite repeated attempts by health authorities to awaken civic interest, sewage disposal projects were generally not popular and failures to gain support for bond issues necessary for their construction were frequent. Then came the depression and with it an emergency need to provide employment at public expense. Public works programs became a sign of civic recognition of this need, and under this stimulus sewage treatment plants were provided in many cities.

In anticipation of Federal aid for construction projects, those concerned with water pollution abatement problems took an active interest in possible legislation which would further stimulate activity in this field of public works. It was recognized that many needed sewage treatment plants would fail to reach the construction stage, in part, at least, because of the failure of sponsoring communities to recognize their civic responsibilities in this field in competition with other more popular public works projects.

Because of the well recognized need for stream pollution control in the Ohio River Valley, it was logical that civic interest quickly developed into an active program at Cincinnati. In a resolution adopted by a committee of the Cincinnati Chamber of Commerce on June 8, 1934, it was proposed that sewage disposal facilities be made a part of any flood control or conservation projects proposed for the streams in that area. This action was followed by the organization of a Committee on Stream Pollution in the Cincinnatus Association in December, 1934, and the publication of a printed report in January, 1935. In May, 1935, the Health Committee of the Chamber of Commerce of Cincinnati, in a resolution, urged the other river cities of the Ohio Valley to join in a request to the Federal Government for aid in abating pollution.

In June, 1935, the Cincinnati Chamber of Commerce took definite steps to promote interest both in the pollution problem of the Ohio River and in possible national legislation. A Committee on Stream Pollution, under the chairmanship of Mr. Hudson Biery, was appointed and a comprehensive program of committee activity was soon underway. The first formal meeting of the Committee was held July 30, 1935, at which time the State sanitary engineers of Kentucky, Ohio, and Indiana reviewed the efforts which health authorities of those

* Prepared for the use of the Committee on National Water Policy, Conference of State Sanitary Engineers.

States were making to accomplish pollution abatement in the Ohio River. The committee concluded that the streams of the Ohio Valley were not intended to serve as sewers and that they should be restored to their proper use in the fields of public health, conservation, commerce, and recreation; and went on record as being in favor of providing for the necessary co-ordination of State effort in pollution abatement and of the drafting of such Federal legislation as might be necessary. By November, 1935, the committee had before it two proposed bills, one to establish a water treaty for the Ohio Valley for the control of future pollution, and one to establish in the U. S. Public Health Service a Director of Stream Purification responsible for developing means and methods for the elimination of stream pollution.

These preliminary drafts were somewhat revised and were formally presented in a committee report, December 24, 1935. The Ohio Valley Water Treaty bill was presented in a more completed form, and the proposed bill for Federal assistance was presented in two forms—one that proposed the creation of a Division of Stream Pollution Control in the Public Health Service and one which would place a similar responsibility with the Chief of Engineers, U. S. Army. In submitting these drafts of proposed legislation, the committee voiced the opinion that Federal legislation should provide for co-operation between the States and the Federal Government in regional planning but that the actual construction of projects would be done, for the most part, by the cities and by political subdivisions.

The Barkley-Hollister bills, introduced in the 74th Congress in March, 1936, were based on the recommendations of this committee.

When the Conference of State and Territorial Health Officers met in April, 1936, it expressed its position regarding proposed stream pollution legislation in a resolution dated April 14, 1936. This resolution is as follows:

"The committee on Stream Pollution of the Conference of State and Provincial Health Officers assisted by a technical committee composed of the chief engineers of several State health departments reviewed the legislation on the subject of stream pollution now pending before Congress and made the following recommendations relative to control of such pollution and the type of legislation which is believed would encourage and increase activities and will meet with the approval of the various interested groups:

"1. That there be established in the Public Health Service a Division of Stream Pollution Control.

"2. That this Division should co-operate with the agencies of the several States authorized or designated by law to deal with water pollution.

"3. That the Division should encourage co-operative activities by the several States in the enactment of uniform laws relating to water pollution and in the formation of compacts for its control.

"4. That provision should be made, upon such terms as the President may prescribe, for grants-in-aid and/or loans to civil subdivisions of States and loans to private corporations for the construction of necessary remedial treatment works.

"5. That there be appropriated annually to the Public Health Service $300,000 for studies, development of comprehensive plans, and administration of grants-in-aid, and that for a period of ten years there be appropriated annually $700,000 for allotment to States to carry out the necessary promotion, investigative and supervisory work in stream pollution."

This resolution was followed by the introduction of a bill by Congressman Fred Vinson which incorporated the acceptable parts of the Hollister Bill, and at subsequent hearings the support of the Hollister Bill was transferred to what was now known as the Barkley-Vinson Bill. This bill might have become a law had opposition not developed on the part of those who favored Federal regulation of stream pollution.

Senator Augustine Lonergan of Connecticut had sponsored a Washington conference on stream purification problems, which had been held in the office of the Secretary of War, George H. Dern, on December 6, 1934. In a letter dated November 22, 1934, to the Surgeon General, extending an invitation to the Public Health Service to be represented at this conference, it was stated that while "originally it had been planned to call for a congress of representatives from all states but because of the necessity for prompt action before the 74th Congress convenes in January . . . it has been decided to limit the first conference to a group of experts and leaders who are believed to represent a cross section of the general views of the entire country on this subject."

This conference, attended by more than thirty, did much to center Congressional interest in Federal legislation in the field of stream pollution control. A committee of five, appointed to draft plans for legislative procedure, failed to agree and majority and minority reports were filed.

The majority report did not favor an attempt to secure legislation which would provide for the assumption of Federal control of stream pollution irrespective of State consent, but did favor legislation which would provide for unified Federal leadership. The minority report asserted "the supremacy of the Federal jurisdiction of the interstate navigable waters and of the tributaries thereto from which pollution is carried or washed into navigable portions of the streams."

Subsequently, a bill providing for Federal water pollution control was introduced by Senator Lonergan and, in the resulting conflict of views, no legislation was enacted.

These conflicting opinions regarding the merits of State versus Federal control have been reflected in the many bills which have been subsequently introduced in the Congress. The bills individually are not of particular interest but, insofar as they reflect the somewhat conflicting policies of sponsoring groups, a brief review will give perspective to the present.

One group, anticipating difficulty in securing sufficient local or State support to obtain local legislation for the control of stream pollution, believes that a correction of stream pollution should be effected by a transfer of control from the State to the Federal Government. This group includes many who are interested in the objective of an immediate abatement of all stream pollution and who regard the past failure of States to secure pollution abatement to be a sufficient reason for a change in what may be regarded as fundamental governmental procedure.

The other group recognizes the need for Federal leadership in water pollution control but does not believe that pollution abatement will be expedited by centralizing control in the Federal Government. This group recommends the development of a Federal-State relationship that would foster a democratic procedure which would educate the individual citizen to demand through his local government the betterments that can be had when the majority favors the improvement. The Federal Government would assist States in the development of procedures, including interstate compacts to carry forward projects not confined to single States, and, by financial assistance, aid in expediting local action on urgently needed improvements.

In general, those experienced in matters relating to stream pollution abatement recognize the soundness of a program that requires that there be public support for pollution abatement as opposed to the Federal regulatory type of legislation.

In a hearing on bills before the 75th Congress, held in March, 1937, Mr. Adolph Kanneberg, Chairman, Wisconsin State Committee on Water Pollution, clearly developed the difference in the two approaches to pollution control by stating that one bill proposed to enlist Federal aid in the control of water pollution and the other was directed to the enlistment of Federal authority to prevent pollution—one bill would aid State authority and the other would make the Federal Government responsible for the prevention of pollution.

A bill providing the type of legislation favored by the Conference of State and Territorial Health Officers (H. R. 2711, 75th Congress) was later passed by both Houses of Congress only to be vetoed by the President due to certain administrative procedures contained in the bill. The Presidential memorandum of disapproval, dated June 25, 1938, is as follows:

"I have withheld my approval of H. R. 2711, an act to create a Division of Water Pollution Control in the United States Public Health Service, and for other purposes.

"This bill authorizes the appropriation of $300,000 for administrative expenses of the Division of Water Pollution Control, $700,000 for expenditure by State health authorities for the preparation of project requests, and, in addition, such amounts as may be necessary for loans and grants-in-aid of States, municipalities, public bodies, or individuals to carry out projects for treatment works to prevent water pollution.

"I appreciate the importance of the results sought to be accomplished by the legislation and I fully approve the establishment of a Division of Water Pollution Control in the Public Health Service. This bill, however, provides for the direct presentation, through the Secretary of the Treasury, of the recommendations of the Surgeon General for the authorization of Congress of specific projects to be carried on under the loan or grants-in-aid provisions of the bill, without any opportunity for review by the Chief Executive.

"Thus, this bill provides for the legislative assumption of responsibilities of the executive branch, and, therefore, runs counter to the fundamental concept of our Budget system that the planning of work programs of the executive agencies and their presentation to Congress in the form of estimates of appropriation is a duty imposed upon the Chief Executive and not one for exercise by the legislative branch.

"I am convinced that appropriations for projects of this character should be based upon estimates submitted in the annual Budget. Only in this way can the merit of such projects be considered in their proper relation to the merits of other projects of a similar nature, and all of these projects be then considered in their relation to the needs of the other Government activities that are presented for incorporation in the annual Budgets."

The administrative policy of the Federal Government is more clearly defined in the message of the President to the Congress on the subject of Water Pollution Control, submitted on February 15, 1939. This message was as follows:

"The last Congress recognized the national importance of pollution abatement in our streams and lakes by passing during its closing days an act providing for the creation of a Division of Water Pollution Control in the United States Public Health Service and for the establishment of a permanent system of Federal grants-in-aid and loans to assist in constructing pollution-abatement projects. Although fully subscribing to the general purposes of that act, I felt compelled to withhold my approval of it because of the method which it provides for the authorization of loans and grants-in-aid. It would have prevented the consideration of such appropriations as a part of the annual budget for all purposes. My reasons are set forth in detail in my memorandum of June 25, 1938. I hope that at this session the whole problem of water pollution may again receive your attention.

"To facilitate study of the problem by the Congress I am transmitting a report on Water Pollution in the United States, which outlines the status of pollution, the cost of bringing about a reasonable degree of abatement, and the financial, technical, and administrative aspects of such a program. The document was prepared at my request by a special advisory committee of the National Resources Committee composed of representative experts from the Departments of War, Treasury, the Interior, Agriculture, and Commerce, and from private and State agencies.

"No quick and easy solution of these problems is in sight. The Committee estimates that an expenditure by public and private agencies of approximately $2,000,000,000 over a period of 10 to 20 years may be required to construct works necessary to abate the more objectionable pollution. Inasmuch as the needed works are chiefly treatment plants for municipal sewage and industrial waste, the responsibility for them rests primarily with municipal government and private industry. Much construction work is in progress. Many State agencies have forced remedial action where basic studies have shown it to be practicable.

"Unprecedented advances in cleaning up our streams have been made possible by the public works and work-relief programs during the past 6 years. The report states that more progress has been made in abatement of municipal waste during that period than during the entire 25 years preceding, chiefly as a result of Federal financial stimulation. As in many other fields of conservation, great improvement in the Nation's basic assets of water has been incident to the fight against unemployment. If this construction work is to continue at a substantial rate and if the necessary research, education, and enforcement activities are to be carried out most effectively, the Federal Government must lend financial support and technical stimulation.

"It is my opinion that pending further experimentation with interstate and State enforcement activities Federal participation in pollution abatement should take the general form of establishing a central technical agency to promote and co-ordinate education, research, and enforcement. On the basis of recent experience, it should be supplemented by a system of Federal grants-in-aid and loans organized with due regard for the integrated use and control of water resources and for a balanced Federal program for public works of all types. The time is overdue for the Federal Government to take vigorous leadership along these lines."

Several water pollution control bills have been introduced in the current session of Congress (78th Congress). Senate Bill S. 186 was introduced by Mr. White (for himself and Mr. Brewster, both of Maine) on January 7, 1943. A companion bill, H. R. 98, was introduced by Mrs. Smith (Maine) on January 6, 1943. Comments on these bills, prepared by the Public Health Service, under date of January 27, 1943, are as follows:

"The bill (and its companion bill H. R. 98 introduced in the House on January 6, 1943, by Mrs. Smith and referred to the Committee on Rivers and Harbors) in its major aspects is consistent with several other measures of the same type introduced in previous sessions of the Congress during the past several years."

Senate Bill 186 was referred to the Committee on Commerce and H. R. 98 was referred to the Committee on Rivers and Harbors. These bills are essentially identical and provide for the fixing of standards of water quality by Federal authority. They further provide that a failure to maintain the standards of water quality shall constitute a "public and common nuisance." It is further provided that after three years the Federal Government shall take action in court to abate such nuisance as may exist due to a failure to maintain these standards of water quality. It is anticipated that this type of legislation would have the support of the proponents of Federal water pollution control.

On March 22, 1943, Mr. Spence introduced H. R. 2251, which was referred to the Committee on Rivers and Harbors. This bill, unlike Senate Bill 186 and H. R. 98, makes no provision for Federal control of water pollution but does conform to the general type of legislation that recognizes State and local responsibility in water pollution abatement programs. Later, on May 3, 1944, Mr. Spence introduced H. R. 4741 which revises H. R. 2251 to provide for the planning of postwar works for the abatement of water pollution. This bill has also been referred to the Committee on Rivers and Harbors. A companion bill, S. 1989, was introduced by Senator Alben W. Barkley on June 8, 1944, and referred to the Committee on Commerce.

These bills (S. 1989 and H. R. 4741) are in their major aspects consistent in principle with proposed water pollution control legislation which has received favorable consideration by the Congress but with revisions incorporated for the purpose of eliminating the objections to budgetary procedures outlined in the Presidential memorandum of disapproval dated January 25, 1938, with reference to H. R. 2711 (75th Congress), previously noted. They provide for the further development of Federal-State co-operation to include assistance in the promotion and planning of needed sewage treatment projects for postwar construction. The importance of planning the structures necessary for the proper control of stream pollution well in advance of construction and the development of local interest in and support for pollution abatement programs have been emphasized. It is proposed that immediate grant-in-aid be provided to municipalities on the recommendation of State health departments for the purpose of preparing engineering reports, plans, and specifications for postwar construction, and that authorization be given for Federal appropriations not to exceed $50,000,000 for grants-in-aid or loans on a 50–50 basis for postwar construction.

THE OPERATOR'S CORNER

REGULATION OF SEWER USAGE

It has been said that "sewage treatment begins in the sewers," which statement contains a good deal of fact. There is certainly no question but that many problems of sewage treatment can be eliminated or partially solved by the proper regulation of the usage of the sewage collection system. Even more important, perhaps, is the improvement which would result in service to the public if such control were exercised intelligently and with care. Without proper control, a public sewer system cannot render completely satisfactory service; it becomes a hazard to the public safety and entails a substantial waste of funds used for original and corrective construction.

The municipality is empowered with full authority to regulate and control the use of sewers and drains within its corporate limits. The too frequent reluctance of the municipal official to accept this responsibility may be a result of his failure to understand its importance and, if this is the case, there is a selling job to be done by those who are responsible for the operation and maintenance of the system.

The first requirement for proper regulation is an ordinance which prescribes clearly and completely which wastes may be discharged to the sanitary and storm sewer systems and, just as important, which wastes may *not* be discharged to either or both systems. Among the major items to be included in the ordinance are:

1. The requirement that the public sanitary sewer system be used by all properties within a reasonable distance of its laterals.
2. A clear definition of the wastes which constitute sanitary sewage and the requirement that such wastes be discharged *only* to the sanitary system.
3. The requirement that surface waters from roofs, yards, etc., be discharged *only* to the storm sewer system.
4. The prohibition from any public sewer or drain of inflammable, explosive, corrosive, or toxic wastes.
5. The prohibition from any public sewer or drain of wastes containing or capable of causing solids to deposit therein.
6. The requirement that suitable preliminary treatment facilities at commercial and industrial establishments be provided and properly maintained. This should include recommendations covering acceptable grease traps, oil receptacles and grit basins for common business services such as restaurants and filling stations. The ordinance should, however, be sufficiently comprehensive to cover any industrial waste of unusual strength or character and limiting values for B.O.D., suspended solids, pH and temperature might well be specified.
7. Provision for suitable inspection and testing of all new service connections. An inspection fee is commonly set forth in the ordinance as well as the proper inspection and testing procedures.
8. Provision for enforcement of all sections of the ordinance with the establishment of heavy penalties for violations.

Where a combined sewer system is to be controlled the ordinance will, of course, not provide for the separation of sanitary sewage and surface waters. The ordinance should be adapted to meet the local situation insofar as possible and there should be no hesitancy in amending it to conform with changing circumstances.

Receipt recently of several requests for copies of ordinances for guidance of those engaged in preparing such regulations indicates that there is a definite need for a "model" form, and the writer has suggested this as a project for the Sewage Works Practice Committee of the Federation. In the meantime, the writer will be glad to have copies of any ordinances which are proving to be successful, in order that we may be able to assist those who seek help in drafting sewer control regulations.

Passage of the ordinance, though it may be flawless, is not sufficient in itself to attain the desired results. There must be constant vigilance to achieve full compliance; there must be firmness in denying requests for individual favors in some cases; there must be conscientious and rigid inspection and testing and, above all, there should be no tendency to avoid imposition of penalties when reasonable opportunity has been allowed for compliance to be effected. Co-operation is nearly always forthcoming if a detailed explanation of the violation is given with the first notice and if recommendations are made as to how the violation can be corrected. It is best to administer the ordinance in a spirit of co-operation but there will always be some persistent violators who must be taught the hard way—by means of the penalties.

Do not delay in approaching this problem if there is need of better sewer system control in your community. Elimination at the source is the best way to handle the oil, chicken feathers, excess surface water or what have you, that is causing extra work and expense at the treatment plant. When the sewer system does rebel against maltreatment it usually does so when a maximum of damage and inconvenience will result and often takes a life or two in addition.

Finally, if your city has an ordinance in force, send us a copy for our reference files.

W. H. W.

SEWAGE TREATMENT BY THE GUGGENHEIM PROCESS AT ANDERSON, INDIANA *

By R. R. Baxter

Superintendent of Sewage Treatment

The Guggenheim Process sewage treatment works at Anderson, Indiana was completed and placed in operation in June, 1940, at which time the population of the city was 41,600. The design capacity of the plant is 8.0 m.g.d.

* Presented at 17th Annual Meeting, Central States Sewage Works Association, Oshkosh, Wis., June 22–24, 1944.

The two primary sedimentation tanks are rectangular in shape and are equipped with Link Belt, flight type sludge collectors. The tanks are 40 feet wide, 10.5 feet deep and 106 feet long, affording a combined detention period of 2.0 hrs. at design flow. The primary effluent passes through a flume at the rear of the Administration Building where the chemical dosage is introduced. From this point on to the aeration tanks, sufficient air is applied in the channel to effect thorough mixing and to prevent deposition of solids.

There are two aeration tanks, each consisting of two channels, 22 feet wide. The tanks are 106 feet long and provide 1.9 hrs. detention at the design rate of 8.0 m.g.d. Aeration is effected by Chicago swing diffusers.

Fig. 1.—Administration Building, Moss Island Sewage Treatment Plant, Anderson, Indiana.

The two final sedimentation units are 90 feet in diameter and 8 feet deep at the periphery, affording 2.3 hrs. detention at the design flow. These tanks are equipped with Link Belt circuline sludge collectors.

Sludge handling facilities include a thickening tank, 12.5 feet by 16 feet by 24.5 feet deep; one 65-ft. digester equipped with a P.F.T. floating cover; vacuum filtration equipment and an incinerator of the multiple hearth type.

The treatment works is located on a 64-acre plot of ground at the west edge of the city.

In January, 1943, the incinerator was out of use due to mechanical breakdowns and the sludge filter cake was being conveyed by truck to suitable dumping places on the grounds. The expense of operating the vacuum filters and the inconvenience of handling the filter cake were so excessive that serious consideration was given to some other method of handling the sludge.

In March, 1943, use of the vacuum filters was discontinued in favor of pumping liquid sludge from the digester through a 2½-inch fire hose and discharging it on the grounds about the plant. This was more or less an experiment and considerable anxiety was expressed over the likelihood of creating objectionable odors. After some time it was proven that objectionable odors were not encountered and that the experiment was worth continuing. It was then decided to install an underground iron pipe to replace the hose, which was rapidly deteriorating from the continued use. One does not have to draw upon his imagination to observe that this method of sludge disposal effected a substantial saving in cost over the sludge conditioning, filtering, hauling or burning. This present method of sludge disposal appears to be proving both satisfactory and economical.

It is our practice, when possible, to return approximately 20 to 25 per cent of the flow from the final tanks to the aeration tanks, wasting

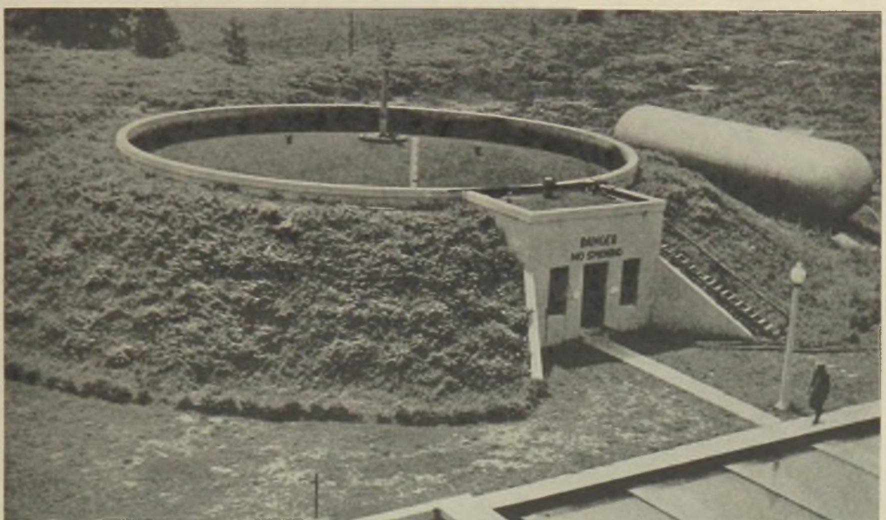


FIG. 2.—Sludge digestion and gas storage tanks, Moss Island Sewage Treatment Plant, Anderson, Ind.

sufficient sludge to maintain the solids between 1,300 and 1,400 p.p.m. in the mixed liquor. The floc in the aeration tanks takes on a dull red color from the ferric sulfate, this being the principal chemical used in the Anderson plant.

Considerable experimental work has been carried on to determine the optimum suspended solids concentration in the mixed liquor. Concentrations ranging between 500 p.p.m. and 2,000 p.p.m. were studied and it has been concluded that best results are obtained with concentrations in the order of 1,300 to 1,400 p.p.m.

The required dosage of ferric sulfate is quite variable and frequent checks are made on the feed rate. Dosages range from 2 p.p.m. to as high as 6 p.p.m. as Fe. The average dosage during the past 17 months has been 3.6 p.p.m. as Fe.

Lime is used occasionally in the primary settling tanks, but only on rare occasions and then only in quantities sufficient to control the pH of the primary effluent. An effort is made to maintain the pH of the primary effluent at 7.6.

TABLE 1.—*Operating Data, Anderson, Indiana*

(17-Month Period Ending May 31, 1944)

Month	Sewage Treated (M.G.)	Detention Periods (Hours)			Applied Air (Cu. Ft. per Gal.)	Chemical Dosages			5-Day B.O.D. (P.P.M.)			Suspended Solids (P.P.M.)			Sludge Index
		Prim.	Aeration	Final		Lime to Primary		Ferric Sulfate as Fe (P.P.M.)	Raw Sewage	Primary Eff.	Final Eff.	Raw Sewage	Primary Eff.	Final Eff.	
						Days	Lbs. per Day								
1943															
January	6.04	2.6	2.3	3.0	0.54	—	—	5.1	166	72	15	246	80	46	45
February	6.58	2.5	2.2	2.8	0.55	—	—	4.4	—	—	—	—	—	—	44
March	7.52	2.2	2.0	2.6	0.54	—	—	3.4	322	66	9	215	115	59	30
April	6.90	2.3	2.0	2.6	0.55	—	—	3.6	165	75	13	249	65	29	52
May	7.78	2.2	2.0	2.5	0.54	—	—	4.5	158	71	10	209	79	32	39
June	9.12	1.8	1.6	2.0	0.43	18	366	3.0	222	86	12	220	68	22	41
July	8.04	2.0	1.9	2.3	0.45	2	350	4.4	131	53	15	230	83	30	39
August	7.72	2.1	1.9	2.4	0.48	24	908	4.2	111	55	18	192	66	22	44
September	8.57	1.9	1.8	2.2	0.51	25	131	3.7	188	77	21	255	67	19	64
October	13.67	1.2	1.2	1.3	0.25	17	788	3.9	152	37	13	358	73	27	53
November	13.99	1.1	1.1	1.3	0.26	6	983	3.2	109	41	10	227	57	23	41
December	10.25	1.6	1.5	1.8	0.34	—	—	4.4	133	48	11	220	67	19	42
1944															
January	8.07	2.0	1.8	2.3	0.39	—	—	4.4	146	60	15	245	64	21	42
February	9.29	1.8	1.7	2.0	0.44	—	—	2.8	148	58	16	271	82	17	40
March	11.34	1.4	1.4	1.6	0.30	—	—	2.0	108	42	12	194	80	18	31
April	9.51	1.8	1.7	2.1	0.34	—	—	2.7	112	44	11	155	65	18	34
May	10.90	1.5	1.4	1.7	0.27	—	—	2.2	133	53	11	214	82	18	45
Average	9.13	1.9	1.7	2.1	0.42	15	588	3.6	157	59	13	233	75	26	43

TABLE 2.—*Removal of 5-Day B.O.D. and Suspended Solids, Anderson, Indiana*

(17-Month Period Ending May 31, 1944)

Month	Per Cent Removal 5-day B.O.D.			Per Cent Removal Suspended Solids		
	Primary	Secondary	Over All	Primary	Secondary	Over All
1943						
January	57.0	79.0	91.0	67.0	42.0	81.0
February			90.0			85.0
March	79.5	86.3	97.2	47.4	56.6	72.5
April	54.5	82.7	92.1	73.9	55.4	88.3
May	55.1	85.9	93.7	66.2	59.5	84.7
June	61.2	86.0	94.6	69.1	67.6	90.0
July	59.6	71.7	88.6	63.9	63.8	86.9
August	50.5	67.3	83.8	65.6	66.6	88.5
September	59.0	72.7	88.8	73.7	71.7	92.5
October	75.7	64.9	91.4	79.6	63.0	92.5
November	62.4	75.6	90.8	63.0	59.6	89.9
December	63.9	77.1	91.7	69.5	71.6	91.4
1944						
January	58.9	75.0	89.7	73.9	67.2	91.4
February	60.8	72.4	89.1	69.7	79.3	93.7
March	61.1	71.4	88.9	58.7	77.5	90.7
April	60.7	75.0	90.1	58.1	72.3	88.4
May	60.1	79.3	91.7	61.7	78.0	91.6
Average	61.3	76.4	90.8	66.3	65.7	88.2

The sewage at Anderson contains, in addition to the sanitary sewage of the city, the industrial wastes from a greatly diversified line of manufacturing. These wastes include steel mill pickling liquor, chrome plating wastes and considerable quantities of pickling liquor from an aluminum forging plant, along with the wastes from a packing plant and a canning factory. Also, there are wastes from a sodium silicate manufacturing plant.

Operating data and plant efficiency during the 17-month period ending May 31, 1944, are shown in Tables 1 and 2. The unusually high removal of B.O.D. and suspended solids in the primary sedimentation tanks will be of interest, this being probably due to the chemical precipitation effect of certain of the industrial wastes contained in the raw sewage. Attention is also directed to the lime used for pH control at the primary tanks in the summer and fall of 1943, when cannery wastes brought about acid conditions in these units.

Operation costs, including operating and maintenance labor, chemicals, heat, light and power, for the 17-month period since Jan. 1, 1943, were $17.73 per m.g. of sewage treated or $15.85 per 1,000 lbs. of 5-day B.O.D. removed. The cost of chemicals during the same period averaged $2.01 per m.g. of sewage.

OPERATION OF DIFFUSED AIR ACTIVATED SLUDGE SEWAGE TREATMENT PLANTS SERVING ARMY CAMPS *

By John E. Koruzo

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The treatment of army sewage has presented problems somewhat different from those encountered in municipal treatment plants. Army sewage is comparable in B.O.D. values to that received at municipal treatment plants which are served by separate sewer systems, but army sewage lacks the industrial organic and inorganic loadings contributed to municipal plants. Inorganic loadings, being chemical and usually settleable, have aided in eliminating organic matter and grease by sedimentation in municipal plants. It is evident, therefore, that the carbonaceous and nitrogenous substances present in purely organic sewage have complicated problems of sewage treatment at army posts. The most objectionable phases of decomposition are represented in carbonaceous substances of raw sewage and require accelerated oxidation for stabilization. Army treatment has also been complicated by population fluctuations, wide variations in sewage flows, and the delivery of pyramided B.O.D. loadings to the accompaniment of excess grease loadings, all at the same time. These are the times when inorganic or chemical loadings would be welcome to expedite chemical reactions and help remove grease by sedimentation. However, since these elements are lacking, we leave it to the guidance of a Good Providence to correlate the aeration, sedimentation, and detention requirements to produce effective stabilization.

General

Raw sewage, after entering the plant through grit chambers, screens or comminutor, is pumped or conveyed by gravity to primary sedimentation basins where the beginning of the anaerobic cycle takes place. The primary sludge is then conveyed to the sludge digesters where the cycle is completed. The primary detention period is usually from three quarters of an hour to one hour. This treatment will not remove the fine solids that will not settle and those dissolved in the water, so the liquid is conveyed to aeration tanks where the aerobic cycle of oxidation and nitrification is completed to the degree required by the condition of the receiving stream. This is the beginning of the activated sludge process.

Activated sludge is the rapidly settled sludge obtained from the constituents of sewage which has been agitated in the presence of abundant oxygen. It is composed of clumps of amorphous matter upon

* Paper presented at the Twelfth Annual Short Course in Water and Sewage Treatment, Daytona Beach, Florida, May 18, 1944.

which numerous microscopic plants and animals live and multiply. An efficiently operated activated sludge plant must have the following provisions:

1. Sufficient oxygen, which is supplied to army plants in this area by air compressors.
2. Sufficient contact time for the microscopic organisms to complete the cycles of oxidation and nitrification.
3. Continuous mixing and agitation of the mixture of activated sludge and sewage. This is accomplished in army plants by the same equipment that supplies air to the aeration tanks.

It takes from 48 to 72 hours to build up a healthy activated sludge. This means a continuous aeration and detention of the sewage during this period, so it is evident that it would not be practicable nor economical to treat all the sewage received at a sewage plant on this basis. Therefore, the purification cycle is accelerated by a continuous return of "seed" or activated sludge from the final sedimentation tanks to the inlet of the aeration tanks, to be mixed with the incoming raw sewage or primary effluent. This speeds up the action to obtain the required removal of organic matter in a shorter time and smaller tanks.

The activated sludge that is not returned to the aeration tanks for seeding purposes is wasted to separate small sludge thickening tanks, and transferred therefrom to the digesters, or directly to primary sedimentation tanks; it is almost never wasted directly to the digesters due to its high water content.

The most common practice at army plants is to force air under pressure through porous plates or tubes, causing small air bubbles to pass upward through the mixed liquor and setting up an agitation across the surface. This makes oxygen available from the air bubbles and results in atmospheric oxygen envelopment by the circulation across the surface. It provides efficient, constant circulation and mixing of activated sludge and sewage as well as for the application of oxygen.

In the activated sludge process, microscopic plants, animals and bacteria break down objectionable organic matter if maintained in a suitable oxygen environment. Biological, physical, and chemical actions are all involved in the process. Some of the organic matter is consumed by the organisms but one of their most important functions is to produce substances of a chemical nature called enzymes which react with amazing speed to oxidize, mineralize or otherwise convert objectionable matter to substances not objectionable. After sewage is liberally aerated for several days, there will be a formation of visible, brownish, feathery flakes or "flocs" and the aerated sewage will lose its identifying color and odor. When the air is stopped, these flocs will settle out and leave a very clear and odorless liquid above. This brownish floc is the "activated sludge." When examined under a microscope, it will be found to comprise a slimy, sponge-like mass upon which there are colonies of moving organisms. If the correct environmental conditions are maintained, this biological population passes through its life cycles, continuously working to stabilize the objectionable matter in the sewage. After performing their varied tasks in a universe of sewage, the flocs settle, as a moving filter, sweeping out any remaining objectionable matter that may yet be suspended in the final sedimentation tanks.

If plant capacity is exceeded, efficient operation of the activated sludge process cannot be expected. Everything should be done to increase primary settling tank efficiency by preaeration or dilution of raw sewage, diversion of digester supernatant or chemical arresting of the biochemical oxygen demand of the raw sewage until additional capacity can be provided.

Army Camp Problems

At army camps, the rate of flow and strength of sewage varies between wide limits during the day. The sewage received at 9:00 A. M. is 30 to 40 times as strong as sewage received at 1:00 A. M. This condition presents the plant operator with a difficult situation to offset a serious upset of plant performance. Increase in volume accompanies increase in strength of sewage and the loading is pyramided. At the same time, improperly operated grease traps contribute excess amounts of grease to coat "flocs" and prevent sufficient contact with the sewage. Usually, the application of air in increased quantities and chlorine applied at the rate of 5 p.p.m. (based on sludge return) will float the grease and help stabilize the activated sludge within a twenty-four hour period. Other contributing septic loading factors are bad conditions in carrier lines, long sewage detentions at lift stations, or adverse flow conditions within the aeration tanks. Some of these inhibitory conditions can be blamed on construction or operating deficiencies or a combination of both. The following is a list of construction deficiencies:

1. The placing of influent or effluent flumes within the tanks, resulting in sludge adherence to the undersides.
2. The construction of grease and scum flumes within the tanks or paralleling influent flumes without sufficient design capacity.
3. Low capacity primary effluent flumes that overflow sewage into out-of-service primary tanks.
4. Grit chambers without sufficient flexibility to take care of minimum and maximum flows.
5. Long primary tank detention periods caused by minimum night flows.
6. Long activated sludge return lines or flumes of excessive design capacity.

Some of the corrective operating procedures follow:

1. Operate sludge collectors in primary tanks constantly, especially in warm areas.
2. Sample tank bottoms for the presence of solids caused by poor collector action or uneven tank bottom construction.
3. Avoid sludge accumulations in grease and sewage flow channels.
4. Draw sludge (primary) no faster than 40 g.p.m. to preclude rising sludge and a carry-over to following units.
5. Draw primary sludge to digesters on a timed two-hour cycle in warm areas.
6. Recirculate final tank effluent to primary tanks during low night flows to shorten detentions and to improve aeration tank conditions in general.

7. If primary tanks are preceded by grease flotation units, insist on rigid detention periods in order to conserve "food" values for the aerators.
8. Check B.O.D. and pH values at the influent and effluent of primary tanks for indications of septicity. Low B.O.D. removal with normal suspended solids removal is an indication that septic action is taking place.
9. Waste activated sludge to primary tanks slowly and uniformly.
10. Flush the sewer system regularly and inspect manholes for locations below grade lines.

Effect of Digester Supernatant

One of the most persistent of nuisances is the treatment of supernatant from improperly operating digestion tanks. As a general rule, the supernatant is wasted back to the inlet of the primary settling tanks, to be passed through the treatment works with the regular sewage flow. With efficient operation of the sludge digester, the supernatant will be relatively clear with a total alkalinity value of 1,000 p.p.m. or less, especially if stage digestion is employed. From improperly operating tanks, the supernatant will be black in color, have a foul, sour odor similar to overripe sauerkraut, a pH below 6.6 and a total alkalinity value of 2,000 p.p.m. or more. Partial chlorination, liming, or aeration will prove beneficial. Partial chlorination and liming of return activated sludge will also prove beneficial. Chlorinating the supernatant received in the primary tanks for a few hours at the rate of 40 to 80 pounds per m.g. by inserting a hose one foot or so below the fluid level will usually improve operation. If plant design permits, digester supernatant should be conducted directly to the aeration tanks. Regardless of whether good or bad, always return supernatant to treatment at a slow and uniform rate.

Mixed Liquor Solids

In this process, there must be a close relation between the aeration period, air supply and mixed liquor solids. The amount of suspended solids carried in the mixed liquor must be sufficient to produce the desired stabilization in the aeration period available. We have found that a too efficient primary tank has made it very difficult to maintain the required amount of mixed liquor solids in the aeration tanks. This was probably due to a lack of "food" requirements for the bacterial load in the aerators. With the necessary concentration of aeration solids, it will be found that 70 to 85 per cent of the total purification takes place in the first few hours of aeration. Frequent mixed liquor solids determinations must be made to determine the available number of working organisms present in the aeration tanks. This is done to determine the concentrations of mixed liquor solids at which the plant functions best and most economically under all loading conditions. We have found that the mixed liquor solids must be maintained to meet about two extreme peak periods that occur on a nine to ten-hour cycle. This makes it very difficult to maintain an economical usage of air. Air supply, aeration period, and strength of sewage limit the amount of solids that can be carried. If too great a solids content is present, the air requirements will exceed the air supply and bulking will result. The proper suspended solids concentration must be fitted to the sewage load, aeration period and air supply all at the same time. The solids content of the mixed liquor must be adjusted to any change in air supply or sewage load. We have maintained from 1,200 to 2,000 p.p.m. of aeration solids.

Waste Sludge Control

The mixed liquor solids content is controlled in the aeration tanks by wasting the excess activated sludge, usually to the inlet of the primary sedimentation tanks. This should be done in a slow and uniform manner to allow complete sedimentation in the primary tanks. Otherwise, the return activated sludge will pass right through the tank into the aerators again. Being in poor condition, after passing through the primaries and absorbing the worst features of the anaerobic cycle, it will cause disturbances in the aerators. If separate sludge concentration tanks are available, they present the most desirable way to handle waste activated sludge. The mixed liquor solids content of the aerators is the best guide as to when and how much to waste. When sludge is in good condition, it will occupy about 10 to 15 per cent of the volume of a sample of mixed liquor after 30 minutes settling.

Quantity of Air

Army plants have used from 0.8 to 2.0 cubic feet of air per gallon of sewage or from 700 to 1,000 cubic feet of air per pound of B.O.D. removed. It has been found that air requirements were lowered at plants practicing recirculation of final effluent for the control of detention periods during low night flows. The easiest way to determine the proper amount of air is by means of the dissolved oxygen test on samples of mixed liquor taken progressively throughout the aeration tank.

If the dissolved oxygen at the effluent is on a par with the dissolved oxygen at the influent or the effluent contains oxygen when a trace is present at the influent, the operation of the aerators is satisfactory. Residual oxygen is desirable in the plant effluent and should be regulated by the requirements of the receiving stream, but it will vary widely with temperatures. Septic conditions will result in aeration tanks if the air supply is insufficient for only part of the day and bulking of sludge and its loss over final weirs will be inevitable. It is obvious that more air is consumed at the beginning of the aeration period than at the end. So it is good practice to adjust the aeration equipment so that the air supply tapers off as the aeration process lengthens. Be guided in such adjustment by the dissolved oxygen content through the aerators. Excess air is wasteful and may impair purification in the same way as does an overlong detention period.

Aeration Period

It has been previously mentioned that 75 to 85 per cent of the total purification takes place in the first few hours of aeration. This does not mean that the aeration process should be discontinued at that point, as there must be a regeneration and conditioning of the activated sludge after its stabilization of the carbonaceous organic matter at the very beginning of the aeration period. During this period, the strongest demand has been placed on the available oxygen supply by the reduction of the carbonaceous matter present in the raw sewage. So naturally, a "cycle of adjustment" should follow when nitrogenous matter is converted to mineralized nitrates. During this stage there is a slower and more uniform demand on the available oxygen supply to provide a "finish" to the treated sewage and a reconditioning of the working sludge at the end of the period. By trial and error, establish the aeration period to produce the desired purification under varying conditions of flow and to suit the seasons of the year. Most army plant aeration periods, in this area, are based on twenty-four hour average flows with mixed liquor solids contents based on peak flows. Aeration tanks should be checked for short-circuiting and corrected by the careful location of baffles in the tanks or a rearrangement of inlet and outlet gates. Short-circuiting will cause underaeration and an unhealthy condition of sludge within the aeration tanks as well as interference with the aeration period. Too long aeration periods may cause activated sludge to become light yellow in color and leave a dispersion of tiny particles in the water overlying the final tank sludge blanket and in the effluent, usually caused by ebullitions of nitrogen gases. Aeration periods that are too short may cause activated sludge to become dark in color and rise in clumps that disintegrate and blanket the final tank and pass out in the effluent. A contributing cause of this condition is the greater production rather than the reduction of carbon dioxide due to uncompleted cycles of oxidation and nitrification.

Rate of Sludge Return

Return activated sludge should be removed as soon as possible from the bottom of the final settling tank after allowing sufficient time for sludge concentration. The "storing" of sludge should be confined to the aeration units where the proper environmental conditions are maintained. The rate of sludge return is closely related to the aeration period. A high rate of return brings the sludge back into the presence of air more quickly, thereby maintaining the activity of the sludge. If a thick sludge blanket is held in the final tanks, septic action may take place, especially in warm areas, with the resultant rising in large chunks of dark colored sludge to break up and pass out in the plant effluent. Dissolved oxygen determinations at plant effluents will show that final settling tanks holding sludge just a sufficient time to allow for sludge concentration suffer a smaller loss of oxygen than those carrying a three or four-foot sludge blanket. Reaeration of return activated sludge has become a late practice in many plants. The writer has found that oxygen demand of the concentration of solids has usually exceeded the available air supply and that reaeration, at minimum rates, in long sludge return and aeration effluent flumes to final tanks has proven more effective in maintaining activated sludge activity.

Operation Difficulties

There is some reduction in over-all plant efficiency caused by hot weather temperatures on the activated sludge process. This is probably due to the low oxygen saturation values obtainable at this time, but high temperatures with low sewage flows are responsible for the delivery of raw sewage to plants in a stale and septic state. This is probably the principal cause of a lowering of plant efficiencies during hot weather. Indirectly, high temperatures also affect the process when primary sludge is drawn to digesters on less than a two-hour cycle, especially so when activated return sludge is wasted directly to primary sedimentation tanks. These conditions promote the development of septicity in the primary tanks which reflects itself in the aerators. Increasing the aeration period and the rate of sludge return and chemical arresting of biochemical oxygen demands in the raw sewage have proven helpful under these conditions. In other words, do everything in your power to dilute or freshen the sewage flow.

An improperly working activated sludge plant manifests its condition to the operator by sludge "bulking" or rising in the final sedimentation tanks. The color, odor, size of flakes and their characteristics give some indication of the causes of "bulking" to an experienced operator. The sludge flocs will become large and fluffy, settle poorly, and pass over the final tank weirs instead of settling to the bottom. A condition like this makes it difficult to maintain the required amount of mixed liquor solids, creates sludge banks in the receiving stream, and upsets the entire treatment process so that purification efficiency is reduced. It is caused by an unbalanced condition in the aeration tanks whereby the biological life in the activated sludge is affected, causing the floc to swell and lose density. Sometimes it is caused by a highly efficient primary tank that removes "food" values that are necessary to complete bacterial life cycles in the aerators, especially in those plants handling purely organic wastes.

Bulking Sludge

One of the principal causes of bulking is the formation of septic conditions in the aeration tanks. Septicity reduces the efficiency of treatment by bacterial retardation of oxidizing and nitrifying cycles. The toxic effects of septic conditions reduce the desirable working organisms leaving the field open for the development of undesirable microscopic life and one of the indirect causes of bulking. At such times, the sludge will be black and malodorous, will settle poorly, and the plant effluent will be unsatisfactory. If high nitrate values are maintained, the sludge will be light brown or yellow in color and of a fluffy character that can be readily observed as billowing clouds in the final tanks. The liquid above it will be clear and contain high dissolved oxygen values and will not be malodorous. Samples will rise in cylinders in from 10 to 30 minutes, being lifted by accumulations of nitrogen gases. This type should not be considered as bulking in the true sense of the word and can be readily controlled by an adjustment in the air supply. The causes of bulking may be an excessive load on the plant, a poor digester supernatant, an inadequate or too long aeration period, insufficient or too much air, too high or too low mixed liquor solid contents, a stale return sludge, or septic loadings caused by sludge accumulations in sewers, channels, primary or final clarifiers, or any combinations of the above items. Permanent correction depends on isolating and eliminating the cause. Be careful in the use of chemicals to control bulking. Start with low dosages and work up to the required amount to preclude overtreatment. Correct bulking by operational adjustments. The following is a list of operational and chemical adjustments that have proven helpful:

1. *Overaeration.*—Cut down the air supply or return more activated sludge to the aerators. Direct applications of digester supernatant or raw sewage will help by increasing mixed liquor solids. Reduce the number of units in service.
2. *Underaeration.*—Increase the air supply or tanks in service, if possible. Eliminate digester supernatant. Return final effluent to primary tanks. Decrease activated sludge return.
3. *Too long aeration period.*—Shorten the detention period by recirculating final effluent or eliminating units from service. Increase the amount of mixed liquor solids by increasing activated sludge recirculation. Direct applications of supernatant or raw sewage will help to increase mixed liquor solids.
4. *Too short aeration period.*—Increase the detention period by decreasing sludge return or by increasing the number of units in service. Eliminate digester supernatant. Chlorine applied to the return sludge at a dosage between 0.7 and 7.0 p.p.m. (based on return sludge flow) will prove helpful. Return of final effluent to the raw sewage will decrease the B.O.D. concentration.

Lime added at the inlet to aerators at the rate of 300 to 500 pounds per m.g. to raise the pH in tanks to 8.5 in 4 to 6 hours has controlled bulking. Application as a solution of hydrated lime is recommended. Ferric chloride added to the raw sewage has given some success, especially in overloaded plants; a dosage of from 60 to 70 pounds per m.g. of sewage has given good results. Applications of ferric chloride in dosages of from 20 to 50 pounds per m.g. (based on return sludge flow) to the return sludge have given good results.

If aerators are badly septic, it is usually impossible to revive good conditions without emptying and cleaning the tanks and developing a new activated sludge. The addition of lime to the aerators (as milk of lime) to raise the pH above 7.0 will usually condition the sludge when septic action is just beginning. Chlorine applied to the return activated sludge at the rate of 30 pounds per m.g. (based on sludge return) for a twenty-four hour period will usually help.

MUNICIPAL ROSE GARDEN AT HICKORY, N. C.*

By P. L. Abernethy

Superintendent of Plants, Hickory, N. C.

The City of Hickory is very much like many municipalities in at least one respect; that is, Hickory has been sued successfully time and time again because of its sewage disposal systems. Also like other municipalities, Hickory had one lawyer who did most of the suing.

In the fall of 1939, Hickory completed and began operating its new Northwest sewage disposal plant. The plant is located on the old Hickory-Lenoir Highway approximately 2.8 miles from the center of Hickory, and is near a high class residential section. The citizens living near the plant strenuously objected to the plant being built at this location.

The lawyer, who had previously done most of the suing, was very friendly toward the city administration in power in 1939 and, instead of taking suits against the city, he wanted to do everything possible to avoid them. Said lawyer was also president of the Hickory Rose Club, and he conceived the idea of building a Municipal Rose Garden at the disposal plant, with two objectives: to create a beauty spot and to help avoid law suits.

A committee representing the Rose Club met with the City Council in the fall of 1940. At the meeting, it was decided to build a Municipal Rose Garden at a suitable location on the disposal plant property. Also, it was agreed that the Rose Club would have supervision of the plans, planting and care of the garden and that the city would furnish the labor to build the garden, plant the bushes, and to maintain the garden. The Rose Club agreed to raise the money necessary to buy the bushes to plant the garden.

The site chosen was between the control building and the highway. This site was a real eye-sore, as it had two large gulleys partially filled with worthless junk and refuse. A survey was made and plans were drawn. A circular design with a lily pool at the center and with a diameter of 200 feet was adopted. The plans called for 80 beds of hybrid tea roses with 50 roses to the bed; 120 miniature roses to be planted around the lily pool, 156 Pauls' Scarlet Climbers to be trained on a low fence around the garden and 54 roses to cover an unsightly bank.

The Rose Club, through committees, canvassed to secure funds to buy the bushes. People were asked to contribute enough to buy a bed of 50 roses; however, any donation was accepted. Much to everyone's surprise, by March, 1941, enough money, approximately $2,500, had been contributed to buy 4,637 rose bushes.

* Presented at 23rd Annual Meeting, North Carolina Sewage Works Assn., Nov. 2–3, 1943, Winston-Salem, N. C. Reprinted from *Journal* of North Carolina Section, A. W. W. A., and North Carolina Sewage Works Association, Vol. 19, No. 1 (1944).

By the middle of April, all the rose bushes had been planted and all the beds had a small place card giving the name of the rose and the name of the donor. By the middle of May, the garden was in full bloom, and was opened to the public.

We do not know the number of visitors we have had since the garden was opened, but we know on May 25, 1941, we had a total of 716 to register. We estimate that about one-third of the visitors registered. Of the 716 registered, 181 were from 29 North Carolina municipalities, and the remainder from eleven different states.

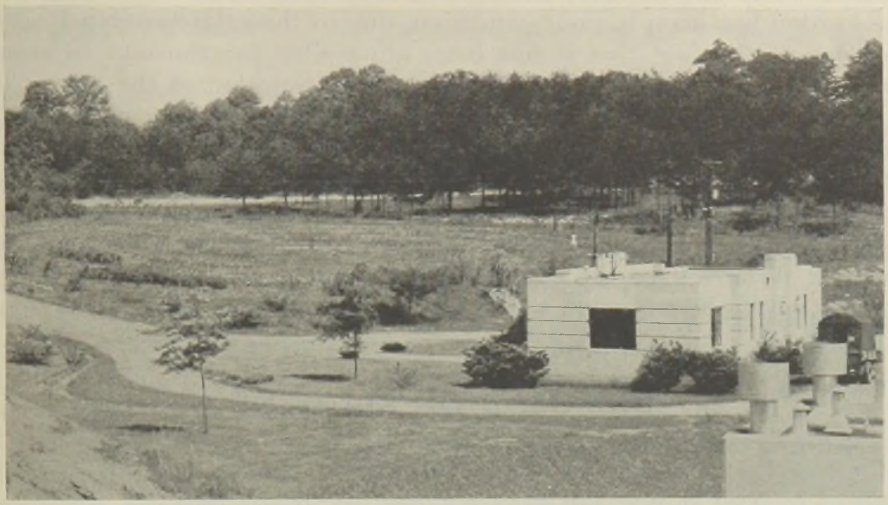

FIG. 1.—Rose garden at Hickory, No. Carolina. Control building at right.

The Rose Club rules prohibited any roses being cut for any purpose except for the local hospitals. They decided to send a vase of roses to every patient in the hospitals each week during the months of June, July, August and September. We constructed crates similar to those used for handling soft drink bottles, each of which hold 16 large glasses used as vases. Each week a committee from the Rose Club would fill enough vases with water and cut from five to seven roses for each vase, and then the vases were delivered to the hospitals. All the nurses had to do was deliver a vase to each patient, with a card inscribed, "Kindly accept these flowers from the Municipal Gardens. Best Wishes, City of Hickory." The first year we delivered 1,142 vases of roses to the hospitals. The city received many cards and letters of thanks from the patients receiving the roses.

The soil was prepared by spreading a heavy coat of sludge over the entire garden area and plowing the sludge under. Then the beds were staked and a stake was placed where each bush was to be planted. We found that a post-hole digger was the best tool with which to dig the holes for the plants. I might add that the distance between the bushes varied from 12 inches to 19 inches, because the beds had to be different lengths in order to keep the circular design.

There are four main paths leading into the garden. A 1-inch water line was placed under each path with spigots located so that a 75-foot length of hose will reach any part of the garden. The city has a dam on a small creek at an elevation of 45 feet above the plant; so the only cost of watering the roses is in labor. As to the cost of planting, four men averaged about 300 bushes per 8 hour day.

The first year the garden was a big success. The second year, because of gasoline and tire rationing, it was decided not to send roses to the hospitals for the duration. However, rationing did not keep visitors away and the garden was still very successful. This past year the garden has been in poor condition, due to three late spring freezes, and due to the fact that it has been impossible for the city to secure enough labor for proper maintenance. It is the plan of the Rose Club to try to maintain the garden until after the war, and then they hope to enlarge it and add more bushes. I might say in closing that the citizens who so strenuously objected to the sewage plant being built at its present location are now frequent visitors, and instead of complaints, we have had many compliments about both the plant and rose garden. Where once the gulleys, junk and refuse created an eyesore, we now have a beauty spot, which attracts all persons passing the plant.

DISPOSAL OF SLUDGE *

By G. A. Parkes

Civil Engineer, City Engineer's Office, Los Angeles, California

''The production of sludge at a sewage treatment plant is unavoidable.'' This statement is made in a report on the ''Salvage of Sewage'' by a committee of the American Society of Civil Engineers, submitted in January, 1942. The statement is true of any and every type of plant and it is also true that the sludge so produced must be given proper disposal.

The report referred to presents a very comprehensive study of the various methods of sludge disposal, together with comparisons of the cost of the said methods. Articles have frequently appeared in *This Journal* and other publications, such as *Sewage Works Engineering* and *Water Works and Sewerage,* which tell of the designs and operating experiences at a number of plants, including many of the larger plants where mechanical dewatering and heat drying is practiced. It is the purpose of this paper, however, to present briefly the case of the small plant, in which the solution of the problems of final sludge disposal has been, in most cases, left to the ingenuity of the operator.

It is unfortunate that so little information has been published regarding the operating experiences at small plants. This is largely due to the reluctance, in general, of operators to write papers and submit

* Presented at the Sixteenth Annual Meeting, California Sewage Works Association, Fresno, June 10–13, 1943.

them for publication. They feel that they have nothing novel or spectacular to tell and they are also naturally unwilling to admit ignorance of matters pertaining to their work. If they only knew that everybody else, including the engineers, is in the same boat and that nobody knows more than a very little about the subject of sewage disposal, they would be more willing to tell what they know and ask questions about the rest. It is only by so doing that all may learn and that the status of the profession may be advanced.

Drying Methods

In almost all small and medium sized plants in the West, the sludge produced by the sewage treatment processes is digested in one of several types of digestion tanks. In most cases, the digested sludge is periodically drawn to sludge beds. These beds are sometimes provided with underdrains but often, if natural sand or gravel deposits exist at the plant site, the underdrains are omitted. In a few cases, elaborate systems of beds with concrete walls, walks and roadways are provided, but usually sludge beds are enclosed by earth banks or wooden walls. Glass covers or "greenhouses" are rare in the West.

It is sad, but often true, that sludge beds as originally constructed are of insufficient area or that the whole plant, including the beds, is overloaded due to unforseen increases in the quantity and strength of the sewage to be treated.

The sludge beds, however, are usually one portion of the plant which the operator can enlarge, with or without additional help. Earth or sand banks are quite adequate but should be made wide enough so that access may be had to new beds. Ramps or driveways should be provided, in order that trucks can be backed onto the beds for direct loading. Portable wooden tracks should be provided to prevent cutting of the surface of the bed by the trucks. Underdrains are desirable but not necessary except when the soil is very tight and impermeable. If cast iron pipe is not available, clay or cement pipe, or even wooden flumes can be used to carry sludge to new beds. Care should be taken to allow plenty of fall in these extensions, particularly if the sludge is likely to be thick.

Operating Hints

There is a tendency, when there is insufficient sludge bed area, to load the bed too heavily. This results in a thick, heavy cake, which dries slowly, further aggravating the trouble. It is suggested that the operator try drawing sludge more frequently in thinner doses, which procedure will result in a faster drying cake. Although it will require that the bed be cleaned more frequently, it may have the result that the beds will dry a larger total tonnage of sludge in a given time.

It should be understood that after the initial water has drained out of a bed full of sludge, which usually occurs within 48 hours, the remainder of the water is removed by evaporation only. Evaporation takes place very slowly after the surface has dried. Consequently, cracking of the sludge is extremely important, in that the water inside of the cake can continue to evaporate through the greatly increased area exposed to the air. Anything which increases the cracking will speed the rate of drying. A thin dose of sludge cracks more readily and for this reason dries more quickly. It is sometimes possible to hasten the final drying of a thick bed of sludge by turning over the partly dried cakes with a fork or a heavy rake.

The use of a cheap grade of commercial alum to increase the rate of drying has been reported from several eastern plants. It is now being tried out at the Terminal Island plant of Los Angeles, with indications of success. It is suggested that those interested write to the General Chemical Company, New York, or Los Angeles, for information, as this company has studied this procedure extensively.

Probably the most difficult digested sludge to dry is one from which the gas has been allowed to escape before drawing to a sand bed. Normally, well digested sludge contains a considerable portion of gas which is held in solution by the hydrostatic pressure in the bottom of the digester. When such a sludge is drawn, the pressure is released and the gas comes out of the solution, causing the sludge to assume a foamy condition. This foam has a tendency to rise and permits the liquids to seep away from the solids into the sand, leaving the sludge in a porous condition which favors drying. If, however, the sludge has been exposed to the atmosphere, as is sometimes the case in the transfer boxes of two-stage digestion systems, or has been stored in open tanks or basins, the gas will have been lost. This degassed sludge, when drawn to a drying bed, will settle to the sand, sealing the same, while the liquid will come to the surface. The liquid can only be removed by evaporation and the sludge will not dry for a very long time. If it is not possible to prevent the loss of gas by sealing sludge transfer boxes or storage tanks, it may be possible to remove most of the ponded liquid from the surface of the bed by bailing or pumping from a small sump provided at one corner. The use of alum, already mentioned, appears to be a great help in handling degassed sludge, in that alum releases carbon dioxide gas from the sludge and restores the desirable foamy condition.

It is obvious that sludge dries best during the warm, dry months of the year. It is, therefore, equally obvious that a wise operator will program his sludge drying to take advantage of the good drying weather of the spring, summer and fall so as to go into the wet winter months with a minimum of sludge in his tanks. In many cases, it may be possible to entirely avoid the drawing of sludge during the winter.

In this connection, it may be said that many operators have an erroneous idea as to the amount of sludge which must be carried in a digester in order to insure good digestion. Sludge which has already been fully digested and is lying on the bottom of a digestion tank, is out of action and is of no benefit in the digestion of incoming material. In fact, such sludge is merely "excess baggage" and is occupying space needed for digestion. It has been repeatedly noted that a digester has functioned perfectly, even when the bottom was entirely clear of sludge. In many cases apparent overloading of a digester has been remedied by drawing sludge. Where "seeding" of raw sludge is practiced, it is not necessary to keep more digested sludge on hand than is required for this purpose.

Occasionally there are complaints regarding odors and flies from sewage plants and, while it is not possible to eliminate such nuisances entirely, the operator can usually do a great deal to reduce the trouble by control measures.

A small fly, similar to the *Psychoda* or filter fly, sometimes infests sludge beds, particularly when drying is slow. Fortunately, these flies do not migrate very far, except in a strong wind and then only in small numbers. Generally, if there are no near neighbors these flies may be ignored. However, any measure which tends to hasten sludge drying will reduce the infestation. Similarly, any insecticide such as fly spray, insect spray, gasoline, chloride of lime, or quicklime will assist in controlling these insects. House flies, on the other hand, ordinarily do not breed in digested sludge but prefer raw sludge, screenings, garbage and similar material. The remedy is obvious and the prompt removal, burial or burning of such material and liberal use of some of the disinfectants mentioned above will greatly reduce, if not eliminate, these pests.

Odors from sewage plants usually emanate from such sources as outfall sewers, clarifiers, supernatant overflows, etc., as will be discussed by others at this meeting. Well digested sludge usually has a characteristic tarry or creosote odor when first drawn, which odor disappears within a few days. A foul smelling sludge indicates underdigestion. The operator should look for trouble in his digester, including the possibility of industrial wastes in the sewage, when this occurs. Dried digested sludge is practically odorless, except when used as a fertilizer on the ground and dampened. Then it may give off a musty odor for a few days.

Raw sludge and screenings, however, will produce bad odors unless dried quickly and should be promptly disposed of, as pointed out elsewhere in this paper. In this regard, it should be stated that it is unwise for the operator to trust his own nose when it comes to odors. Anyone can become used to an odor, particularly if it happens to be connected with his means of livelihood. What may seem to be a slight and unobjectionable odor to a plant operator, may be an exceedingly foul one to somebody else. It is suggested that the operator should occasionally invite someone with a good active "smeller" to visit his plant.

While one or more of the measures outlined may assist in increasing the capacity of existing sludge drying beds, the only permanent remedy for inadequate beds is to build more beds. While the operator can, in many cases, do this himself, it is urgently recommended that he ask for additional help needed for the job. The operator should study the problem, lay out the work to be done, estimate the amount of labor required and submit the project to his superiors for action. In most cases, his forethought and planning will be appreciated and help will be provided for the job, particularly if he can show that no new materials will be required.

Emergency Methods

The foregoing discussion has dealt with the operation of sludge disposal in plants running under more or less normal conditions, or where overloading is of a continuous nature which will require permanent remedies. It sometimes happens, however, that, even in a normally operating plant, it is necessary to dispose of digested or raw sludge in an emergency.

Some plants are so situated that the plant effluent is discharged into some body of water. In such cases, it may be possible to discharge digested sludge into the outfall with the effluent. This should be done at night only and on an outgoing tide or under such conditions as will result in a minimum of nuisance and only when no other method of disposal is possible. It should be remembered that the primary function of a sewage treatment plant is to remove polluting material from the sewage and that after such material has been taken out, it should not be put back again.

Another method of sludge disposal is lagooning; in fact, this is used as a regular procedure in some plants. A sludge lagoon is simply a large basin or low area, with or without underdrains, into which sludge is discharged. When such a lagoon is filled, another must be found, as very little water will seep away and evaporation will be slow. Eventually, the sludge in a lagoon will dry out sufficiently for removal with shovels, or the remaining space may be again filled with wet sludge. Only in cases when there is an extensive area of low ground and there are no neighbors to complain of odors, is lagooning recommended as a permanent means of sludge disposal. Nevertheless, it is often the only method of disposing of excess sludge in an emergency. Digested sludge, when lagooned, will not give off more odor than will a similar area of regular sludge drying bed, except that the odor will continue as long as the lagoon is in use. Raw sludge, when exposed to the air in any case, will soon give off very foul odors unless heavily dosed with chloride of lime, chlorine or some other disinfectant. Heavy applications of powdered gypsum have been used in some cases to control odors. If raw sludge can be discharged in thin layers or shallow ditches and promptly covered with earth, or plowed under, most of the odors will be eliminated. Raw sludge can only be applied to the soil in limited quantities, particularly in winter. Consequently a considerable area is required if sludge is to be disposed of directly on land for any long period of time. Raw sludge lagoons become virtually open septic tanks and it has been reported that odors are reduced if scum is allowed to form over the surface of the liquid.

It must be repeated that the exposure of raw sludge to the air for any length of time, particularly in hot weather, will certainly give rise to the nuisances of odor and flies and should be avoided if possible.

Air-dried digested sludge may be stored in piles almost indefinitely, if methods of final disposal fail temporarily. Dried sludge is not seriously affected by rain but the value as fertilizer may be reduced by prolonged storage.

Dried sludge cannot be successfully burned in the open, even if gasoline or oil is used, as a smouldering, smoky fire usually results.

Final Disposal

Final disposal of sludge is accomplished only when the said material has been entirely removed from the plant in a manner sanitary, permanent and satisfactory to all parties concerned.

There are several methods which may be considered as constituting final disposal, *i.e.,* incineration, filling, barging, and use as fertilizer.

Disposal by incineration is generally limited to large plants and is usually preceded by mechanical drying. It is possible to burn air-dried sludge, such as is produced by a small plant, in a properly designed trash or garbage incinerator. If such burning is practiced at small plants the disposal of the high ash content (about 50 per cent) may complicate the whole problem.

Barging to sea is also a method limited to large plants situated on or near the ocean, as the high cost of sludge barges and equipment would be prohibitive for a small plant. The nearest thing to barging is the discharge of digested sludge to sea along with the otherwise treated effluent from the plants situated on sea coasts. Such a method of disposal must be very carefully used, in order to avoid nuisance, and is not recommended except in emergencies.

Filling of low ground with dried or partly dried sludge is practiced in many plants. The limitations of this method are several. There must be a considerable area of low but well drained land (if not well drained, a bog will result). The fill must be kept covered with earth and, due to the fact that such a fill will continue to settle for a long time, the land cannot be used for building purposes nor, due to the high ratio of sludge to soil, can the area be used for farming for many years.

By far the most favorable method of sludge disposal is for use as a fertilizer. The use of digested sludge for this purpose has been the subject of many published articles and reports, and innumerable official as well as backyard experiments. The reports are almost all favorable, with the exception that digested sludge is not recommended for use on root type vegetables or low growing vegetables or fruits which are eaten raw. Raw sludge is, almost without exception, frowned upon as a fertilizer, and heat-dried activated sludge, while an excellent fertilizer, is not now produced in the West.

Digested sludge, in lump or pulverized form, has apparently been used with success on all sorts of soils and crops, from orange groves to lawns and from sandy gravels to adobe. It may be used straight but is sometimes used by manufacturers to mix with other materials to produce fertilizers for specific purposes.

Most of the plants in the West, which have been operating for any length of time, have arranged with some fertilizer contractor for the sale of the sludge. The terms of these contracts vary widely but in most cases the contractor removes the sludge from the beds and pays a certain price per ton, per load, per year, or on some other unit. In general, this is the most satisfactory method in that it produces some revenue and requires very little of the operator's time.

In some cases, it may be to the operator's advantage to call favorable attention to himself and to his plant by instituting a system of local sales, either wholesale or retail. This method, while requiring a good deal of his time, may serve to advertise him as a "live wire" and eventually may have a favorable reaction on his pay check.

At this point, it should be emphasized that, while liberal "samples" of sludge may be distributed to interested parties, a charge should always be made for such material delivered on a regular basis. People always get the idea that a thing is valueless if it has to be given away, just to get rid of it. How much should be charged will depend upon local conditions and upon the degree of preparation of the sludge, but it will actually prove to be more satisfactory in the long run to use the sludge for filling low ground or to burn it up than to depend upon persons coming to get it "free." This, of course, does not apply to the use of sludge upon parks, public golf courses, or for similar public purposes, although even in such cases the sewage works should receive credit for supplying the fertilizer and possibly payment in the form of materials or exchanged labor.

Local chambers of commerce, merchants, and growers associations should be contacted and perhaps advertisements should be placed in local papers calling attention to the availability of sludge. At first, sales will be slow, until people have tried the new fertilizer and the arrangements for deliveries and payments worked out. However, the writer believes that, with proper handling, a good market can be developed for the digested sludge from almost any plant.

A pulverized sludge, sold in sacks, will find a more ready retail market. A hammer-mill or impact type of grinder, driven by an electric motor of sufficient horsepower, is most satisfactory for pulverizing sludge, but a reconditioned truck motor operating on gasoline or sludge gas can be used as a power source to good advantage. Due to the fact that air dried sludge usually has sand adhering to it, the material is very abrasive. The wearing faces of the hammers must be reinforced with "stellite" or similar hard alloy. If the mill is equipped with a blower which draws the ground material out of the mill, rapid wear in the blower will result. The blower must be rearranged to "blow" instead of to "suck." The discharge piping should be as short and straight as possible, and use of a cyclone separator in connection with this operation is desirable. A light, farm type of mill may be used if the sludge production is small, but a heavy duty machine is recommended for larger plants. The sludge must be well dried, preferably not over 10 per cent moisture, before grinding in this type of mill and it will keep indefinitely in storage, if warehoused dry. The so-called belt type sludge disintegrator or shredder is not recommended where a finely ground dry material is required.

As has been stated at the beginning of this paper, the matter of the ultimate disposal of sludge from the average small plant has been largely neglected by the magazine and journal writers. Although this paper has become rather lengthy, it has been necessary on account of the ground to be covered, and the writer hopes that some points mentioned herein may be of value to someone.

INTERESTING EXTRACTS FROM OPERATION REPORTS

JACKSON, MICHIGAN (TWO YEARS ENDED JUNE 30, 1943)

By A. B. Cameron

Superintendent

Description of Plant

The Jackson sewage treatment plant (Fig. 1) comprises 2 comminutors, manually cleaned grit basins of 20 m.g.d. capacity, six rectangular primary sedimentation tanks affording one hour detention, eight aeration tanks equipped for air diffusion and four circular final sedimentation tanks. The mixed primary and excess activated sludge is digested in six 50-foot tanks equipped for gas collection and storage. Digested sludge is air dried on eight beds, each 7,600 sq ft. in area. Effluent discharge is to the Grand River.

Mechanical Problems

Few, if any, mechanical difficulties have developed during the past year. Results of the year's operation again indicate that we can operate very successfully without mechanical aerators, and at this time we feel safe in stating that no additional plates need be installed in the aeration tanks. The mechanical aerators were removed from the aeration tanks in 1940. The new comminutors continue to give satisfactory service without undue maintenance; repairs still consist of shearing bars, retaining rings, cutters, and other minor replacements. The baskets show some wear but undoubtedly will last another year or more before requiring replacement. The plate holders are still holding up and none have been replaced; this is attributed wholly to the installation of zinc strips attached to the plate holders where excessive corrosion has been noted. It is very apparent that the zinc strips have solved this problem of excessive corrosion, and if and when new plate holders are required, they will be equipped with zinc strips immediately.

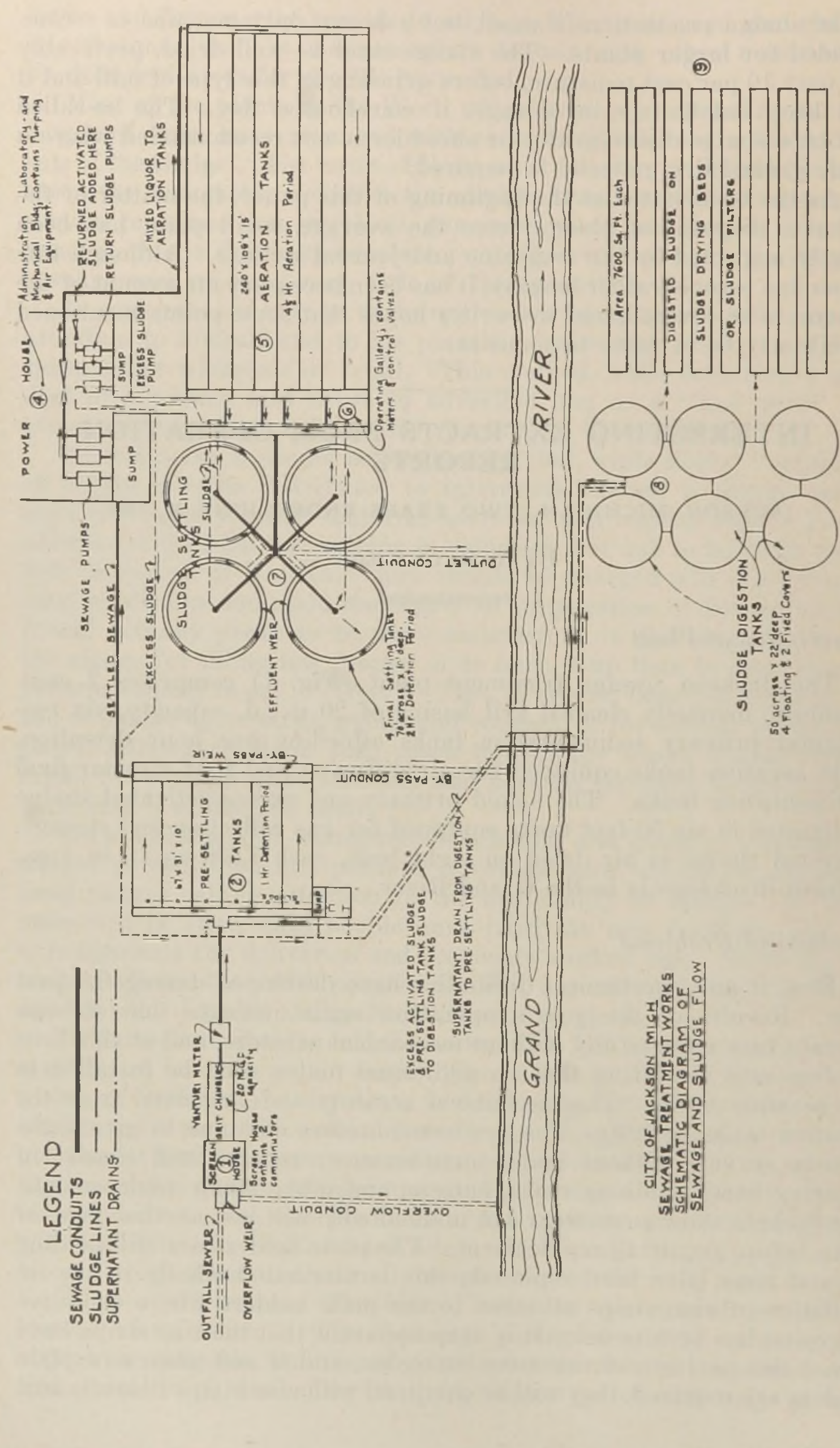

Fig. 1.—General plan of sewage treatment works at Jackson, Mich.

Diffuser Maintenance

In former reports, some mention has been made of our practice in using chlorine to keep the diffuser plates free and open. Little difficulty has been noted on this score the past year. During 1942 all plates were removed and given a chromic acid bath. During the present year all that has been done is an occasional shot of chlorine, and once in a while the system is blown out by using additional blower capacity, thus greatly increasing the air output. This blowing out period only lasts about 24 hours. After cleaning with the chromic acid solution, the pressure recorded was six pounds and eight ounces, and this has only increased to seven pounds and four ounces. The plant will continue to operate satisfactorily until this pressure reaches about eight pounds. Another thing that has been noted is that these pressures fluctuate considerably, so we feel that with the aid of chlorine and blowers, we can avoid plate cleaning for a couple more years. Two other things may contribute to our freedom from trouble, we are carrying slightly lower suspended solids in the mixed liquor, and we have been very fortunate in making a fairly complete separation of industrial wastes carrying iron salts from the sanitary sewage. Late this year steps were taken to eliminate completely one source of iron salts, and a little later another industry effected a complete separation. The iron content of the sewage dropped from an average of 18 p.p.m. to 8 p.p.m. Apparently these lower iron values have little if any effect in clogging the filter plates.

New Digesters Improve Results

As noted in last year's report, we had completed and placed in operation two 60-ft., gas collecting digesters. These digesters have worked out very satisfactorily in all respects. We are now handling more solids than at any other time, and the sludge from these digesters has been greatly improved over the sludge obtained from the plant when operating with only four digesters. This is clearly indicated by the solids and volatile content. Prior to putting the new digesters into service, the digester sludge was slightly under 5 per cent solids and the volatile matter slightly over 50 per cent. This year's average, with a greater load, is 8.3 per cent solids and 48 per cent volatile matter for sludge drawn to the drying beds. In addition to these improvements, we find the sludge dries much better and we get a greater yield per square foot of sludge bed area. The gas collecting feature of the new digesters has made the plant more flexible, and all operations in which gas is used have worked out more satisfactorily.

Industrial Waste Flow Equalized

In connection with the disposal of industrial waste, a scheme has been worked out between the State Department of Health, the City of Jackson, and a manufacturer, in which the manufacturer utilized some abandoned contact beds as holding tanks so that the discharge of industrial wastes from this plant to the river is not in slugs but is equalized over a 24-hour period, thus improving stream conditions to a marked degree.

TABLE 1.—*Summary of 1941–43 Operation Data, Jackson, Michigan*

Item	Average 1941–42	Average 1942–43
Connected population	50,000	50,000
Sewage flow—m.g.d.	7.50	9.15
Per capita daily—gal.	148	183
Grit removal—c.f. per m.g.	0.98	0.80
Analytical data—p.p.m.		
Raw sewage:		
Suspended solids	222	191
5-day B.O.D.	156	122
Dissolved oxygen	1.3	2.0
Ammonia nitrogen	13.3	10.5
Organic nitrogen	7.8	7.7
Oxygen consumed	50.6	42.7
Primary effluent:		
Suspended solids	132	141
2-hr. residual suspended solids	102	—
5-day B.O.D.	139	118
Dissolved oxygen	2.4	3.2
Ammonia nitrogen	13.7	11.3
Organic nitrogen	6.9	7.8
Oxygen consumed	36.8	35.0
Plant effluent:		
Suspended solids	16	17
5-day B.O.D.	10	7
Dissolved oxygen	5.0	5.8
Ammonia nitrogen	8.1	7.2
Organic nitrogen	2.5	3.6
Nitrate nitrogen	3.3	3.3
Oxygen consumed	7.7	7.7
Activated sludge data:		
Applied air—c.f. per gal.	0.7	0.6
Mixed liquor solids—p.p.m.	3,200	3,020
Sludge index	43	35
Waste activated sludge—1,000 g.p.d.	33.3	32.3
Return sludge ratio—per cent	20	15
Sludge digestion data:		
Raw sludge quantity—gal. per m.g. sewage	3,550	3,320
Solids content—per cent	5.5	5.5
Volatile content—per cent	63.0	61
Digestion temperature—deg. F.	79	87
Gas production—c.f. per cap. daily	1.1	1.15
Per lb. vol. matter digested	20.3	16.5
Digested sludge:		
Solids content—per cent	5.6	8.3
Volatile content—per cent	52	48
pH	7.2	7.2
Alkalinity—p.p.m.	3,007	3,275
Supernatant liquor solids—p.p.m.	4,331	6,441
Dried sludge solids (open beds)—per cent	32	33
Operation costs—per m.g. treated	$23.35	$18.73
Per capita per year	$ 1.28	$ 1.25

Wartime Grounds Maintenance

Every effort has been made to maintain the grounds about the plant as they are being used more and more by the general public as picnic and recreational grounds. This year additional grills, tables, and waste receptacles have been installed, and fresh water and a drinking fountain have been added immediately adjacent to the picnic grounds proper. Probably due in some part to gas rationing, we find that these facilities are appreciated by the public; in good will to the plant, we feel they are worth while. Due to the labor shortage it has been impossible to get men for mowing lawns and general upkeep about the grounds, so we had to resort to high school students this last year as a source of labor. As a whole this has worked out reasonably well, but costs were higher inasmuch as we had to pay the prevailing city labor rate to these boys. In terms of production, the unit price was increased. Next year we have arranged to use a sliding scale based on the incentive motive; the new rates will vary from 50 to 65 cents per hour, plus allowance for living costs, depending upon the ability of the individual employee.

Operation Data

Yearly averages of fundamental operating results for 1942 and 1943 are shown in Table 1.

In connection with these data it is noted that the use of suspended solids determinations on samples of raw sewage subjected to quiescent settling in the laboratory, as a criterion of theoretical sedimentation efficiency of the primary tanks, was discontinued in February, 1943. A monthly summary of these data for the year ended June 30, 1942, is presented herewith:

Month (1941–42)	Suspended Solids—p.p.m.			Per Cent Removal		Efficiency
	Raw	Primary Effluent	Laboratory Settling (2 hrs.)	Plant	Laboratory	(Plant/Lab.)
July	216	113	89	47.8	58.8	81
August	217	105	94	51.7	56.7	91
September	238	113	92	52.6	61.3	86
October	228	124	104	45.7	54.4	84
November	201	122	106	39.3	47.2	83
December	261	131	115	49.8	56.0	89
January	254	144	126	43.3	50.4	86
February	219	149	118	32.0	46.1	69
March	205	144	85	29.8	58.6	51
April	196	138	97	29.6	50.5	59
May	230	156	99	32.2	57.0	56
June	199	130	79	34.7	60.4	58
Average	221	130	100	40.7	54.8	74

In a letter explaining the discontinuance of the above procedure, Mr. Cameron states:

"Settling periods have a marked effect on these efficiencies. Likewise, flowing through times are always considerably lower than the theoretical displacement periods. We feel that the daily average flows do not present a true picture and that the hourly flows actually represent much greater fluctuations in a plant of this size than is indicated in the 24-hour figures.

"We also feel that changes in the character of the sewage are as important as the fluctuation in flow rates. This is especially true in our plant due to the wasting of excess activated sludge to the plant influent.

"The combination of these two influences will account for the variations in the data and, since we have no way of evaluating their effects, we have concluded that the residual suspended solids determinations are of little value in the plant."

THIRD ANNUAL REPORT, MARION, INDIANA (1943)*

By David Backmeyer

Superintendent

Description of Plant

The layout of the combination sewage treatment and garbage disposal plant at Marion, Indiana is shown in Fig. 2.

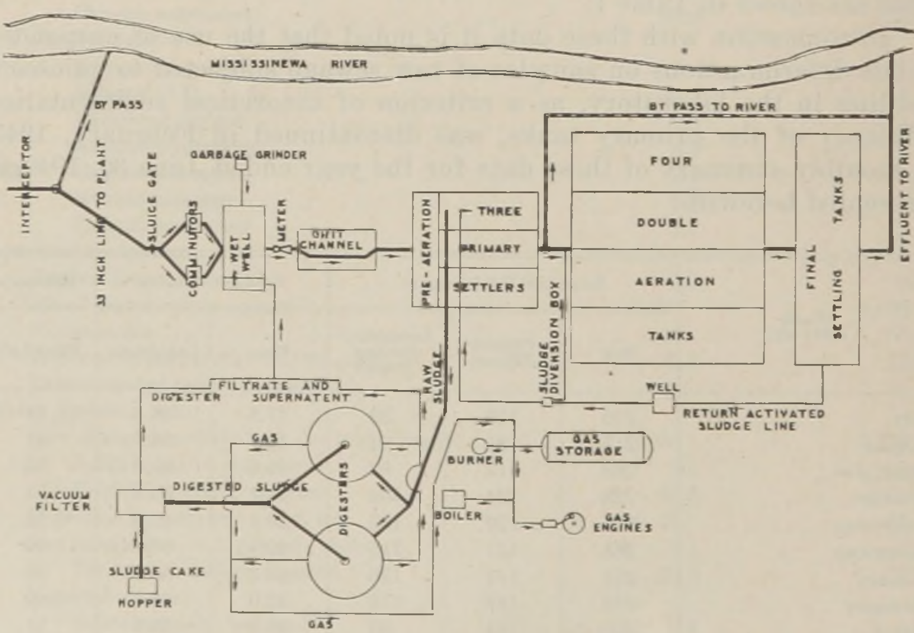

Fig. 2.—General plan of sewage treatment works at Marion, Ind.

Design capacity is 4.0 m.g.d. with garbage grinding up to 6,000 lb. per hour.

* Report covers last four months of 1942 and full year of 1943.

Meeting the Manpower Shortage

The year 1943 was an unusual one in many respects. Shortage of labor, material scarcities, priority regulations, and many other factors directly and indirectly connected with the war effort have had a pronounced effect upon the operation routine of the sewage treatment plant. During the first part of the year it was necessary to operate the plant for several months without the services of one of our regular operators. Until such time when we were able to find a suitable replacement, it was necessary for some of our employees to work sixteen hours per day to keep the plant operating in a satisfactory manner. This extra work was willingly and cheerfully done by our regular operators, and these men are to be commended for the fine spirit of co-operation they have shown throughout the period of emergency.

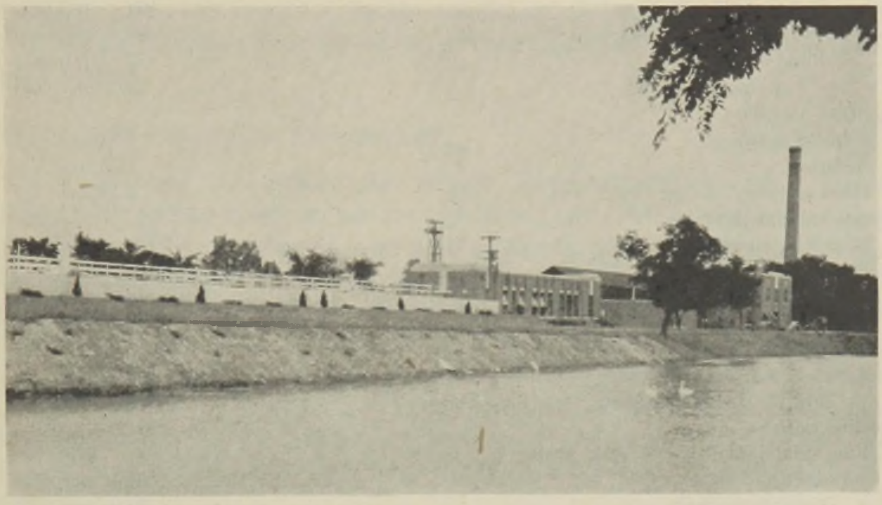

FIG. 3.—View of Marion, Indiana sewage treatment plant. David Backmeyer, Supt.

Garbage Handled Separately

The disposal of garbage, formerly accomplished by adding the ground garbage to the raw sewage at the treatment plant, was altered in such a way as to permit the ground garbage to be kept separate from the sewage flow and be pumped to the digestion tank without coming in contact with the sewage. Provision is made for removing grit and mineral matter from the garbage before it is transferred to the digestion system. This new setup has worked satisfactorily to date, and considerable time and effort is saved since the added load of garbage solids and solubles no longer enters the primary settling tanks or secondary treatment units. The ground garbage has been sampled as it is pumped from the 4,500 gallon well to the primary digester, and laboratory tests made for solids and volatile content. As a very small amount of construction work was required to make the above mentioned change,

TABLE 2.—*Summary of 1943 Operation Data at Marion, Ind.*

Item	1943 Average [1]	
Connected population	26,700	
Sewage pumpage	3.78	m.g.d.
Per capita daily	142	gal.
Green garbage received daily	3.0	tons
Ground garbage pumped—1,000 gal.	3.8	
Solids content	4.85	per cent
Volatile content	83.0	per cent
Grit removal daily—per m.g. sewage	1.1	c.f.
Analytical data:		
5-day B.O.D.—raw sewage	145	p.p.m.
Primary effluent	98	p.p.m.
Removal—primary	41.0	per cent
Final effluent	9	p.p.m.
Removal—plant	94.1	per cent
Suspended solids—raw sewage	241	p.p.m.
Primary effluent	104	p.p.m.
Removal—primary	53.1	per cent
Final effluent	12	p.p.m.
Removal—plant	94.5	per cent
Detention periods:		
Primary settling	1.84	hrs.
Aeration	4.06	hrs.
Final settling	2.27	hrs.
Activated sludge data:		
Mixed liquor solids	2,999	p.p.m.
Return sludge solids	10,844	p.p.m.
Volatile content	53.2	per cent
Return sludge ratio to sewage flow	31.9	per cent
Sludge index	57	
Applied air—per gal. sewage	0.62	c.f.
Per lb. B.O.D. removed	907	c.f.
Digestion data:		
Raw sludge quantity per m.g. sewage	6,400	gal.
Solids content	5.67	per cent
Volatile content	50.9	per cent
Digestion temperature—primary	96	deg. F.
Secondary	68	deg. F.
Supernatant liquor quantity—1,000 gal.	44.8 [2]	
Solids content	3.1	per cent
Gas production—per capita daily	1.54	c.f.
Portion total power from gas	72.2	per cent
Portion of gas from garbage	14.6	per cent
Digested sludge quantity—per m.g. sewage	2,400	gal.
Solids content	6.27	per cent
Sludge dewatered—dry solids daily [3]	2.6	tons
Lime applied (72% CaO)	345	lbs. per day
Ferric chloride applied (anhydrous)	60	lbs. per day
Filter rate—per sq. ft. per hr.	6.76	lbs.
Sludge cake solids	26.6	per cent
Operation cost—per m.g. treated	$16.57	
Per capita per year	0.89	

[1] Data actually includes 16 months ended December 31, 1943.

[2] Transfer sludge diluted with quarry water for temperature control in second stage.

[3] Dewatering by vacuum filters discontinued in March, 1943 in favor of liquid sludge disposal.

the project was carried out during a fifteen-day period in May when the sewage flow to the plant was shut off because of flood conditions.

Liquid Sludge Disposal

Another change made in method of operation concerns chiefly the removal of digested sludge solids. Vacuum filtration and subsequent disposal of the filter cake on farm land was practiced until March, 1943. At that time, liquid disposal by tank truck was started. This latter method of disposal was given such an enthusiastic reception by the farmers in the vicinity of the plant that it has now completely replaced the former method. The details of the operation procedure used in removing the liquid sludge are reported in an article published in *Sewage Gas* of June, 1943, and reprinted in SEWAGE WORKS JOURNAL of November, 1943. Funds have been allocated in the 1944 budget for the construction of another sludge conditioning tank that should enable us to further reduce the cost of removing digested sludge solids in the liquid form.

Sewer System Leakage Eliminated

For the past two years the Sewer Department has been having trouble preventing river water from leaking into the intercepting sewer chamber at the Nebraska St. and also at the Orphans Home river crossings. This leakage resulted in an unnecessary increase in flow at the plant which amounted to 15 per cent of the normal flow during rainy weather periods. During August of 1943, special retaining walls were built at these chambers which will prevent the river water from coming in contact with the gates until the elevation of the river water rises six inches above normal stage. This improvement in the sewer system, which was designed and approved by the City Engineer, has saved the Sanitation Department a considerable sum in operation expense to date, and will continue to bring about further savings in the future.

SEWAGE PUMPS *

BY A. B. SHEARER

Manager, Main County Sanitary Dist. No. 1, San Anselmo, Calif.

The subject of sewage pump selection and care is old, but continues to hold our attention. It has often been discussed at operators' meetings and all other places where people gather who are interested in sewage treatment.

Most often the discussion is how to care best for the old pumps now installed in our plants. It might be to a greater advantage if the problem of selecting a new pump were undertaken or, better still, if all ex-

* Presented at 16th Annual Meeting, California Sewage Works Assn., Fresno, June 10–13, 1943.

perienced operators were to pool their ideas and aid the manufacturer in building a good pump.

We are all familiar with the many everyday troubles such as worn packing, damaged wearing rings and sleeves, misalignment and a loss of prime, for everyone who works around a sewage treatment plant learns of these things all too soon. We know that the most common trouble is worn packing and the wear that takes place on the wearing sleeve or shaft at the point on the sleeve or shaft where the packing makes contact. We know that this is largely due to the grit and abrasive material in the sewage. All other troubles are minor in comparison. We are left with one small but important question—how to exclude this grit from the packing and bearing?

Too much time and talent has been spent by the engineers and designers who are more interested in capacity and efficiency curves than they are in the convenience of pump operators, or the maintenance costs to the owners, or the disruption of service caused by frequent shutdowns. If these engineers would put away their slide rules for a time and operate and repair one of their own installations under the same conditions that we do, they might gain a better understanding of mechanics, and so become more valuable to the industry.

The principle of using a water seal to prevent grit from getting into packing is very good in theory, but experience has been disappointing, for the cost of the water necessary to make these seals effective is about ten times as costly as new sleeves and the labor. Therefore, they have been abandoned in many cases.

A very satisfactory substitute for the water seal has been found in what might be called a grease seal, whereby a hole is drilled in the packing gland housing directly over the center of the packing proper. This hole is threaded and a grease nipple is screwed in for use with a high pressure grease gun. When the packing is placed, the middle ring is cut short and the open space is placed over the grease nipple outlet, then the packing is completed in the usual manner. If a shot of grease at high pressure is applied every other day, the grit will be forced back into the pump. The bearing will be well lubricated at all times and no loss of prime will be experienced by air being drawn in through loose packing.

Many experienced operators sincerely believe that there is no such thing as a clogless pump in the smaller sizes, yet the world is full of papers and catalogues offering guaranteed clogless pumps for sale. There are two of them in one plant that clog regularly every day and twice on Sunday. It is realized that this condition varies from plant to plant, depending on the equipment at the plant, the character of the sewage and the habits of the people in the community. The effect on the pumps is that, if they clog at night when there is no operator present, the pumps run wild and heat the packing, causing the grease to drop out and increasing the packing replacement troubles.

The horizontal pump should be one with a split housing that will permit the mechanic to remove the shaft and runner without disconnecting the suction or discharge lines. There should be hand holes for removing stoppages. Many pumps do not have these features but they are very handy and save time and work. When the wearing sleeve is worn to the point of replacement, it is best to secure another made of a good grade of stainless steel. Standard factory practice is to furnish these sleeves of brass or bronze, which are soft and easily worn or damaged. Stainless steel can be had in many combinations of alloy and some are very tough and will finish to a hard polished surface that will take many times the wear as will bronze. Neither of them will rust or corrode. They cost more but are worth the difference. Even a fine grain, pure cast iron is better than bronze. They wear better and do not rust as readily as might be supposed; then, too, they are easy to remove—a few sharp blows with a hammer and they will fall away, while it takes a lot of fussing to remove any sleeve made of other material.

Sometimes you may find the sleeve entirely worn through and a cut into the body of the shaft proper. If this is found to be the case, do not try to build up the shaft by a welding process. You may succeed, but it is ten to one you will distort the shaft with the heat and it will be very difficult, if not impossible, to true it up and balance it again. Further, you will disturb the chemical composition of the metal at that point and sooner or later cause a fracture.

There is a process that is comparatively new, known as metallizing, that is very good for this use. Any metal or alloy of metals may be applied by this process and, when ground and finished to size, is a better and harder wearing surface than the soft steel most often found in shafting.

In some pumps using closed runners the spacing between the runner and the pump housing is too small and rough, with practically no water travel over the front or back of the runner surface, thereby allowing rubbers to gather and form a very effective brake. This reduces the pump efficiency and overloads the motors. In one case, this trouble was corrected by turning off some metal on both sides of the runner and finishing to a smooth surface. In another pump the entire water seal assembly was removed and left out. No further trouble of this kind was experienced and there was no noticeable decrease in the pumping capacity.

On some horizontal pumps, built with the discharge connection on the lower side of the housing, an air pocket is formed in the upper crown above the top side of the suction pipe. All such pumps are provided with a tap hole to relieve the air and thus prevent a so-called air-lock. These vents are easily stopped up, but when so stopped the pump will not always pick up its prime. In an installation where the discharge rises above this point, the trouble may be corrected by taking off a one-inch pipe from the top of the housing and carrying it on an upgrade and into the discharge line, the effect being that a small flow of water will travel through it at all times when the pump is in operation.

If it becomes your duty to install a new pump or pumps, remember that their correct place and alignment are of extreme importance. A strain in the pump bed, a poorly aligned shaft, a loose floor or anchor bolt may cause such troubles as a shaft whip, which in turn causes bearings to wear, run hot and fail, or the shaft itself to finally break. You may fight these troubles for years without knowing that the real cause is faulty installation.

Most of the larger pump repairs can be avoided if a frequent inspection is practiced by the man in charge of the plant. Major pump failures usually announce their coming by some small irregularity in the pump performance that can be recognized by a competent operator and corrected at the most opportune time, thus saving considerable time and expense.

No comment will be made here about sludge pumps, for the writer has had no experience with them.

Lubrication

Any lubrication problem can only be decided after a careful study of the mechanical features involved, such as speed, load, temperature, position and local factors such as dust, fumes, and moisture.

Sewage pumps present practically none of these. The speed is comparatively slow, the load is constant, temperature is low, position very simple, only small amount of dust or fumes, but often too much moisture.

Too often we do not have any choice in the type of lubricant we must use but must follow the pattern selected by the pump designer, insofar as whether we use oil or grease and the manner of its application. Therefore, it may be futile to spend any time or effort on a problem that has already been settled. However, practical shop experience has convinced the writer of a few simple facts.

The greatest single trouble-maker is the carelessness of the operator who is inclined to expect too much from a machine that is not cleaned and oiled regularly. All ball or roller bearings should be lubricated with oil instead of grease; the bearing should be provided with an overflow and should be flushed out with clean oil frequently to remove any grit or dust that may have gotten into the ball race.

Oil or grease retainer rings should be as narrow as possible and never made of felt, but of rawhide or some synthetic material held in tension by a spring and metal case. It is better to have the feather edge facing out instead of in, so that oil may leak through and flush away grit that will gather there. When felt is used, it will gather and hold grit, forming an abrasive wheel that will cut deep into the shaft.

Particular care should be taken in selecting the grease or oil cup or nipple through which the bearing is to be lubricated. It should have a self-closing face and be covered by a hood to keep out dirt. Each time the bearing is oiled this fitting should be wiped clean with a rag before the oil is applied. It is best to oil or grease under pressure and allow the surplus to drain off immediately.

The type and grade of lubricant required varies with the make and size of the pump under consideration. Therefore, it is best to follow the instruction of the manufacturer, who is interested in the performance of his product and has given this question careful study.

THE DAILY LOG *

September 2—Drained final sedimentation tank for annual inspection. The clarifier was found to be in excellent condition, only two of the plows requiring straightening. The gilsonite paint on the underwater metal parts was found to be affording adequate protection after three years of service.

September 8—The designer of the inverted siphon in the main intercepter about a mile above the treatment works did well to provide a chamber for the deposition of grit at the inlet side. It would have been well, however, for cleaning instructions to have been furnished since the chamber cannot be by-passed. Consequently, no previous attempt had ever been made to remove the grit and there is evidence that the capacity of the siphon is affected.

By means of a queer looking scoop, made by affixing a one-gallon ice cream can at just the right angle to the bottom of a 12-foot pole, cleaning of the chamber was begun. With about 8 to 10 cubic yards of solidly packed grit in the basin, many dips, drags and lifts were necessary to remove it.

Maintenance at the siphon was completed by flushing and rodding the twelve, fourteen and sixteen-inch pipes. The work resulted in reducing the head loss at the prevailing low flow by four inches, a most satisfactory reward.

September 18—"I've Been Working on the Railroad" would have been an appropriate theme song today. Began repair and realignment of the industrial railway track used for moving sludge from the drying beds.

September 22—A very sad lady phoned to ask us to look for a diamond believed to have been lost from her ring while she was washing dishes. Our response was sympathetic but did not offer much hope.

Could some good mathematician compute the probability of finding the diamond under these circumstances? We haven't the time.

September 25—The road asphalt ordered seven weeks ago finally arrived and was applied today. The main drive was treated with 0.3 gallon per square yard of MC-2 asphalt and covered with 25 pounds per square yard of ¼-inch stone chips. The secondary drives were given the asphalt application only.

If it is not too late in the season for proper curing, the treatment should be quite satisfactory.

October 1—Painting the interior of the steel sash at the screen house, an annual chore because of the almost constant moist atmosphere. A rust-inhibiting primer and aluminum finish coat are being used.

* Based on the 1943 records (augmented) of the Urbana-Champaign (Illinois) Sanitary District.

October 10—The last of the secondary drives are now sufficiently cured to take traffic.

October 12—For some time it has been evident that the industrial dump cars used for moving dried sludge were in need of overhauling. With materials procurement so difficult right now, we have been reluctant even to ascertain the extent of repair necessary at the wheel bearings.

Today we did take down one of the cars and believe that a reasonably good solution is possible. The axles were originally 1¾ inches in diameter but are badly worn. We intend to turn these down to a uniform surface at 1½-inch diameter and use 9/16-inch roller bearings (cut from bar stock) instead of the original ½-inch rollers. Bushings will be placed at each wheel to take up end play. One of the seven cars will be scrapped to yield castings and other parts which cannot be purchased now.

October 20–24—In Chicago to attend the Fourth Annual Meeting of the F.S.W.A.

Some vacation!

October 25—Returned to learn that a bad leak had developed in the city water service and that a two-day search for the leak had been unsuccessful. We had once heard that leaks could sometimes be located by looking for a patch of particularly long and green grass along the pipe line so we gave it a try.

It worked! The leak was readily located at a pipe joint on a branch serving the flower garden and a heavy loss of water to a nearby storm sewer manhole was found.

October 29—Completed the industrial car repair job at a total cost of $66.00. A slight improvement in the form of journal box fittings for pressure lubrication was added as an afterthought.

November 1—A day we have been anticipating with pleasure for a long time. Our operator-foreman, who had been critically injured by a fall into the final sedimentation tank a year ago last August 10, reported back to work. It seems mighty good to have him back.

November 3—In contrast to the above entry, this is a day of mingled feelings. At the regular meeting of the Board of Trustees, the agenda included presentation of our resignation as Engineer-Manager, effective next December 31, to assume full time duties as Executive Secretary of the F.S.W.A. A sincere regret in extending the resignation was offset by the appreciative resolution passed by the Board in accepting it.

November 9—Had to suspend cleaning of sludge beds on account of insufficient labor.

November 13—Investigating a slight change in the sound of the 4.0 m.g.d. sewage pump, we found that the shaft sleeve had worked loose and dropped down against the impeller. The exposed section of shaft was badly scored and a new shaft will be required.

That AA-1 preference rating under Order P-141 is highly appreciated in times like this.

November 30—Our best sludge user out to arrange to take the entire quantity removed at the next cleaning of the beds. We even have a waiting list now, the demand being in excess of production!

December 3—Special meeting of the Board for the purpose of interviewing four applicants for the position of Engineer-Manager. All of them are top-flight men and the selection will not be easy.

December 10—Regular inspection of the intercepting sewers disclosed that some unidentified culprit had partially closed one of the inlet valves at the small inverted siphon in the Campus. Would have suspected a collegiate prankster in ordinary times.

December 15—Cold. Seven below zero. Winter arrived almost overnight.

December 18—Replacement parts for the 4.0 m.g.d. sewage pump were delivered and reassembly of the unit was begun immediately. Everything went well until we began to lower the impeller by means of the shaft adjusting nut when we found that the shop man had evidently placed the adjusting nut thread below his mark instead of above it. As a result, the wearing ring clearance was quite excessive but we decided to use the pump until the factory could furnish another new shaft.

December 26—One of the operators suffered a severely wrenched back when he slipped and fell on an icy sidewalk. The men simply will not follow their instructions to scatter salt or ashes on the walks before beginning the daily routine. This accident will cause at least a week of lost time.

December 31—Walter M. Kunsch, formerly Superintendent of the plant at Danbury, Conn., and more recently of the sewage works at a naval depot in Rhode Island, arrived to look over the plant he will supervise as Engineer-Manager beginning tomorrow. It pleases us to know that the affairs of the District will be in such capable hands.

So ends an interesting, educational and enjoyable chapter in our professional experience. It has been very worthwhile to obtain the point of view of the plant operator at first hand, which viewpoint we believe will be valuable in tempering our judgment as we engage in other branches of the sewage works field.

HEALTH AND SAFETY IN THE OPERATION OF SEWERAGE SYSTEMS *

By Louis Olsen

Health Officer, Palo Alto, Calif.

The first essential of a program of health and safety in any business is an active, sustained interest in safety and accident prevention. The responsibility for accident prevention rests primarily upon management, but both management and workers must know and appreciate the problem to make prevention effective.

* Presented at 17th Annual Meeting, California Sewage Works Association, Fresno, June 22–25, 1944.

Accident Facts

A few accident facts may serve to stimulate interest. Loss of life today is commonplace, though none the less tragic, while the conservation of life and manpower was never more necessary. In fact, the rising toll of life taken by accidents prompted the President to issue a proclamation in 1941 calling on all citizens to enlist in a concerted and intensified campaign against accidents under the leadership of the National Safety Council.

War casualties naturally overshadow accident figures, so a comparison will emphasize the magnitude of the latter. According to press reports the total war casualties for the United States from Pearl Harbor to the European invasion was in the neighborhood of 200,000. This includes those killed, injured and missing. For the single year 1942, the last for which published figures are available, there were 93,000 accidental deaths and 9,200,000 non-fatal injuries. It is difficult to place a monetary value on such losses, but it is estimated that for this period accident costs amounted to about $5,200,000,000, including wage loss, medical expense, overhead costs of insurance, property damage in motor vehicle accidents and fires, and the so-called ''indirect'' costs of occupational accidents.

The place of accidental deaths in the list of leading causes of death has risen from sixth in 1900 to fourth in 1941. In the ages 2 to 28, accidents kill more than any disease, while in the ages 2 to 38, accidents kill more males than any disease. Knowing the facts, there should be enough interest from a self-preservation standpoint alone to support an attack upon the problem.

Insurance Rates

The limited number of accidents reported from the operation of sewerage systems is due, in part at least, to the relatively small number of employees engaged in this occupation as compared with industries employing hundreds of thousands. The list of hazards found in sewage treatment plants and sewerage systems is impressive and the accident frequency greater than is generally realized. In the absence of comprehensive accident reports the rates charged by insurance carriers for compensation insurance constitute a means of comparison with other occupational risks. It should be pointed out, however, that the rates are based on losses only. The State Compensation Insurance Fund reports rates for sewage plant operators of $1.50 and for sewer cleaning $2.18 per $100 of payroll. These compare with general municipal officers, $0.53; machine shop, $1.67; sheet metal, $1.79; water works, $1.90; firemen, $2.44; and police, $2.92. On this basis, sewage plant operators are in only slightly less hazardous work than sheet metal and machine shop workers, while sewer cleaning ranks a little below firemen.

Special Hazards in Sewage Works

In addition to the usual industrial risks accompanying mechanical operations and the use of machinery, sewage works operators are subject to two special hazards, noxious gases and infections. The most serious is the danger from noxious gases. Various harmful gases often accumulate in sewers as the result of fermentation or decomposition of the organic matter deposited there. In addition, gasoline and oil from filling stations, garages and automobile repair shops, and other inflammable liquids from dry-cleaning establishments, fuel gas manufacturing, ammonia refrigerating plants and other industrial activities find their way into sewers. Before the paving of streets, fuel gas from leaking mains found its way to the surface and passed off into the air above. Now, because of fewer such outlets, it frequently finds its way into a sewer. Certain of these gases may cause serious fires or may explode when mixed with the right proportions of air. Some may asphyxiate or poison persons exposed to them. Some of the gases, being heavier than air, will be found in the bottom of manholes or tanks when the upper air may appear perfectly safe. A number of lives are lost each year by gas due simply to a lack of oxygen in the air breathed.

Sewage may contain disease producing organisms such as typhoid and dysentery bacilli, and pus-producing organisms such as streptococcus, staphylococcus and colon bacillus. It has also been suggested that poliomyelitis virus may be carried by sewage and it is possible that research may add other diseases. The organisms of typhoid and dysentery cause disease when taken into the body by way of the mouth. The others gain entry through a small abrasion or cut in the skin and may cause infection, blood poisoning and death.

Basic Principles of Industrial Safety

Before listing in detail some of the safety measures known to be effective in the face of these hazards, a consideration of the basic principles of industrial safety will be helpful. The occurrence of an injury always results from a sequence of factors, one of which is the accident itself. An accident can occur only when preceded by or accompanied and caused by one or both of two circumstances—the unsafe act of a person and the existence of a mechanical or physical hazard. The unsafe acts of persons are responsible for the majority of accidents. Also, the unsafe act of a person does not invariably result in an accident and injury, nor does a single exposure of a person to a mechanical hazard always result in accident and injury. The most common sewage works accidents reported in the literature are explosions and here we have a perfect example of the above—the existence of a physical hazard and the unsafe act of a person. The reasons that permit the occurrence of unsafe acts of persons provide a guide to the selection of appropriate corrective measures.

Safety measures applicable to sewage works operation include the fundamental safe working habits recommended for industry as well as specific measures for gas and infections. They include the following:

Fundamental Safe Working Habits

1. Employees must know or find out how to do a job safely and do it only that way.
2. Most injuries, particularly strains, occur in handling materials and heavy objects. It is advisable to judge first the weight and bulk of the load, since it may be necessary to get help or use a truck, crane or mechanical aid. Observe proper stance, lift by using leg muscles, take firm grip and wear hand protection.
3. Machinery should be shut down and, if necessary, switch locked or tagged while repairs, adjustments or other work is being done on it.
4. Protection equipment, such as goggles, masks, protecting gloves, safety shoes and other special equipment required by the work, should always be worn.
5. The right tool or implement must be used for the job and used correctly. Defective tools should be discarded.
6. All machinery guards are for workers' protection and must remain in place. This includes guarding of belts, gears and moving parts, as well as fencing, chaining and protection of danger spots.
7. Places in plants which are hazardous due to harmful gases, electricity, or other dangers should be marked. Special colors, such as orange, blue and yellow, have been suggested for identifying particular hazards.
8. It is dangerous to stand or walk under suspended loads, or on railroad rights-of-way.
9. Proper signals should be given before backing a truck, making a lift with a crane, or starting a conveyor machine.
10. Ranking high on the list of reasons for sprained ankles and broken legs are jumping from ladders, platforms and moving trucks.
11. Keep walks and floors clean and free of grease, oil and ice. Structures and appurtenances kept in good repair and maintained in tidy condition are conducive to safety.
12. Horseplay, practical jokes and distracting another worker on a critical job are needless acts often resulting in injury.

Protection Against Gas Hazards

1. Atmosphere in sewers, tanks or other enclosed places should be considered hazardous until proved otherwise.
2. Before men enter sewers or enclosed places where gases may be present, tests of the air should be made to detect gases and determine if sufficient oxygen is present.
3. Sewer or enclosed place to be entered should be well ventilated, preferably by forced means.
4. When entering sewers, manholes or tanks, even though no dangerous gases are considered to be present, men should wear safety belts to which are attached ropes leading to the surface where at least one man, preferably two, should be stationed at all times. Belt should grip wearer around the chest and hold him upright so that he can be pulled through the restricted opening.
5. When necessary for men to enter atmospheres containing dangerous gases, they should be provided with some form of personal respiratory protection in addition to the precautions already mentioned. The most satisfactory is the hose-type mask which supplies fresh air from an outside source. Other types of protective devices should be used only for those conditions for which they have been approved.
6. Precautions against explosions and fire include the use of spark-proof electrical equipment. The use of non-sparking tools is recommended when working around manholes and places where explosive gas may be present. Non-sparking shoes or rubbers should be worn. Smoking should be prohibited and approved fire extinguishers provided.

7. First aid measures, including the Schaefer method of artificial respiration, should be thoroughly understood by plant operators and foremen. The Red Cross First Aid Course is recommended. Well stocked first-aid kits should be provided. A list of doctors and ambulances with telephone numbers should be readily available. First-aid measures also apply to protection against infection and general accidents.

Protection Against Infections

1. Facilities for personal cleanliness are of primary importance in guarding against infection. These should include:
   (*a*) Wash bowls with continuous hot and cold water, liquid or powdered soap containers with soap and paper towels.
   (*b*) Shower baths similarly equipped.
   (*c*) Swing doors, with glass ports, to wash rooms, eliminating need to touch with infected hands.
   (*d*) Water foot-valves such as used in hospitals, for same reason.
   (*e*) Hands should be washed thoroughly before eating and at such other times as necessary.
   (*f*) A daily bath or shower should be taken after work.
   (*g*) Overalls or other working clothes should be washed regularly.
2. Prompt first-aid is important. All cuts and scratches, however slight, should be treated at once with a suitable antiseptic and covered with a protective dressing.
3. While reports of typhoid in sewage plants are not common, it seems foolish to take a chance with a serious disease that can so easily be prevented. Typhoid vaccination is recommended for all individuals living under conditions where there is a possibility of exposure. Immunity lasts from 3 to 5 years approximately. The State Department of Public Health recommends immunization of 3 injections followed by 1 injection at 3 year intervals.

The above is only a partial list of safety measures applicable to sewage works operations. Others will readily be apparent. As already stated, the first essential is an active interest in safety. A wealth of material and assistance is available if wanted. The Industrial Hygiene Service of the State Department of Public Health, and the Accident Prevention Bureau of the State Industrial Accident Commission are but two of the agencies ready to help. If there is the will to do, remedies are available which, if applied, are bound to bring results. That sewage works operators and personnel are interested in safety and accident prevention is shown by the relatively low loss that has been achieved.

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TIPS AND QUIPS

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Springing from Springfield, Massachusetts, where the New England Sewage Works Association met for its Spring Meeting on May 17 . . . . a bus man's holiday visiting sewage plants on the preceding day . . . . the Guggenheim process plant at New Britain, Conn., ably attended by John Szymanski . . . . the attractive and well kept plant supervised by George H. Craemer at Hartford, Conn., with its complete equipment for preventing accidents . . . . probably the L. W. Van Kleeck influence . . . . Frank L. Flood and his swarm of 20 army plant operators who moved down from Bradley Field to take in this meeting as the final day of the First Service Command Training School . . . . a total attendance of 110—very satisfactory . . . . an inspection trip to the Springfield plant (an unusual feature at wartime meetings), where Lt. John McDonald demonstrated the facts given in his program paper . . . . a fine example of good design, the Springfield plant features the use of aluminum wherever light weights and corrosion resistance are significant . . . . an Executive Committee session in which a lengthy agenda was executed with unusual thoroughness and dispatch . . . . the well advised selection of F. Wellington Gilcreas as recipient of the Federation's Kenneth Allen Award, in recognition of his past and continuing service to the Association . . . . the courtesy and thoughtfulness evidenced by President Muldoon, Secretary Van Kleeck and many others, bespeaking the utmost for New England hospitality.

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Before leaving New England and the Springfield, Mass., plant, the method of salvaging waste mineral oils from Springfield's many industries merits mention. The first departure from ordinary practice is the use of one of the four digesters only for skimmings from the primary tanks—no sludge being sent to this unit. A hand pump with the suction hose dropped into the annular opening between the outside of the floating cover and the tank wall is used to pump off the oil so collected. This pump discharges into a receptacle containing a simple cloth filter for straining out extraneous solids, whence the oil flows to a storage tank. About 150 gallons of oil is thus recovered daily, which quantity is sufficient to operate the boiler furnishing digester heat and to give an excess of fuel for use at the sewage pumping stations.

Fuel oil rationing? No problem here!

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Another request just received for assistance in preparing a municipal sewer ordinance. Does your city have one that is effective (or would be if enforced)? If so, we could improve our service in connection with these requests if you would favor us with copies.

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Joseph L. Quinn, Jr., Acting Director of Environmental Sanitation in the Indiana State Board of Health, writes with justifiable pride to report on the progress being made by two staff members now on military leave:

"Major B. A. Poole, Chief Sanitary Engineer of the State Board of Health, on leave since July, 1942, with the Sanitary Corps, has been transferred from the position of Regional Sanitary Engineer of the Sixth Service Command, with headquarters in Chicago, to the Office of Chief of Engineers, Repair and Utility Branch, War Department, Washington, D. C. This new position will give Major Poole supervision of all the water and sewage plants operated by the Army in the continental limits of the U. S.

"Captain Paul W. Reed, Senior Sanitary Engineer of the State Board of Health, on leave since April, 1942, has been transferred from Sanitary Engineer in charge of Camp McCoy, Wisconsin, to Regional Sanitary Engineer of the Sixth Service Command, with headquarters in Chicago."

Congratulations, Hoosiers! The promotions are well deserved!

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News Broadcast of the New York State Sewage Works Association (May issue) carries a couple of interesting excerpts from letters written by two of its members on foreign military duty.

The following is taken from a letter written from the Yukon last January by Capt. Joseph A. Salvato:

"It would probably be of interest to you to know that the water temperature is in the neighborhood of 32 degrees F. and that consideration must be given to heating of the water at intake to prevent the formation of needle ice. Hot water or steam lines, recirculating and pumping to waste are resorted to in order to prevent freezing. Although this is said to be a comparatively mild winter, the average temperature last year was reported as 32 degrees F. The maximum was 79 degrees and the minimum 57 degrees below. Under such conditions, effective sewage treatment would require elaborate installations. Private facilities include privies, cesspools, septic tanks and tile fields or the equivalent. A five-foot earth cover over absorption fields was found satisfactory where the system was in use continuously."

Another informative letter from Major A. J. Fuller in China included these paragraphs:

"I really do envy those who have chlorinators, water plants and sewage plants to play around with. Instead of the water-borne sewage system, we have the coolie-borne system—you know, 'The Honey Bucket Parade'—which has been a hit here for centuries. The coolie spreads the sewage out on the adjacent vegetable gardens and there you are—aeration and ultraviolet light treatment complete with vegetables. Good old Mother Nature takes her course.

"Here, one must also learn a slightly different vocabulary in the sanitary field. For example: a filth water filter well is a grease trap and soakage pit; a sewage dugout is a septic tank and a shallow dugout lavatory is a straddle trench, while a filth burning stove is an incinerator.

"As for water purification, turn back the pages of time about 4,500 years and imagine a mandarin of the Tang dynasty bending over a small vessel filled with water, heated by a few embers of burning charcoal where he is preparing the inevitable cup of tea. Like father, like son—and so today as then, we, like the coolie, boil our water over a charcoal fire, or at least we do a bit of flash pasteurization.

"We also have our problems with lice and fleas, although I imagine Egypt is an incubator deluxe. I think that the native of India must have a case-hardened epidermis compared with the Arab of Egypt, as the latter always spends considerable time after his noonday meal to take off his clothes wherever he may be and look for lice just before his afternoon siesta, while the native of India sinks into his daily coma with or without food and lice."

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Superintendent John R. Szymanski at New Britain, Connecticut does not believe in half measures—particularly when there is a war to be won. His 1942–43 annual report points out that there was (*a*) 100 per cent participation by employees in the War Bond purchase program, (*b*) 100 per cent participation in the activities of the Municipal Utilities Division of the City Defense Council, (*c*) 100 per cent participation in the local scrap iron drive and (*d*) approximately 100 per cent increase in the load on the sewage treatment works since the war began.

Which should certainly make it unanimous!

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The following experience is described in the 1942 annual report of Superintendent R. A. Anderson at Muskegon Heights, Michigan:

"Some difficulty was experienced with the operation of the digestion units due mainly to heavy, inert sludge. Being slightly apprehensive as to whether these solids could be withdrawn from the tanks, not quite enough of the heavier sludge was allowed to accumulate. As a result, there was a reduction in gas production of about 2,000 cu. ft. per day over that of the previous year.

"Storage tank inventories showed that the heavy, inert sludge had accumulated to a depth of six feet in one tank and nine feet in the other. Fire hose was obtained and wired to a 20-foot length of 1¼-inch pipe, allowing the pipe to extend beyond the end of the hose nozzle about three feet. The hose and pipe were lowered into the tank until the end of the pipe rested on the bottom and sludge withdrawal was commenced. When the sludge became thin at the outlet the hose was moved to another position by means of a sash cord attached to the lower end of the pipe. It was found desirable to have the tank as full as possible in order to provide maximum pressure on the discharge line as this line was subject to some clogging difficulty.

"All of the heavy sludge in the two tanks was withdrawn successfully by this method."

The Yeomans Guard warns about sabotage to pumping units by agents of the enemy who function during war or peace:

"Anything that damages the costly sleeves or shafts of a pump is definitely an enemy agent. Packing rings can be cast in this unsavory role if they are not fresh and clean. Therefore, when replacing worn packing rings on your pumps, make a thorough job of it. Don't leave any dry, compressed packing to score metal parts, and don't expose unused spare packing to abrasive dirt. Keep it wrapped."

Or, to put it briefly, "Poor packing practice penalizes pumps!"

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Secretary Arthur T. Clark of the Water and Sewage Works Manufacturer's Association passes on this tip from Ritzville, Washington:

"Tree roots were clogging the city sewers, but Earl Conwell, Water Superintendent, could not identify the trees for removal. 'Taste the roots,' Councilman Ed Lundgren admonished, 'You can tell any type of tree by the taste of the root.' (The sewers are still clogged.)"

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Have you noticed the attention given to plant operation topics in the program of the coming annual meeting of the Federation? The demonstration and discussion of safety equipment will alone justify your attendance. The Operator's Forum theme, "The Effect of Increased Industrial Waste Loads on Sewage Treatment Processes," will also interest many.

Make your transportation and hotel arrangements immediately for the . . . . . .

FIFTH ANNUAL MEETING
FEDERATION OF SEWAGE WORKS ASSOCIATIONS
Hotel William Penn, Pittsburgh, Pa.
October 12–14, 1944

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Editorials

THE FIFTH ANNUAL MEETING

As this is written, plans are well toward completion for the Fifth Annual Meeting of the Federation, to be held at the Hotel William Penn, Pittsburgh, Pa., on October 12–14, 1944. Chairman L. S. Morgan and his Local Arrangements Committee are working out the last of the multitude of details involved in the staging of the meeting. Chairman F. W. Gilcreas and his Program Committee have assembled an outstanding array of speakers and topics, designed to bring something of interest and value to everyone in the sewage works and industrial waste field.

If there be a few who desire assurance that their attendance of this meeting is justified under present wartime conditions, let there be no uncertainty on this account. The Federation's Executive Committee has offered an overwhelming vote of confidence in justification of the meeting, the general opinion being held that the work of the Federation is of utmost importance in both wartime and postwar aspects. Cancellation of our single annual meeting would not have hurried the end of the war one iota—holding it, with your support and attendance, will advance the art of municipal sanitation with lasting benefits in public service. Remember that the *real* cause of the critical transportation situation during the past summer is the "just going places" and vacation travel, which is truly unnecessary. Much of this, particularly by vacationists, will have abated by October.

As to the program, heavy emphasis is given to industrial waste problems, to meet a long-felt need. A full day of the program is devoted to papers and discussions on industrial waste topics. The Friday afternoon symposium is nationwide in coverage, including a discussion of packinghouse waste treatment based on experience at Austin, Minn. and Sioux Falls, South Dakota, by Kenneth V. Hill of the firm of Greeley and Hansen; up-to-date developments in oil refinery waste treatment, by W. B. Hart of the Atlantic Refining Co.; results of extensive research in the treatment and disposal of citrus fruit canning wastes, by Dr. R. S. Ingols, Research Fellow, Florida Citrus Commission; analysis of the diversified industrial waste problem encountered in Connecticut by William S. Wisek, Chief Engineer of the State Water Commission; and, finally, a detailed report, illustrated with moving pictures, of the treatment facilities which handle the phenol wastes from the Dow Chemical Co. plant at Midland, Michigan, by Thomas J. Powers, Superintendent of Waste Treatment.

The Operator's Breakfast Forum on Saturday will comprise a morning-long, open discussion of the "Effects of Increased Industrial Waste Loads on Sewage Treatment Processes." The forum will be conducted under the leadership of Christian L. Siebert, Executive Engineer of the Pennsylvania Sanitary Water Board. This session will also include opportunity for open discussion of the 1943 report of the Federation Committee on Qualifications of Sewage Treatment Plant Operators. It is suggested that every operator be prepared to present his views on this report, which was published in *This Journal,* **15**, 6, 1235 (November, 1943).

A highlight of the meeting will be the Federation Luncheon on Thursday, October 12. Dr. A. H. Stewart, Secretary of Health of the Pennsylvania Department of Health and Chairman of the State Sanitary Water Board, will speak on "Stream Pollution Control in Pennsylvania." The Pennsylvania Sanitary Water Board is one of the oldest pollution control agencies in the U. S. and Dr. Stewart's remarks will be founded upon a wealth of administrative experience.

There is a constant demand for authoritative information on the operation and maintenance of sewerage systems, and the Thursday afternoon symposium on this topic will find good reception. Director E. T. Cranch of the Department of Public Works of New Rochelle, N. Y., will open the symposium with a review of his experience in locating "lost" sewers and manholes with the use of an "M-scope." Problems of infiltration and storm flow in sewers will be ably discussed by Ralph W. Horne of the firm of Fay, Spofford and Thorndike of Boston. The extensive and pioneering research conducted at Los Angeles in connection with ventilation of sewers will be described by Richard D. Pomeroy, Consulting Chemist—a timely and important contribution.

A diversified program is offered in the technical session on Friday morning, October 13. To open the session, LeRoy W. Van Kleeck, Senior Sanitary Engineer of the Connecticut State Department of Health and Chairman of the Sewage Works Practice Subcommittee on Safety, will present a demonstration of the use of various items of safety equipment with a discussion of the salient features and limitations of each. Operators please note! Sewage works designers will be attracted by the paper on design of final sedimentation tanks for activated sludge, in which Norval E. Anderson, Engineer of Design of The Sanitary District of Chicago, will make available the findings and conclusions determined by the District. Those interested in the comparison of high rate and conventional trickling filters, and there will be many, will find much of the answer in the final paper of this session, in which Dr. H. Heukelekian will discuss the biological characteristics of the two types of filters. This paper is founded on a year of study by the Department of Water and Sewage Research of the New Jersey Agricultural Experiment Station.

There will be entertainment, too, to relieve the "solid" technical program. The Pre-Convention Get-Together scheduled for the evening of October 11 will give early comers an opportunity to greet old friends and meet new ones. The Stag Smoker on October 12 will offer the usual fellowship, entertainment and refreshments and the Annual Dinner Dance and Entertainment on October 13 will fittingly climax the social aspects of the Conference. Arrangements are also being made to entertain the ladies, several interesting tours and social events being scheduled for their enjoyment.

As usual, the Manufacturers Exhibit will be an important part of the meeting, so that one may see and hear of the latest developments in sewage works equipment and supplies.

Chairman L. S. Morgan and his several arrangements committees have put in much time and work in setting the stage. Be one of the many who will attend and benefit. Make your hotel and railroad reservations as soon as possible and come prepared for a fine meeting!

W. H. W.

SANITARY CORPS SEEKS SANITARY ENGINEERS

The War Department has granted the Sanitary Corps authority to commission an additional 211 sanitary engineers in the grades of 2d Lt., 1st Lt., and Captain. Qualifications are a degree from a recognized college or university in civil, sanitary, or chemical engineering; and 2 years' experience in sanitary engineering for 2d Lt.; 4 years' experience for 1st Lt.; and 8 years' experience for Captain (for applicants between 38 and 42 years of age).

Further information can be obtained by writing to the Officer Procurement Service Office, located in each Service Command Headquarters, or to the Officer Procurement Service, War Department, Munitions Building, Washington 25, D. C.

A need for 100 sanitary engineers has also been announced by the U. S. Public Health Service. Only those not now engaged in essential civilian health services will be eligible.

Proceedings of Member Associations

FLORIDA SEWAGE WORKS ASSOCIATION

Third Annual Meeting

Daytona Beach, Florida, May 19, 1944

The Florida Sewage Works Association in co-operation with the Florida Section of the American Water Works Association held the annual Short Course School in Water and Sewage Treatment at Daytona Beach on May 17, 18, 19, and 20. One hundred and sixty-four members and guests attended. Of the total registration approximately sixty were Army personnel and twenty-five were Navy—an indication of the extent to which our armed forces are active in water and sewage plant operation in Florida.

The following papers pertaining to the sewage treatment field were presented:

"Water and Sewage Borne Diseases," by Dr. R. D. Higgins, Director, Volusia County Health Department, Daytona Beach, Florida.

"Internal Security," by Captain Frank J. McKee, Sanitary Corps, Internal Security Branch, Headquarters Fourth Service Command, Atlanta, Georgia.

"Florida's Citrus Wastes Disposal Problems," by Dr. Robert S. Ingols, Research Fellow, Florida Citrus Commission, Winter Haven, Florida.

"Design Criteria for Military Sewage Treatment Plants," by John T. Norgaard, Senior Sanitary Engineer, Repairs and Utilities Branch, Office of Chief of Engineers, Washington, D. C.

"The Need for Sewage Treatment in Florida," by J. B. Miller, Chief Sanitary Engineer, Florida State Board of Health, Jacksonville, Florida.

"The University of Florida Industrial and Engineering Experimental Station," by George W. Reid, Sanitary Engineer, College of Engineering, University of Florida, Gainesville, Florida, with discussions by Joe Williamson, Jr. and F. A. Eidsness.

"Methods of Financing Sewerage Projects in Florida," by Wylie W. Gillespie, Consulting Engineer, Smith and Gillespie, Jacksonville, Florida.

"Activated Sludge Plant Operation," by John E. Koruzo, Sanitary Engineer, Repairs and Utilities Branch, Headquarters Fourth Service Command, Atlanta, Georgia.

"Chemical Precipitation in Sewage Treatment," by L. L. Hedgepeth, Manager, Technical Service Division, Pennsylvania Salt Manufacturing

Company, Philadelphia, Pennsylvania, with a discussion by Major L. H. Scott.

At the Business Meeting the following officers were elected for the ensuing year:

President: J. B. Miller, Jacksonville
Vice-President: George W. Reid, Gainesville
Secretary-Treasurer: J. R. Hoy, Jacksonville
Director, Federation Board of Control: Fred A. Eidsness, Jacksonville (to 1947).

J. R. Hoy, *Secretary-Treasurer*

MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION

Eighteenth Annual Conference

Baltimore, Maryland, May 19-20, 1944

The Eighteenth Annual Conference of the Maryland-Delaware Water and Sewerage Association was held in the Lord Baltimore Hotel, Baltimore, Maryland, May 19 and 20, 1944, with 209 members and guests attending.

The program included the following papers pertaining to the sewage works field:

"Some Observations on Grease in Sewage at Army Posts in this Area," by Major A. E. McCaskey, Repairs & Utilities Section, Third Service Command, Baltimore, Maryland, with a discussion by Ralph Fuhrman, Superintendent of the Blue Plains Sewage Treatment Plant, Washington, D. C.

"Postwar Sanitary Program in the United States," by Dr. Abel Wolman, Professor of Sanitary Engineering, Johns Hopkins University, Baltimore, Maryland.

"The States Will Be Ready This Time," by R. C. Beckett, Chief Engineer, Delaware State Department of Health, Dover, Delaware.

"An Editor Looks Ahead," by Linn H. Enslow, Editor, *Water Works and Sewerage,* New York City, N. Y.

"Information Please," an open discussion conducted by I. M. Glace, Consulting Engineer, Harrisburg, Pennsylvania.

"The 'Why' of Blueprint Now," by E. L. Filby, Field Director, American Water Works Association, New York City, N. Y.

"Industry Co-operates with a Municipality in Solving a Wartime, Industrial Water Demand," by William P. Hill, Chief Steam Engineer, Bethlehem Steel Company, Baltimore, Maryland, with discussions by C. E. Keefer, Associate Engineer, Bureau of Sewers, Baltimore, Maryland, and Norman D. Kenney, Whitman, Requardt and Associates, Baltimore, Maryland.

The following Executive Committee will preside during the coming year: A. L. Genter, Ralph Fuhrman, R. C. Willson, J. B. Benton, R. J. Stewart.

Officers for the ensuing year are:

J. W. Alden, Wilmington, Delaware, *President*
Clarke Gardner, Salisbury, Maryland, *First Vice-President*
J. W. Engle, Washington, D. C., *Second Vice-President*
E. V. Gipe, Baltimore, Maryland, *Secretary-Treasurer*

The Executive Committee appointed Dr. Abel Wolman as Chairman of a committee to choose a recipient for the Kenneth Allen Award, presented to one who has been outstanding in the sewage works field.

E. Virginia Gipe, *Secretary-Treasurer*

NEW ENGLAND SEWAGE WORKS ASSOCIATION

1944 Spring Meeting

Springfield, Mass., May 17, 1944

The Spring Meeting of the New England Sewage Works Association was held on Wednesday, May 17, 1944, at Hotel Kimball in Springfield, Massachusetts, with one hundred and eight members and guests attending. President Joseph A. Muldoon presided.

The reports of the Secretary and Treasurer were read and accepted. Another progress report of the Postwar Planning Committee was presented by E. Sherman Chase, Chairman. In connection with this report a resolution was presented and it was accepted by the membership urging postwar construction of sewerage projects. The resolution is substantially the same as one approved by the New England Water Works Association on February 17, 1944.

It was voted that the Secretary would contact the various State Sanitary Engineers in New England to ask whether a copy of this resolution should be forwarded to the Chairman of their State Planning Board. Inasmuch as the resolution was primarily an approval of the previous New England Water Works Association resolution it did not appear necessary or desirable to forward the resolution to the Board Chairman unless the State Sanitary Engineers felt that it would be of help to them.

The membership stood in silent memory of E. H. Thompson of Stratford, recently deceased.

The first paper in the morning session was given by E. A. Locke, superintendent of sludge digestion and filtration at the Hartford, Conn. Metropolitan District Sewage Treatment Plant, on "Use of Plug Valves Versus Gate Valves for Piping at Sewage Treatment Plants." The next discussion was presented by F. Wellington Gilcreas, Division of Laboratories and Research, New York State Department of Health, on "Considerations in the Safe Utilization of Sewage Sludge as Fertilizer." There was considerable discussion on both topics.

Present at the Heat Table for luncheon were Harry J. Marceau, Alderman, City of Springfield; Edward J. Davidson, Councilman, City of Springfield; George H. Craemer, Second Vice-President; Benjamin H. Grout, Superintendent, Department of Engineering and Streets, Springfield; W. H. Wisely, Executive Secretary-Editor, Federation of Sewage Works Associations, Champaign, Illinois; J. A. Muldoon, President; Lt. John McDonald, former Superintendent, Springfield Sewage Treatment Plant; Frank L. Flood, First Vice-President; George M. Granger, Deputy Superintendent of Sewers, Springfield; C. A. Emerson, Past President, Federation of Sewage Works Associations and Consulting Engineer for the Springfield Plant; and LeRoy W. Van Kleeck, Secretary-Treasurer.

An address of welcome to the membership was given by Benjamin H. Grout, Superintendent of the Department of Engineering and Streets of Springfield. W. H. Wisely, Executive Secretary-Editor of the Federation of Sewage Works Associations, spoke to the membership on Federation affairs and outlined the aims and activities of the Federation. Mr. Emerson, a member of the consulting firm for the Springfield Sewage Treatment Plants, spoke briefly on the sludge drying process as used at the main treatment plant in Springfield. A paper was presented by Lt. John McDonald, former Superintendent of the main Springfield plant, on "Operation of Springfield, Mass. Sewage Treatment Plant with Particular Reference to the Sludge Drying Process."

Lt. McDonald's paper was followed by an inspection trip to the plant in cars furnished by the Springfield Department of Engineering.

LeRoy W. Van Kleeck, *Secretary-Treasurer*

MEMBER ASSOCIATION MEETINGS

Association	*Place*	*Date*
Georgia Water and Sewage Association	Atlanta Municipal Auditorium, Atlanta, Georgia	Oct. 5–7
Federation of Sewage Works Associations	**Wm. Penn Hotel, Pittsburgh, Pa.**	**Oct. 12–14**
Pennsylvania Sewage Works Association	Wm. Penn Hotel, Pittsburgh, Pa.	Oct. 12–14
Missouri Water and Sewerage Conference	Tiger Hotel, Columbia, Missouri	Oct. 30–31
Canadian Institute on Sewage and Sanitation	Toronto, Ontario	Nov. 2–3
South Dakota Water and Sewage Works Conference	Watertown, S. D.	Nov. 14–15

Federation Affairs

FIFTH ANNUAL MEETING

FEDERATION OF SEWAGE WORKS ASSOCIATIONS

In Conjunction With

17TH ANNUAL CONFERENCE,

PENNSYLVANIA SEWAGE WORKS ASSOCIATION

October 12–14, 1944

Hotel William Penn

Pittsburgh, Pennsylvania

PROGRAM

Wednesday Evening, October 11

P.M.

8:30 Pre-Convention Get-Together and Registration—Silver Room

Thursday Morning, October 12

A.M.

9:00 Registration—17th Floor Corridor
Inspection of Exhibits—Ballroom and Adonis Room

TECHNICAL SESSION

Urban Room

Presiding: A. M. RAWN

10:30 Opening the Fifth Annual Meeting of the Federation of Sewage Works Associations
President A. M. Rawn
Greetings from Pittsburgh
Mayor Cornelius D. Scully

10:45 Business Meeting—Federation of Sewage Works Associations
Report of Secretary
Final Report—Committee on Water and Sewage Works Development
E. L. Filby
General Business

12:00 Federation Luncheon—Cardinal Room
Address: Stream Pollution Control in Pennsylvania, Dr. A. H. Stewart, Secretary of Health, Pennsylvania Department of Health; Chairman, Pennsylvania Sanitary Water Board

Thursday Afternoon, October 12

Urban Room

Presiding: Albert E. Berry

P.M.

2:30 Operation of Sewerage Systems—A Symposium
Locating Lost Manholes and Sewers
E. T. Cranch
Infiltration and Storm Flow Control
Ralph W. Horne
Ventilation of Sewers *
Richard D. Pomeroy

Thursday Evening, October 12

Pittsburgh Room

P.M.

8:30 Annual Smoker and Entertainment

Friday Morning, October 13

Urban Room

Presiding: Theodore S. Bogardus

A.M.

8:30 Registration—17th Floor Corridor

8:30 Demonstration of Use of Safety Equipment in the Operation of Sewerage Systems
LeRoy W. Van Kleeck

10:30 Design of Final Settling Tanks for Activated Sludge
Norval E. Anderson

11:15 A Comparison of the Quantity and Biochemical Characteristics of the Film in a Biofilter and Standard Filter
H. Heukelekian

12:15 Luncheon Period—Non-Programmed
Luncheon and Business Meeting of Pennsylvania Sewage Works Association—Forum Room

Friday Afternoon, October 13

Urban Room

SYMPOSIUM ON INDUSTRIAL WASTES

Presiding: A. M. Rawn

P.M.

2:15 Treatment of Packinghouse Wastes
Kenneth V. Hill
Treatment of Oil Refinery Wastes
W. B. Hart
Florida's Citrus Canning Waste Problem
Robert S. Ingols
Industrial Wastes in Connecticut and Their Treatment
William S. Wisek
Treatment of Some Chemical Industry Wastes
Thomas J. Powers

* Tentative.

Friday Evening, October 13

Pittsburgh Room

P.M.
7:30 Annual Dinner and Dance

Saturday Morning, October 14

Urban Room

OPERATOR'S BREAKFAST FORUM

Leader: CHRISTIAN L. SIEBERT

A.M.
8:30 Effects of Increased Industrial Waste Loads on Sewage Treatment Processes
11:00 Discussion of Report of Committee on Operator's Qualifications
12:00 Adjournment

Reviews and Abstracts

H. Gladys Swope
705 Waverly Road, Highland Park, Illinois

SOME ASPECTS OF RIVER POLLUTION *

By H. Clay

The Surveyor, 103, 185-186 (April 21, 1944)

Pollution is defined as the creation of objectionable conditions in a watercourse caused by the discharge of sewage or industrial wastes to the extent that the water may become harmful on public health grounds, or rendered unfit for agricultural and industrial purposes, fishing or other recreational uses.

From the public health standpoint the greatest danger is sewage contamination of water used as a source of domestic water supply. There are no actual standards in England which river water must fulfill to be considered fit for domestic water supply. The standards of the United States Public Health Service are quoted at some length, and the point is made that lowering of ground water levels in England may require more surface supplies to be utilized, in which event adoption of a similar standard may become necessary.

Pollution may also cause transmission of water-borne disease through milk supplies. The use of water polluted by sewage for watering cattle, milk-cooling or washing operations is highly dangerous. Reference is made to an epidemic of typhoid fever at Bournemouth in 1936 which was traced to this cause. Chlorination of sewage effluents discharged to streams is a possibility in the future.

Bathing in polluted water may give rise to diseases of the aural and nasal passages, and the malady known as Weil's disease (leptrospiral jaundice). Attention is also called to the danger to the public health through polluted shell fish.

Fish life may be destroyed by toxic substances or by the low oxygen content of the water. Pollution may first destroy plant life which provides fish food. Deposits on the bed of the stream may prevent development of fish spawn or may cause fish to leave for new environment.

Pollution of streams may also render the water unfit for industrial uses. It is thus seen that a number of interests may be affected. Any consideration of allowable pollution must include the interests of local bodies who bear the cost of works for treatment of sewage or industrial wastes.

The Eighth Report of the Royal Commission contains a suggested classification of rivers based on the 5-day oxygen demand test, as follows:

	5-Day Oxygen Demand p.p.m.
Very clean	1.0
Clean	2.0
Fairly clean	3.0
Doubtful	5.0
Bad	10.0

Dilution factors were worked out for effluents of varying degrees of treatment whereby not more than 4.0 p.p.m. of dissolved oxygen would be taken up, assuming the stream above the outfall had a demand for oxygen of around 2.0 p.p.m. The Royal Commission standard for effluents is 30 p.p.m. suspended solids and 20 p.p.m. oxygen demand.

* A paper read before a meeting of the Institute of Sewage Purification at Birmingham, England, April 20, 1944.

Examples of attempts to control river pollution in the United States are cited, such as the rivers classification of the Sanitary Water Board of Pennsylvania which has three classes of streams, Class A, relatively clean and pure and suitable for water supply after chlorination; Class B, streams in which pollution shall be controlled, and Class C, streams so polluted they are not fit for sources of domestic water supply, will not support fish life, are not used for recreational purposes, and which from the standpoint of public interest and practicability, it is not considered advisable or economical to restore to a clean condition.

The classification of surface waters of the Tri-State Treaty Commission for the Abatement of Pollution of Harbor and Coastal Waters of the Metropolitan Area of New York is cited as follows:

Class A. Suitable for bathing and recreational purposes. Prescribed standards *B. coli* index limit of 50 cc. and maximum dissolved oxygen saturation of 50 per cent.

Class B. Waters not suitable for the above purposes, where the degree of sewage treatment suffices to avoid nuisance by floating solids and the formation of sludge banks, and to effect a reduction in the oxygen demand of the sewage sufficient to maintain a minimum dissolved oxygen saturation of not less than 30 per cent in the vicinity of the outfall during any week of the year.

Rivers of England are much smaller than those of the United States and sources of pollution are much closer together. Abatement of pollution by storm water is more important.

It does not appear that legislation for the creation of Comprehensive River Boards is necessary for solving the problem of river pollution. Where established, Joint Committees have accomplished a great deal. There is no lack of machinery for dealing with the problem. Awakening of the general public to the importance of clean streams and preventing of river pollution would be helpful.

K. V. Hill
T. L. Herrick

Editor's Note: Where two abstractors' names are shown, abstracts were submitted by both and were combined into one.

SEWAGE PURIFICATION SERVICES

The Surveyor, **103**, 235-236 (May 19, 1944)

Research on a Regional Basis

This paper states the views of the Institute of Sewage Purification on possible reorganization of sewage purification services in connection with postwar planning, for submission to the appropriate government departments and other authorities concerned with sewage purification and rivers conservancy. The paper is in memorandum form and is supplemental to a previous memorandum issued by the Institute in November, 1942, in which the view was expressed that the most satisfactory way of dealing with the service of sewage purification was through regional authorities possessing full executive powers over all matters pertaining to treatment of sewage and storm water within one or more catchment areas.

Without disparagement of the excellent research conducted by classicists and a number of progressive authorities, the Institute feels that research in this field under existing conditions suffers fundamentally from lack of funds. Regionalization of services would provide sufficient funds for research without placing undue burden upon any one authority. Research conditions which would prevail under regionalization may be stated briefly as follows:

1. In connection with problems of local importance, most regional authorities would have sufficient autonomy and resources to carry out all necessary research.

2. Larger and more fundamental problems would be more readily solved by well coordinated collective effort supported by adequate financial resources. These would fall into two classes:

   CLASS "A"—Problems confronting several or all regions, *e.g.*, improvements in design of sedimentation tanks.
   CLASS "B"—Problems confronting the service as a whole and also kindred bodies, such as pollution prevention authorities, water supply boards, and agricultural authorities, *e.g.*, pollution involving chemical and biological surveys of rivers.
3. Fundamental research in pure science could be undertaken by a regional authority having qualified personnel and necessary equipment, or in collaboration with the Water Pollution Research Board, or the science schools of universities, and could be financed in whole or in part from the central research fund. To encourage research in pure science, grants could be made to qualified scientists or research scholars, to work in a regional research laboratory.
4. A research panel of sewage experts selected mainly from the regions should be set up by the central research body to act as advisors generally to the body and in particular:

   (*a*) to consider problems affecting the service requiring investigation, and proposals for research thereon; (*b*) to select regions suitable for the prosecution of any particular research; (*c*) to consider application from regional authorities for financial assistance for research; (*d*) to act as assessors of scholarships.

Sewage Sludge Utilization in Agriculture

This subject is discussed in a second supplement to the Institute's memorandum of November, 1942.

Much agricultural land in England has become impoverished through extensive use of artificial fertilizers which lack the humus contained in natural manures. While sewage sludge is a low grade fertilizer, its humus content is valuable and should be returned to the land.

Careful investigation reveals a shortage of farmyard manure to maintain soil fertility. The total amount of sludge produced, if returned to the land, would supply only a small percentage of the balance of organic requirements. In view of this fact, utilization of surplus sludge is a matter of national importance.

Past attempts to promote the use of sludge have not been entirely successful, due to inadequate presentation of the intrinsic value of the sludge and exaggerated claims as to its value as a fertilizer.

Long term trials of sludge now being carried out by the Rothamsted Experimental Station will provide valuable information for future guidance.

Regionalization of sewage service could help in the carrying out of sludge disposal on land in an entire catchment area. The regional authority could act as an agent between the agricultural interests and the sludge producers and provide much better distribution and utilization of sludge.

An example is cited of the service which could be rendered by a regional authority in the collection of straw and composting of the same with sludge to produce a valuable manure. At the present time there is no use for much of the straw produced.

K. V. Hill

BRIGHOUSE SEWAGE DISPOSAL WORKS

The Surveyor, 103, 249-250 (May 26, 1944)

On May 13, 1944, members of the North-Eastern Branch of the Institute of Sewage Purification visited the Brighouse sewage treatment works. This paper describes the principal features of the works and operating results secured.

The plant serves a population of 32,000 from an area of 5,250 acres. The farthest point drained is 6½ miles from the works. Daily dry-weather flow is 2,250,000 gallons made up of 50 per cent domestic sewage, 20 per cent trade waste, and 30 per cent infiltration. The sewage is of "average" strength. The trade effluents consist of silk waste, worsted and wool washings, wire pickling refuse, tannery waste, dye-water and gas liquor.

The plant comprises two detritus tanks having a total capacity of 47,000 gallons, which can be used separately or together, three storm water tanks having a total capacity of 700,000 gallons, five sedimentation tanks having a total capacity of 700,000 gallons, which provide 8 hours' displacement period for the dry-weather flow, 7 Simplex aeration units having a total capacity of 649,000 gallons, ten 100-ft. diameter trickling filters 6 ft. deep and three final settling tanks having a total capacity of 149,000 gallons. These units serve the filters only; the effluent from the Simplex aerators passes directly to the river without sedimentation other than provided by corner pockets in the aerators. Flow of sewage through the plant is entirely by gravity.

Raw sludge is ejected onto sludge drying beds covering 2½ acres and is allowed to air dry. Sludge from the settling tanks following the filters is pumped onto 12 acres of arable land adjoining the works, where it is spread thinly, allowed to dry and then plowed in. No mention is made of the method of disposal of the sludge from the aerators.

Intermittent lime precipitation is carried out when flushes of wire pickling refuse are received, control being effected by means of an automatic pH recorder.

Twenty-five per cent of the sewage flow is treated in the Simplex aerators and the remainder by the trickling filters. The latter were designed to treat 62 gal. per cu. yd. per day, but are now working at about 100 gal. per cu. yd.

During the period April, 1943, to August, 1943, when no picric waste was present in the sewage the 4-hour oxygen absorbed values varied as follows: crude sewage 98, tank effluent 69, aeration plant effluent 31.7, filter effluent 24.4 p.p.m. The B.O.D. of the aeration plant and filter plant effluents were 29 and 29.9 p.p.m., respectively.

During the period September, 1943, to March, 1944, with no picric waste present, the 4-hour oxygen absorbed values varied as follows: crude sewage 73, tank effluent 48, aeration plant effluent 10.9 and filter plant effluent 10.2 p.p.m. The B.O.D. of the aeration plant and filter effluents were 18.8 and 16.3 p.p.m., respectively. The aeration plant and filter plant effluents contained 2.6 and 13.2 p.p.m. of nitric nitrogen, respectively.

K. V. Hill

DEVELOPMENT OF MAIN DRAINAGE IN AYRSHIRE

By John Allan

The Surveyor, **103**, 251–252 (May 26, 1944)

The county of Ayr is segmental in shape extending 63 miles from north to south, and 28 miles from east to west. It is largely agricultural but is also to some extent industrial. It is bounded on the west coast by the Firth of Clyde. It is divided into a series of ridges and valleys and along these valleys flow the rivers and their tributaries. The most important of the rivers are the Garnock, Irvine and Ayr to the north, and the Doon, Girvan and Stinchar to the south.

These physical features favor development of main or valley sewers and to date two such have been constructed, namely (1) the Garnock Valley sewer, and (2) the Irvine Valley sewer.

Garnock Valley Sewer.—This serves the towns of Stevenson, Kilwinning, Dalry, Kilbirnie and Glengarnock, with populations of 10,000, 5,325, 5,820 and 10,100, respectively. Prior to 1929, Kilbirnie, Glengarnock and Dalry had sewage treatment works which accomplished little or no purification. Kilwinning had no disposal works, and Stevenson had a short sea outfall. For these reasons, the Garnock River was seriously polluted. In 1937 the Garnock valley sewer was constructed and put into use. Included in the scheme was the town of Beith with a population of 5,340. The total length of sewer constructed is about 12½ miles, and the greatest distance between any two is 3½ miles. The diameter of the sewer varies from 12 in. to 42 in.; the population provided for is 40,000. The total cost of the scheme was about £160,000. Disposal is through a screening plant to an ocean outfall discharging 470 yards below low-water mark at a depth of 15 feet at low tide.

Irvine Valley Sewer.—This serves the Burghs of Kilmarnock, Galston, Newmilns and Darvel, and the county areas of Hurlford, Crookedholm, Kilmaurs, Crosshouse, Fenwick, Dreghorn, Springside, Dundonald and Drybridge, with liberal allowances for extension. The diameter of the sewer is mostly 48 in., with an average gradient of 1 in 1,760, providing for a discharge of 18,000,000 gal. per day, at three-quarters pipe depth. The approximate total cost was £191,000. This scheme will eventually provide service to every town and village in the Irvine valley.

The author enumerates various methods of treating sewage in seaside towns before it is discharged to the ocean and discusses the merits and demerits of each. The point is made that disposal of untreated sewage may be wasteful inasmuch as the valuable by-products of sludge (for fertilizer) and gas (for power) are thrown away.

K. V. Hill

ANNUAL REPORT OF CITY ENGINEER, JOHANNESBURG, SOUTH AFRICA—YEAR ENDED JUNE 30, 1943

By E. J. Hamlin, *City Engineer*

The City of Johannesburg, Union of South Africa, has five sewage treatment plants in operation. Despite the fact that 96 per cent of the City Engineer's total staff of 416 are on active service, he continues to carry on the many activities coming under his jurisdiction.

The following data are reported for the various sewage treatment works for the year ended June 30, 1943:

Antea Works: The total flow treated during the year was 169.5 m.g. (Imp.), an increase of approximately 26 per cent over the previous year. New industries were largely responsible for the increase. Replacement of certain pumps was required and, as new units could not be imported, two new pumps were built in the city shops. The new pumps are providing very efficient service.

Bruna Works: Sewage flow treated was 863.4 m.g. (Imp.), an increase of 111.7 m.g. (Imp.) over the previous year. The average daily flow was 2.37 m.g., the maximum 3.87 m.g. and the minimum 1.73 m.g., all expressed as Imperial gallons. Of this total flow, 44 per cent was treated in the diffused-air activated sludge units. A new compressor was purchased and installed during the year.

The engine-generator unit, operated on sewage gas, was used 95 per cent of the time and produced 77.3 per cent of the total power required in the plant.

Cydna Works: A total flow of 465.3 m.g. (Imp.) was treated during the year. This represents an increase of 37.6 m.g. (Imp.) over the previous year.

Delta Works: The total flow treated was 960.0 m.g. (Imp.). Operation has been satisfactory but the results indicate that activated sludge treatment is not as efficient for the Rand sewage as biological filters.

A new 300 k.v.a. generator set is being installed. The sewage gas operated alternator was used 94.5 per cent of the time, producing one k.w.h. per 31.4 cu. ft. of gas used.

Klipspruit Works: Although planned construction has been retarded by shortages of labor and material, two trickling filters 100 feet in diameter and 12 feet deep were completed except for the revolving distributor equipment. Four new humus tanks, 40 feet deep and in solid rock, were completed and two more are under construction. With the additional sand filters it is possible to supply local power stations with 2.0 m.g.d (Imp.) of treated effluent.

Heavy scum formations have caused difficulty at digestion tanks by obstructing the release of gas.

The average daily flow treated during the year was 7.61 m.g.d. (Imp.) Total flow at all five plants was 14.34 m.g.d. (Imp.) or 17.21 m.g.d. (U. S.).

A summary of the analytical results at the plants is given in the following table.

Sewage Disposal Works at Johannesburg
Analytical Results July 1, 1942 to June, 1943
Parts per Million

Works and Liquid	Oxygen Absorbed		Settleable Solids. Cc. per Liter 1 hr. Imhoff Cone	Nitrogen				Relative Stability
	3 min.	4 hr.		Nitrous	Nitric	Amm.	Alb.	
Antea Works:								
Screened Sewage	35.9	117.3	10.2			69	17.3	
Tank Effluent	29.3	88.0	0.5			72	11.1	
Final Effluent	6.9	16.5	Trace	0.5	23	22	2.7	100
Bruma Works:								
Screened Sewage	36.6	107.7	30.2			62	24.7	
Tank Effluent	21.9	56.9	0.6			66	8.6	
Final Effluent	4.5	10.1	Trace	0.4	29	10	1.5	100
Cydna Works:								
Screened Sewage	32.5	96.0	18.5			46	17.3	
Tank Effluent	16.7	45.8	0.5			49	9.6	
Final Effluent	4.1	9.5	0.1	0.9	24	10	2.0	100
Delta Works:								
Screened Sewage	41.5	100.5	23.0			64	15.2	
Tank Effluent	29.1	63.6	1.4			71	9.1	
Final Effluent	5.0	8.9	Trace	1.7	18	13	2.1	100
Klipspruit Works:								
Screened Sewage	62.8	176.7	18.2			110	38.4	
Tank Effluent	40.8	103.1	1.3			108	11.4	
Final Effluent (Average 4 methods)	9.5	26.2	0.3	0.7	4.3	49	3.3	81

E. B. Besselievre
Langdon Pearse

ADVANCES IN SEWAGE TREATMENT AND PRESENT STATUS OF THE ART *

Proc. American Society of Civil Engineers, 70, 457–519 (April, 1944)

This report is too long and contains too many facts and figures to permit the preparation of an adequate abstract. The previous report of the Committee covered the period ending with the year 1941. The present report covers the first two years of the war and the attending problems arising from wartime activities.

Several reports on large scale pollution surveys are discussed briefly. It is pointed out that these reports are important in that they point the way to considerable construction, mostly in the years following the war. There are also discussions on experiences with ocean outfalls on the Atlantic and Pacific coasts.

Sewage disposal problems created by wartime activities are discussed. It is shown that problems arise from many causes, such as concentration of population which overtax

* Second Progress Report of the Committee of the Sanitary Engineering Division on Sewerage and Sewage Treatment. Langdon Pearse, Chairman.

existing facilities, the establishment of military camps, and increased industrial waste production. The latter is brought about by the manufacture of explosives and munitions, new industries, and by increased production, particularly meat packing and steel.

All phases of sewage treatment and sludge disposal are covered. Some figures on operating results are presented for activated sludge sedimentation tanks, high-rate filters, vacuum filters, and flocculation of sewage without chemicals. The grease problem and the recovery of grease are discussed at some length. Four cities are listed where skimmings containing grease are sold to rendering plants.

The use of sewage sludge as fertilizer is covered, along with a discussion of the use of fertilizer in wartime.

The report closes with a discussion of poliomyelitis and research on the presence of the virus in water and sewage.

An appendix includes a bibliography of references containing 241 items.

T. L. Herrick

SLUDGE DEWATERING BY THE PORTEOUS PROCESS

Water and Sewage (Toronto), 82, 17 (February, 1944)

In the Porteous process the water affinity of the solids is reduced by heating the sludge to about 360° F. for a short period. After this treatment the bulk of the water can be removed by decantation. The concentrated residue can then be dewatered by means of a suitable filter press. Heat exchangers are used to transfer heat from the cooked sludge to the raw sludge.

In the sludge presses the water content can be reduced to about 40 per cent. The cakes dry further in the open air and can be used as fuel, or if ground can be used as fertilizer.

Advantages claimed for the process are:

1. Complete disposal under all conditions.
2. Freedom from sewage sludge odors.
3. Low plant and operating costs.
4. No chemicals required for sludge conditioning.
5. Elimination of drying beds.
6. Complete sterilization of all sludge.
7. Utilization of the sludge in the form of fuel, fertilizers and extracted grease products.

T. L. Herrick

GAS HAZARDS IN SEWERAGE SYSTEMS AND SEWAGE TREATMENT WORKS REFLECTING EXPERIENCES IN OHIO

By A. Elliott Kimberly

Published in Mimeographed Form by the Ohio State Health Department, Columbus, Ohio

Fatal accidents in sewerage structures occur with sufficient frequency to demand careful consideration of the hazards involved and a study of safety measures. Within every sewerage system oxygen deficits or poisonous or explosive gases may be present. Every manhole is a potential death trap. In Ohio there have been a number of fatalities caused by toxic gases or oxygen deficiencies in manholes or other underground structures. All operators, maintenance men and laborers should be thoroughly familiar with gas hazards in sewerage systems.

During July, 1943, two men lost their lives in a sewer manhole at Willoughby, Ohio. The maintenance crew was clearing a stoppage near the upper end of an 8-inch sanitary sewer. One man entered the manhole and removed the obstruction with a flushing hose following which a large volume of gas entered the manhole causing his immediate collapse. A co-worker without protection of any kind attempted a rescue and also immediately collapsed. The fire department was called and the fire chief using a smoke mask attempted a rescue. The chief also became unconscious but fortunately the precaution of using a rope had been taken and the chief was pulled to the surface and revived. The other two men could not be revived. A representative sample of the gas in the manhole showed on analysis 8.8 per cent carbon dioxide, no carbon monoxide and 8.2 per cent oxygen. Oxygen deficiency was obviously the cause of death. The village now has available an approved fresh air mask and a blower.

On October 4, 1928, two men at Cambridge, Ohio, lost their lives and a third had a narrow escape in a 21-foot pit of a sewage ejector station. Stoppages were frequent and after clearing one stoppage a lantern was lowered into the pit to determine whether or not the stoppage had been completely eliminated. One man descended part way into the pit, was overcome by gas and fell suffering a skull fracture. The service director wearing neither mask nor safety belt attempted rescue and was overcome. One of two other men who had descended only part way was also overcome. The other man was able to struggle up the ladder (14 ft.) and report the accident. Protected by a safety rope and wearing a World War I canister gas mask a member of the fire department rescued the man who had descended only part way. At this juncture a local physician descended without protection of any kind and rescued the service director. The doctor ascertained that the first man was dead before returning to the surface. The man rescued by the fireman lived only two hours. Apparently the cause of the tragedy was hydrogen sulfide in substantial concentration as determined later when the sewer again became clogged. Since 1928 no workman is permitted to enter a manhole without a safety rope and hose mask. However as of the date of the accident the equipment available was entirely inadequate to cope with gas hazards.

On July 12, 1921, two men were killed while repairing pumps at a municipal pumping station. It was the custom in repairing pumps to close the suction valve, remove the plate on the clogged pump and in the absence of check valves allow the sewage in the discharge line to run back into the pit from which it was removed by a hand pump. Following this procedure the two men effecting repairs climbed out of the pump pit and started the hand pump. One noticed a floating board and climbed down to retrieve it and was promptly overcome. The second man attempted a rescue and was also overcome. The service director started down the ladder, became dizzy and returned to the surface. Although partially overcome he was able to shout an alarm. A fireman using a World War I gas mask was able to recover the bodies of the two men neither of whom could be revived. Cause of death was reported to be oxygen deficiency due to carbon dioxide. Since this accident gate and check valves have been installed on the discharge lines from both pumps and a blower has been purchased.

A fatal accident occurred at a sewage treatment plant in May, 1932. The scene was a sludge sampling manhole constructed adjacent to a digester. The manhole which was equipped with a hinged cover and cast iron manhole steps had no ventilation. An operator entered to obtain sludge samples and was overcome by gas and fell fracturing his skull. A consulting engineer working some distance away attempted rescue but was also overcome. Both were removed by firemen wearing gas masks. The operator was revived but died of the injury caused by the fall. The engineer could not be revived.

A gas explosion occurred at the Dayton sewage treatment works in November, 1938. The explosion took place in a covered pipe gallery housing sludge, water and sludge gas piping and connected at both ends to control houses in which were located electric motors and control devices. The explosion occurred at 5:00 A.M. Fortunately there was no loss of life. The explosive force carried sections of the gallery roof as large as 12 ft. × 150 ft. × 8 in. thick a distance of 60 to 75 feet. Investigation revealed that sewage gas from U-tube slurry traps entered the gallery and was exploded by sparks from an electric motor.

In 1936 the U. S. Bureau of Mines issued a special bulletin covering a report of investigations on hazardous conditions in manholes. Gases and sources of such gases commonly encountered in manholes are as follows:

Poisonous: Ammonia from refrigerating plants; benzol from storage tanks; gas oil and carbon monoxide from manufactured fuel gas; exhaust gases from motors; gasoline from storage tanks; hydrogen sulfide from decomposing sewage and coal gas; sulfur dioxide from burning insulation.

Suffocating: Carbon dioxide from products of combustion; sewage, natural gas.

Explosive: Benzol and gas oil from storage tanks; carbon monoxide; ethane from natural gas and manufactured fuel gas; gasoline; hydrogen from artificial fuel gases and electrolysis of water; methane from natural gas, manufactured gas and soil gas (and decomposing sewage and sludge); unsaturated hydrocarbons from fuel gases.

The following safety measures are recommended by the Bureau of Mines:

(*a*) Before workers are permitted to enter a manhole the air should be tested for carbon monoxide, oxygen deficiency, hydrogen sulfide and hydrocarbon vapor.

(*b*) A team of at least two men should constitute a crew for this type of work. No workers should be sent to such a job alone.

(*c*) Workers should be provided with air-line respirators and proper life lines and these must be used.

(*d*) Manholes should be provided with adequate ventilation by means of a blower during the whole time the men are working.

(*e*) Manholes should be constructed with vent pipes where locations permit.

Suggestions relative to design for the elimination of gas hazards are as follows:

(*a*) Provide ground level access to control chambers. (*b*) Provide windows for light and ventilation. (*c*) Install forced draft fans of sufficient capacity to insure a complete change of air in two to three minutes. (*d*) Place in an isolated chamber, accessible only from an external ground level entrance, all gas meters, flame traps, gas compressors and controllers.

Quotations from Keefer, "Sewage Treatment Works" relative to gas hazards are also given.

Costs of necessary protective and testing equipment are given as follows:

2-man hose mask with blower	$200.00
Explosimeter	70.00
Flame safety lamp	7.50
Oxygen deficiency indicator	27.50
Hydrogen sulfide detector	35.00
All service gas mask	35.00

Twenty-two references are given in the bibliography.

PAUL D. HANEY

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SEWAGE WORKS EQUIPMENT AND SUPPLIES*

ALUMINUM COMPANY OF AMERICA

Gulf Building, Pittsburgh, Pa.

ALUMINUM IN THE SEWAGE WORKS

From the viewpoint of the Sanitary Engineer, aluminum's resistance to the corrosive action of atmosphere and chemical compounds is of prime importance. This resistance is a result of the oxide coating which forms over the metal upon exposure to air, and it is this same film that gives aluminum its stability in the presence of many chemical compounds, gases and complex solutions. Some chemicals tend to slowly continue the surface oxidation process but, as a rule, the rate of oxidation becomes slower as the reaction proceeds. Strong alkalis dissolve this oxide film permitting chemical action to proceed until the metal is destroyed.

Hydrogen sulfide, which is especially destructive to many common structural materials, is practically without effect upon aluminum and will not corrode the metal even at high temperatures in the presence of steam.

Gaseous or liquid ammonia does not attack aluminum. Ammonium hydroxide or aqueous ammonia attacks the metal only superficially.

Aluminum is not seriously affected by dilute solutions of sulfuric acid at ordinary temperatures, but the rate of attack does increase with increasing concentrations and temperature. Dilute solutions of hydrochloric are somewhat more active toward aluminum than nitric or sulfuric acid of similar strength. Concentrated (80 per cent or above) nitric acid and its vapors have only a slight effect at room temperatures.

Organic acids as a class are not seriously corrosive to aluminum at room temperatures. However, formic acid and organic acids containing chlorine are exceptions and are very corrosive. Others such as acetic, butyric, gluconic, citric, lactic, and tartaric acid solutions have all been successfully handled in aluminum equipment.

Methane is quite harmless to aluminum. On the other hand chlorine, except as a perfectly dry gas, does attack aluminum. Bromine reacts vigorously with the metal.

Solutions of sodium hydroxide or potassium hydroxide in all but the lowest concentrations (below 0.01 per cent) rapidly attack aluminum. For dilute solutions this attack can be prevented by additions of suitable chemical inhibitors. Lime or calcium hydroxide solutions are also corrosive to aluminum but the low solubility of these materials limits the rate of attack.

Aluminum is practically inert to distilled water. Tap waters may or may not attack aluminum, depending upon the nature and concentration of salts dissolved in the waters.

Electrical contact with heavy metals such as copper, iron, nickel and lead can produce galvanic corrosion of aluminum in the presence of an electrolyte. However, contact with zinc gen-

* Contributed by advertisers in this issue.

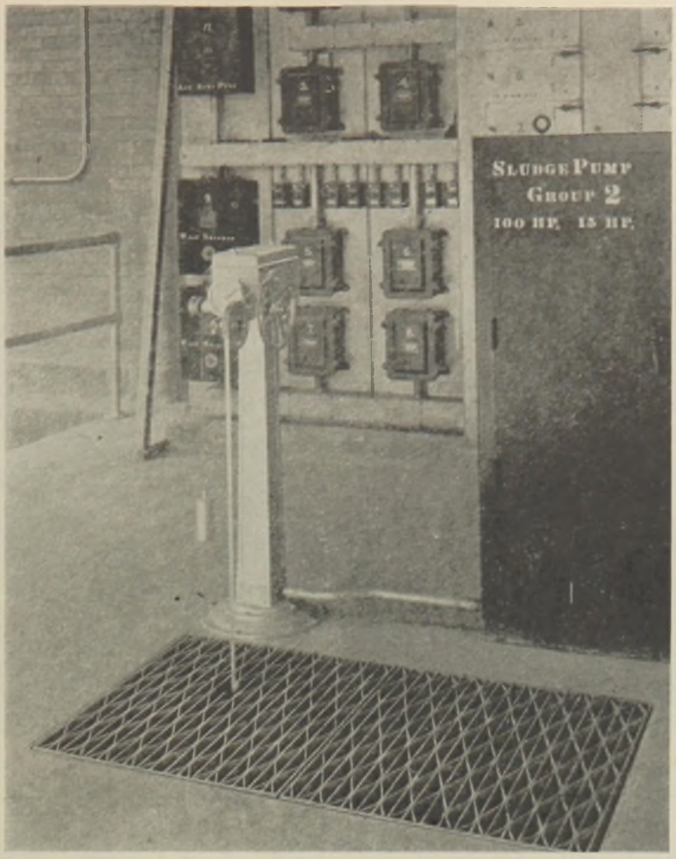


FIG. 1.—Aluminum floor grating and cast aluminum float stand with recorder case.

erally tends to prevent rather than stimulate attack of aluminum since in this case the zinc is corroded galvanically.

When heavy metal salts are present in a solution to which aluminum is exposed, aluminum tends to go into solution replacing the heavy metal which in turn is plated out on the aluminum surface. The deposited heavy metal particles establish local galvanic couples which may further accelerate corrosive action. Certain tap waters, which carry appreciable amounts of heavy metal salts, attack aluminum pipes. The corroded areas usually appear as localized pits.

The choice of aluminum for windows, doors, floor grating, tread plate, conduit, lighting fixtures, hand railings, skylights, and ventilation ducts is primarily a question of economics. An aluminum installation will probably cost somewhat more than one made of ferrous materials, but since aluminum will not require frequent paintings there is a saving in maintenance expense. Aluminum equipment is usually lower in first cost than similar equipment fabricated from non-ferrous metals or stainless steels, and in the great majority of sewage plant atmospheres aluminum has at least equal, if not greater, resistance to corrosion.

During 1931, test specimens of several aluminum alloys were exposed at various disposal plants in widely scattered sections of the country. All these plants handle predominantly domestic sewages. After a two-year exposure period, the test specimens were so little affected that it was believed aluminum

Fig. 2.—Aluminum skylights in use at Easterly Plant, Cleveland, Ohio. They are constructed entirely of extruded sections. The ridge member conceals a screened ventilating device operated from the interior.

could be successfully employed for submerged applications in domestic sewage plants. Numerous installations made since that time have verified that original assumption, and weir plates, sluice gates, collection troughs, cast aluminum diffuser plate holders with their air piping, scum troughs and bar screens are examples of a few of the items which have found a general use.

The aluminum alloys used must be carefully chosen and particular attention must be given to keep the aluminum electrically insulated from dissimilar metals.

Sewages may contain certain elements which of themselves will corrode aluminum but at the same time other elements are present which act as inhibitors or buffers and the metal is thus protected. Single sets of samples for analysis may give a very erroneous idea regarding the average daily contents of a sewage. Comprehensive sampling attended by a complete chemical analysis is not too practical because of the very unstable nature of sewage. A more practical approach is through the actual exposure of alloy test specimens or small pilot plant installations.

While the experience gained by such experimental exposures of specimens has given favorable results in general, local conditions must always be evaluated and a choice of metals made on that basis.

All of the casting as well as the wrought alloys of aluminum, can be given special finishes which greatly enhance their natural resistance to corrosion. The Alumilite and Alrok * finishes are particularly effective, the latter providing an excellent base over which to apply paint or enamel coatings.

* Process patented by Aluminum Company of America.

AMERICAN BRASS COMPANY

Waterbury, Connecticut

EVERDUR FOR SEWAGE TREATMENT EQUIPMENT

Everdur * Metal, The American Brass Company's copper-silicon alloy, is offered as one of the most versatile materials available for the fabrication of sewage treatment equipment. It has given superior service in this field for more than seventeen years.

Everdur, made in several types, consists essentially of copper and silicon, with controlled additions of other elements. The tensile strength, in wrought form, ranges from a minimum of 50,000 lbs. per sq. in. for annealed tank plates to approximately 100,000 lbs. per sq. in. in cold worked forms. Everdur alloys all possess high fatigue resistance and resistance to corrosion equal to or better than pure copper. There are Everdur alloys adjusted for hot working and for cold work and, with two exceptions, these metals are readily welded by either the oxy-acetylene torch or the carbon arc.

* Everdur is a trade-mark of The American Brass Company. Registered in the U. S. Patent Office.

APPLICATION

The principal applications of Everdur for sewage treatment are as follows: coarse and fine screens, swing gates, built-up sluice gates, coarse bar rack aprons, effluent weirs and scum weirs, scum baffles and brackets, troughs, screen hoppers, orifices, baskets, anchors, ladders, float gage chain, valve springs, manhole steps, walkways, bars and plates, bolts and nuts,

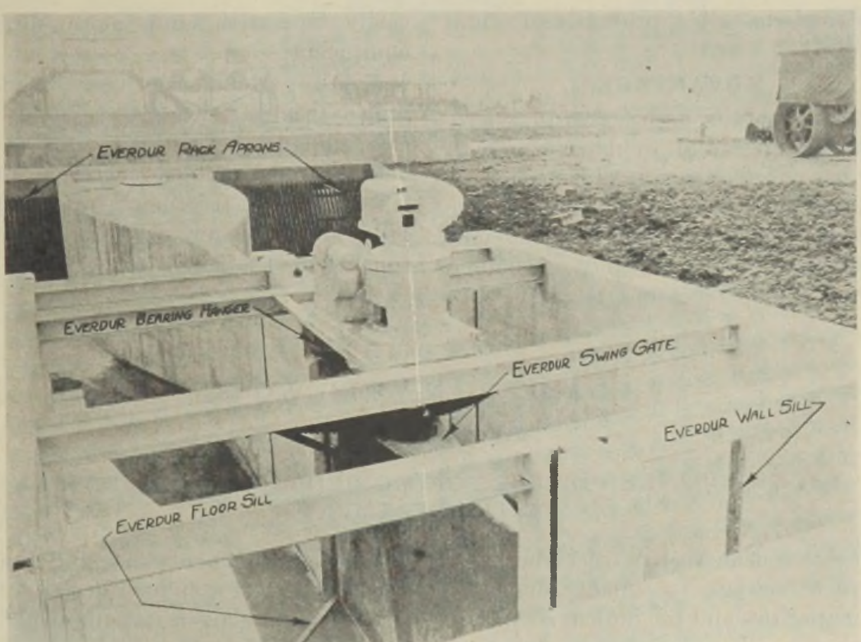


Fig. 1.—Motor operated Everdur swing gate installed in influent flumes at Joint Sewage Treatment Works, Elizabeth, N. J. Gate balances the influent load in each half of the plant.

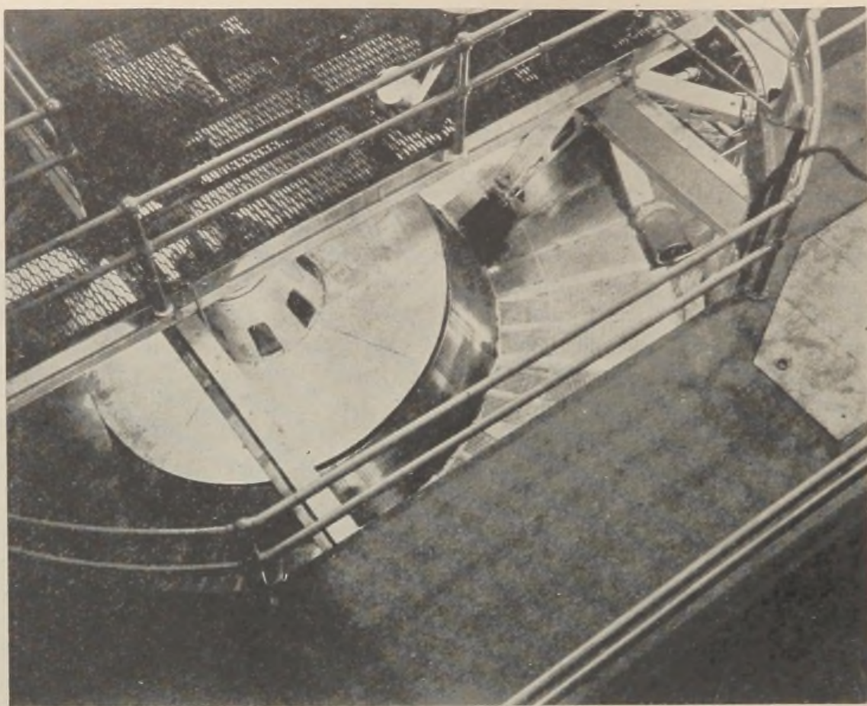


FIG. 2.—Mechanically cleaned fine screen, Bridgeport, Conn., plant, consisting of Everdur plates with milled edges, fastened with Everdur screws.

electrical metallic tubing and rigid conduit.

ADVANTAGES

Because of its high strength, corrosion-resistance and weldability, Everdur has effected considerable economies in equipment previously made of heavy iron castings. Relatively lightweight wrought sheets of Everdur, assembled by welding, provide much lighter, more easily operated, and more durable equipment.

Everdur Metal costs less than most high strength corrosion-resistant alloys, and not only meets many of the definitely determined corrosion problems of sewage treatment, but also provides the necessary additional protection where the forces of corrosion are variable.

THE AMERICAN WELL WORKS

Aurora, Illinois

BACKWASHABLE FILTERS FOR MUNICIPAL AND INDUSTRIAL WASTE TREATMENT

The American Well Works now offers complete sewage treatment for small municipalities and for industrial wastes in a three unit plant, namely, primary sedimentation followed by backwashable filter with separate sludge digestion.

Primary sedimentation and sludge digestion are of standard design. Secondary treatment is accomplished in one unit, by an ultra high rate backwashable filter which is employed to aerate and completely stabilize the waste.

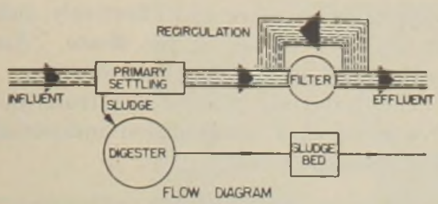


FIG. 1.—Flow diagram of sewage treatment plant incorporating backwashable filter.

The unit consists of a bed of graded anthracite media supported by a false bottom which forms the backwash and underdrain system. Waste is applied to the surface of the media by a rotary aerator, which gives the important uniform dosage over the entire area.

The rotary aerator applies the waste in thin, wide films which trickle uniformly throughout the entire volume of the bed, maintaining optimum contact between sewage, air and the surfaces of the media. The height of the rotary aerator above the bed can be varied to supply oxygen requirements of the water. The rotary aerator maintains the necessary uniform dosage because of its freedom from clogging.

In practice it has been found that backwash runs of approximately one to one and one-half minutes are required to wash the media free of coagulated organic matter. The waste backwash water is returned to the primary tank during off-peak flow periods.

The small media used gives greater surface area per cu. ft. and smaller individual voids per unit volume of filter.

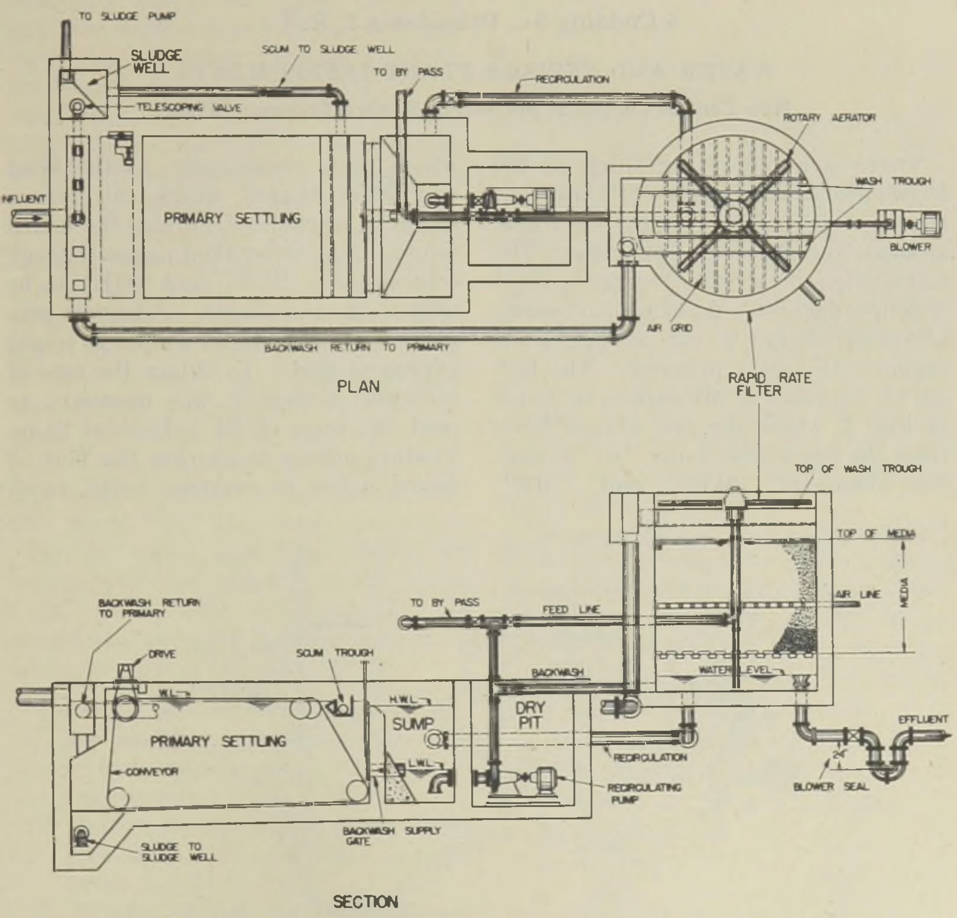


FIG. 2.—Suggested layout of rapid rate filter for sewage treatment plant.

The resulting small interstices limit thickness of bio-jelly growths and, therefore, eliminate internal particle putrefaction. All the biological growth is available for putrification action.

Air is drawn through the bed at atmospheric pressure and effectively aids in the oxygenation of the waste. Air is also used as an aid to backwashing.

The following results are from the treatment of a combination industrial and domestic sewage.

	5-Day B.O.D. (P.P.M.)	Susp. Solids (P.P.M.)	D.O. (P.P.M.)
Raw	350	900	0.0
Primary	169	171	0.0
Filter Effluent	45	47	7.2
Reduction (Prim.-Fin.)	73.5%	72.5%	—
Reduction (Over All)	87.5%	95.0%	—

BUILDERS–PROVIDENCE, INC.

9 Codding St., Providence 1, R. I.

WATER AND SEWAGE PLANT INSTRUMENTS

New Central Control at Milwaukee Sewage Treatment Plant

There is a pioneering spirit at the Milwaukee sewage treatment plant that has kept the plant leading with new methods and improved apparatus. The installation of a new central control system to facilitate closer proportioning of return sludge to raw sewage is an example of recent progress. The layout of the plant at Milwaukee is shown in Fig. 1, where the raw sewage flows from the fine screen house "S" to mixing chambers "MW" and "ME" which lead, respectively, to the West and East Plants where the return sludge is introduced to form the mixed liquor. The latter then passes through control gates "GW" and "GE" to be split to the two plants. Adequate proportioning was not as simple as might appear at first. To obtain the rate of incoming sewage it was necessary to read the rates of 24 individual 24-in. Venturi meters measuring the flow of mixed liquor to aeration tanks, total-

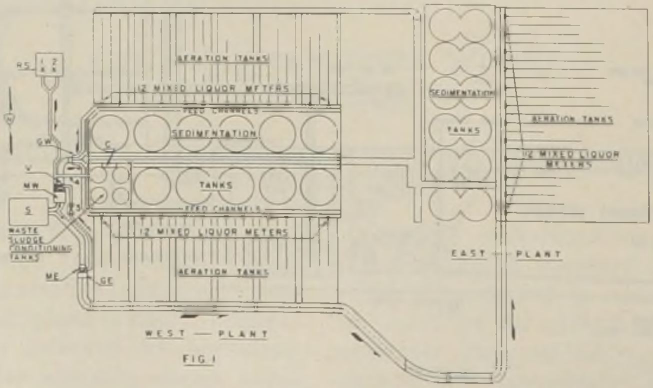


FIG. 1.—Layout of sewage treatment plant at Milwaukee, Wisconsin.

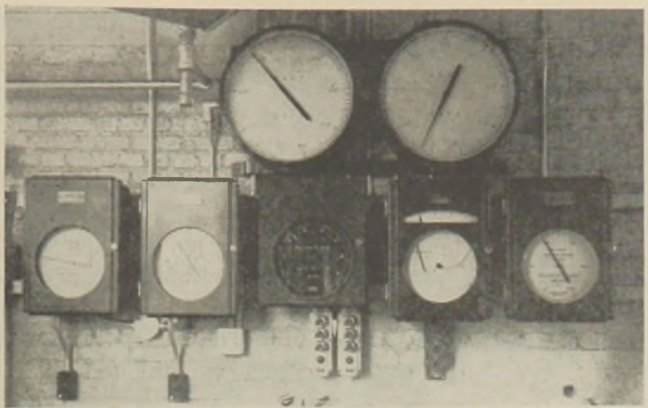


FIG. 2.—Return sludge control panel at Milwaukee, Wisconsin.

ize these rates and deduct the reading of return sludge flow. Readings could not be taken and gates reset more often that once every two hours since the operator walked long distances to make valve readjustments. To say the least, the results were not very satisfactory. Sometimes three trips to No. 3 meter would be required before a satisfactory sludge rate was secured, in a vain effort to produce smooth operating results.

In contrast to the old control, the centralization of flow reporting and control in a central control room "C" (Fig. 1) has maintained a high standard of efficiency. New gauges by Builders Iron Foundry were installed, with telemetered readings, in the control room, and sludge valves motorized with push button control also in the control room. We see in the central control room "C" two large indicators (Fig. 2) which show the amount of opening of the mixed liquor gates "GE" and "GW." Below are five electrically actuated receiver gauges in a row to read as follows:

1 and 2. Return sludge from pumping station—rate indicating, for 48-inch venturi meters No. 1 and 2 respectively.

3. Return sludge to East plant—rate indicating for 36-inch venturi meter No. 3.

4. Return sludge to conditioning tanks—rate indicating, recording, totalizing for 12-inch venturi meter No. 4.

5. Mixed liquor to West tanks—totalized rate of twenty-four 24-inch venturi meters.

Push button controls to valves are visible below the gauges.

All but one of the gauges are Builders Iron Foundry "Chronoflo." Totalizing Gauge No. 5 is of particular interest; this Chronoflo Gauge has, in addition, a Chronoflo "Summator" which receives the impulses from the 24 distant venturi meters. A final integration mechanism, with a Transmitter, gives readings at the Master Gauge (No. 5). The 24 individual venturi meters at the aeration tanks are equipped with Builders "Type M" Indicators to each of which a Chronoflo Transmitter is attached.

To check the accuracy of the summation, many comparisons of the totals of the individual Type M Indicator readings with those of the Master Gauge have been made. The following readings, taken at random from the records, show the closeness of agreement:

Total Return Sludge Flow

(Million of Gallons per Day)

24 Meters	Master Gauge
64.7	65.0
88.0	89.3
99.0	100.0
64.9	64.0
87.0	87.9
101.5	101.0

Thanks to this new equipment, operating procedure is much simplified. The central operator phones the pumping station for the desired rate of return sludge; then the operator adjusts the rate of flow of return sludge to each plant by setting valves "V" with push button controls. The operator observes at a glance any change in sludge flow, while the control room can make precise corrections.

The new equipment has performed so satisfactorily that the 12 venturi meters at the East plant are soon to have automatic summation. It is expected on the basis of late improvements that perfect over all control from central room "C" will soon be possible, and that concentration in the mixed liquor can be held within 1 per cent, year after year. The assistance of Joseph A. Maiers, Field Engineer, and James L. Ferebee, Superintendent and General Manager, is gratefully acknowledged in preparing this article.

RALPH B. CARTER COMPANY

192 Atlantic St., Hackensack, N. J.

53 Park Place, New York, N. Y.

NEW EQUIPMENT ANNOUNCED FOR SEWAGE TREATMENT FIELD

During the past year, the Carter Company has completed installation and witnessed successful operation of two improved types of mechanical equipment which they had recently announced for the sewage treatment field.

Western New York State saw the first Carter fixed roof digesters go into operation, and prove themselves as sturdy, ruggedly designed units, built to handle adequately a tough sewage treatment job. The Carter rotary distributor had its initial installation in Central New Jersey, and here again careful design had introduced several marked improvements over existing competitive units.

The Town of Tonawanda, New York, finding it necessary to enlarge existing plant facilities to handle increased waste capacities from expanded industrial and newly constructed war plants, engaged the firm of Nussbaumer and Clarke, Buffalo, N. Y., Consultants, to plan and supervise the project. Pumping equipment, sludge drying bed and fixed roof digestion were included amongst the required additions.

Considerable difficulty had been experienced at this plant with the existing digesters, especially in the reduction mechanisms. Because of the type of construction employed, industrial plant fly ash would find its way to the reducer bull and spur gears. This ash, when mixed with the reducer lubricating oil, formed a cutting compound that required constant attention and frequent oil changing, to prevent serious reducer damage.

Carter mechanisms with their totally enclosed, triple reduction type units running in an oil-tight housing, were chosen to prevent additional maintenance problems on this score, and also because of the extremely rugged type of design of the rotating elements. Analysis has shown that these Town of Tonawanda 45-ft. diameter units with their heavy duty plow blade trusses, remove grit and similar material regularly, and give a continuous and positive sludge transfer which prevents sludge accumulations in remote tank parts.

The rotating scum breaker arms, which intermesh with fixed arms attached to the tank roof, continuously

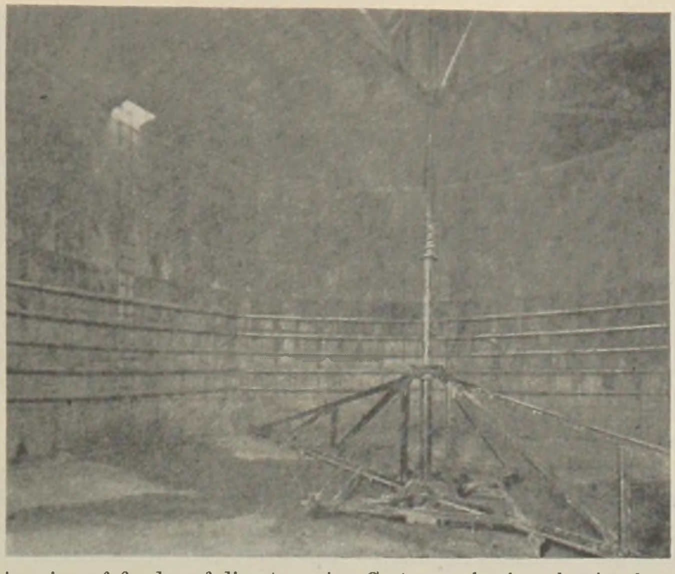


FIG. 1.—Interior view of fixed roof digester using Carter mechanism showing heavy duty spider castings connecting center shafting and truss.

break up all surface scum accumulation, prevent bulking, and permit efficient, continuous gas collection in the gas dome.

The above job, a 40-ft. diameter unit completed and installed for the State of New York at Kings Park Hospital, and several others in various stages of design or erection, promise advantages not previously found in competitive fixed roof types.

The second new piece of equipment announced by the Carter Company this past year, as mentioned above, is a modern and improved reaction type rotary distributor. This Carter distributor, of rugged steel construction, includes such desirable features as an improved type leveling flange, permitting column realignment without disassembly of arms; bronze discharge nozzles which throw a fog-like spray giving maximum aeration and maximum bed coverage, and distributor arms engineered for maximum efficiencies at minimum or peak loads.

Several other units for both water purification or sewage treatment are in the blueprint or test model stage. It is expected that details of this equipment will be announced in the various technical journals, during the latter part of this year.

CHICAGO PUMP COMPANY

2314 Wolfram St., Chicago, 18, Ill.

WIDE-BAND AIR DIFFUSION SYSTEMS WITH SWING DIFFUSERS AND STATIONARY DIFFUSERS, COMMINUTORS, SCRU-PELLER PRIMARY SLUDGE PUMPS, FLUSH-KLEEN SEWAGE LIFT STATIONS, COMBINATION AERATOR-CLARIFIERS, RAW SEWAGE PUMPS, PLUNGER SLUDGE PUMPS AND WATER SEAL PUMPING UNITS

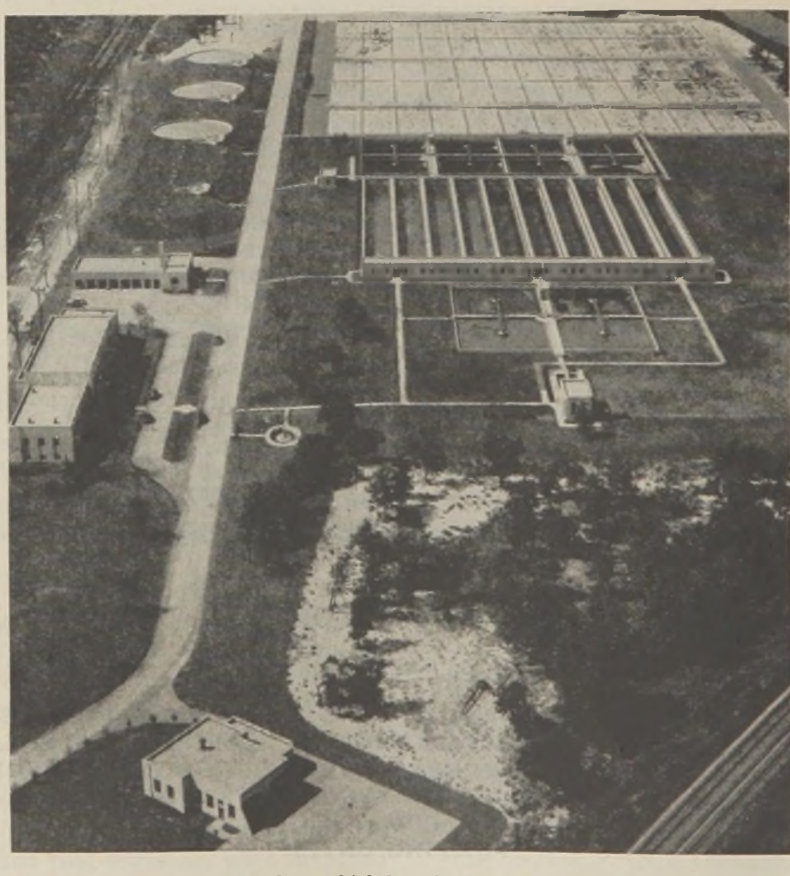
The Chicago Pump Company is continuing its specialization in the activated sludge process of sewage treatment. A competent staff of sanitary engineers devotes its time exclusively to laboratory and field research and to supervising the initial operation of new sewage treatment plants. In addition, our engineers maintain close contact with the superintendents of Chicago-equipped plants and co-operate with them for the successful operation of their plants. We have complete records of the operation of Chicago-equipped plants. These have proved to be invaluable reference data.

PILOT PLANTS

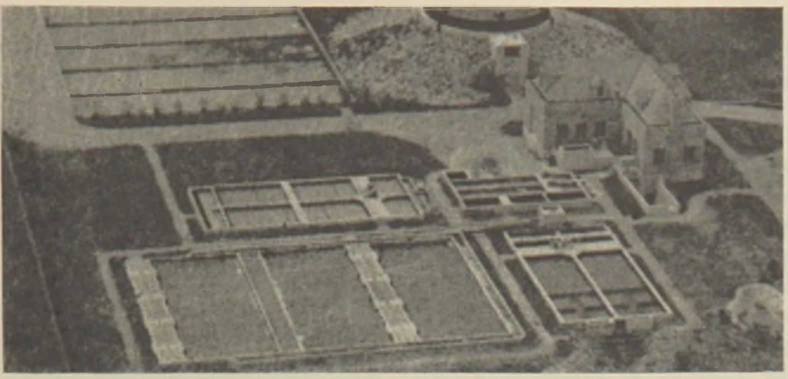
Unusual sewage treatment problems are solved in pilot plants where the aeration period and other variable operational functions can be controlled. The data accumulated makes it possible to determine the proper operation procedure for maintaining the characteristic high degree of purification of the activated sludge process.

CHLORINATION CONTROL

One of the outstanding results of our research work has been the development of procedure for the use of chlorine as a control of the sludge index. Chlorination has been used occasionally for a long time, of course, but experimental work has never been carried out in enough plants in different parts of the country to determine symptoms that indicate whether or not chlorination would be beneficial and to establish procedures for applying to get the desired results.



Gary, Ind., sewage treatment plant which has the Chicago Wide Band Air Diffusers System with stationary diffuser tubes. Five Comminutors cut up the floating solids in the sewage and eliminate the screenings disposal problem. Photo by Chicago Aerial Survey Co.



Celina, Ohio, sewage treatment plant equipped with Chicago Wide Band Air Diffusers System with Swing Diffusers and a Comminutor.

This Chicago "Packaged" Sewage Plant is almost in the front yard of the East End Homes Housing Project at Biloxi, Miss. It was installed above ground because the water table was very close to the surface. The "Chicago" Aerator-Clarifier in plants like this performs the aeration and clarification phases of the activated sludge process in a single tank. Provides for continuous circulation and positive, automatic sludge control. Requires only approximately two hours supervision daily by any average individual trained by Chicago Pump Co. engineers.

GREASE REMOVAL

We have made effective use of our vast experience in the methods of applying air in the activated sludge process by applying it in research work on grease removal problems at war plants. Through experimentation with a scale pilot plant we have worked out a successful grease removal process that requires a minimum of equipment. It is a combination of aeration and a specially constructed tank. The first grease removal plants of this type are now in successful operation.

WASTE TREATMENT

Our work with industrial waste treatment problems continues to progress. Here, too, our experience in the sewage treatment field is of great advantage. The proper methods for treating special wastes are determined in pilot plants set up in co-operation with various industries. Many industrial waste treatment plants now in successful operation are Chicago-equipped based on such experimental work.

INTERMEDIATE, SEMI-COMPLETE TREATMENT

An intermediate, semi-complete treatment process has been developed to meet the demand for a process that is intermediate between primary and complete treatment. It is for use where primary treatment would be inadequate but complete treatment is not required.

The plant consists of comminution, grit removal, abbreviated aeration and settling, with the return of selected sludge. The heavy solids are pumped to the digester in the usual manner, while the lighter, flocculent solids are returned to the aeration tank to aid in coagulation and settling. Plants of this type have now been in successful operation for more than a year.

SWING DIFFUSER IMPROVEMENTS

The installation engineering service furnished by the Chicago Pump Company with the sale of Swing Diffusers has been a source of valuable experience for our engineers. As a result, improvements are being made in equipment design that simplify installation and reduce installation costs, improve operation and increase the life of the equipment. These improvements include a new and simpler air feeder manifold, connecting the air main to the Swing Diffuser, and a new air control valve. Other minor improvements have been made for longer life. There have been no basic changes in the Swing Diffuser.

DE LAVAL STEAM TURBINE CO.

Trenton, N. J.

DE LAVAL OFFERS IMPROVED CLOGLESS PUMP

The De Laval Steam Turbine Co., Trenton, N. J., announces an improved clogless pump incorporating all the basic advantages which have made this pump so well known for trouble-free service in the sewage works field. As in previous models, the large, open, streamlined passages permit the handling of large bodies without choking, wedging or clogging. The efficiency of this pump compares favorably with that of modern clear water pumps and renewable wearing parts make it possible to restore and maintain the original efficiency, with minimum expense, over years of service. The latest models employ an improved, grease lubricated packing box seal which prevents entrance of dirt and grit. Shaft bearing closest to the impeller are of the roller bearing type, to withstand better the heavy shocks occasioned by the striking of heavy objects on the impeller. Improved clearing vanes have been incorporated on the back of the impeller to prevent entrance or entanglement of foreign matter around the hub of the impeller shaft.

Literature will gladly be furnished upon request.

THE DORR COMPANY

570 Lexington Ave., New York 22, N. Y.

During the past year with the rush of work on military camps, bases and ordnance works diminishing, we have been able to devote more time to development work on municipal sewage and trade waste treatment problems. Our program covers the installation of a demonstration and pilot unit combining in a single step the advantages of the Dorrco Vacuator and Dorr Detritor. Full plant scale work is also being studied on a combination of thermophilic and mesophilic digestion. Tests are also being conducted on a special type of round Clarifier permitting primary and secondary sedimentation in the same unit. In addition, two and three stage Biofiltration plants are being operated or installed for the treatment of industrial wastes such as milk, starch, etc., with B.O.D.'s in the raw ranging from 2,000 to 3,000 p.p.m. and effluents of approximately 30 p.p.m. being desired.

BIOFILTRATION

Biofiltration is now an accepted method of sewage treatment, the total number of operating plants exceeding 220 in the United States and other countries. These plants, when operating within their design capacities, have consistently produced the desired character of effluents. They have also demonstrated their ability to absorb shock loads and to continue operation under prolonged overloaded conditions. Due to the type of recirculation employed, septic conditions are absent in Biofilter plants even when operating under very low loadings compared with the design capacity of the plant.

Tests at two milk waste treatment plants using two-stage Biofiltration have indicated 97 per cent or more reduction in B.O.D. Further studies are being made for the adaption of Biofiltration to treatment of trade wastes. In this regard a large trade waste treatment plant is now being constructed to handle a flow of 1.3 m.g.d. containing 2,400 p.p.m. B.O.D. in the raw waste. The total flow is to be given short period digestion at 85° F., followed by three-stage Biofilter plant with desired effluent of approximately 30 p.p.m.

There has been developed also a submerged effluent launder located around the feed well of secondary Clarifiers in Biofilter plants for removal of a portion of the recirculated flow. This development is expected to make much more efficient use of the secondary settling tanks.

VACUATOR

The Dorrco Vacuator has produced good operating results, particularly in regard to handling periodic excessive grease and scum loadings in military installations. The unit is meeting with favorable reception for use along sea coasts as replacements for fine screen installations. This is particularly true in view of the fact that the Vacuator will remove floating grease, oil and other beach contaminating materials. The possibilities of combining in a single unit the desirable features of the Dorrco Vacuator and the Dorr Detritor are being investigated on a pilot plant scale using a representative combined sewage.

DIGESTION

Thermophilic and mesophilic digestion experiments are being conducted to investigate the possibility of reducing the size of digesters required in sewage treatment plants. Indications are that the gelatinous type of sludge obtained from single stage thermophilic digestion will be changed to a readily drainable sludge by subsequent low temperature digestion. Also the poor quality, odorous supernatant obtained

FIG. 1.—An attractively laid out 0.6 m.g.d. two-stage Biofiltration Plant preceded by a Dorrco Vacuator for grease removal. Sludge is digested in a Dorr Multidigestor.

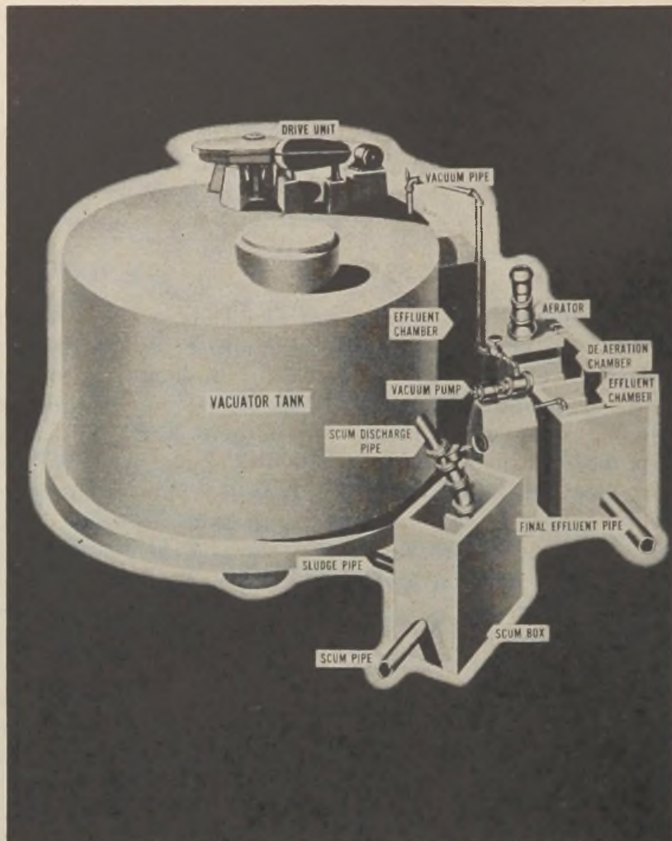


FIG. 2.—The Dorrco Vacuator was developed primarly for the removal of oils, grease scum and light solids from sewage and trade wastes. It is usually installed ahead of primary sedimentation.

from thermophilic digestion will have its physical characteristics changed by second stage mesophilic digestion to a relatively inoffensive material.

Various methods for the treatment of digester supernatant before returning to the main plant are being studied.

DISTRIBUTOR

A field survey has been conducted for the observation of distributors which have been operating for years. The present, improved designs of the Dorrco Distributor, based on actual operation, provide for a unit resulting in trouble-free operation and low maintenance cost.

CLARIFIERS

For the smaller sized projects we are prepared to furnish round Clarifiers in which half the volume will be available for primary sedimentation and the other half for secondary sedimentation. We believe that such units will be particularly applicable to small trade waste problems and will result in a decided saving in installation cost.

Our Sifeed Clarifiers have been functioning satisfactorily for many years and are available for postwar projects. These units are built for long life with low operating and maintenance costs. For example, in one large sewage treatment plant in the United States there are two units which have been operating for approximately eight years and have treated nearly 70 billion gallons of sewage each, without repairs being required to either machine.

DRESSER MANUFACTURING COMPANY

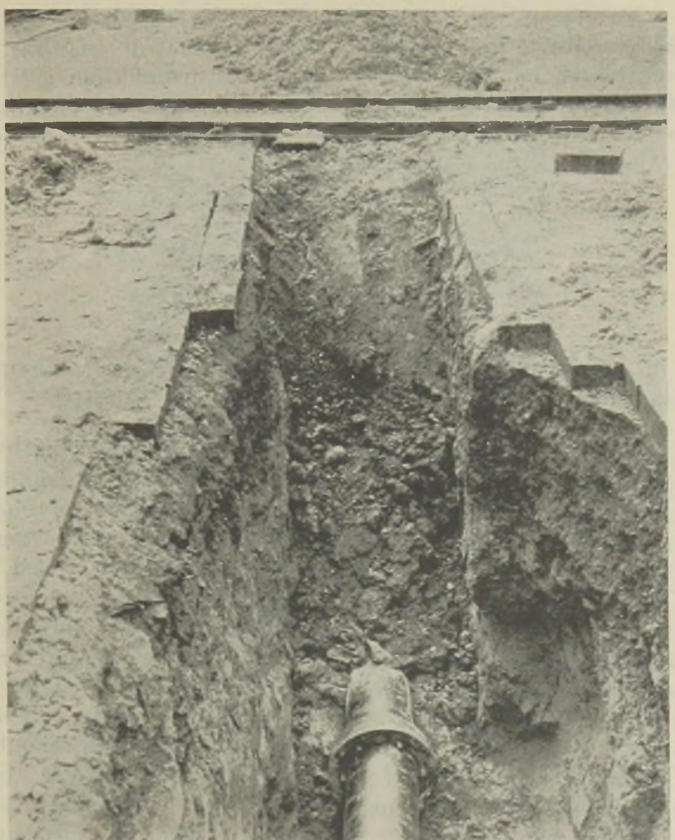
Bradford, Pennsylvania

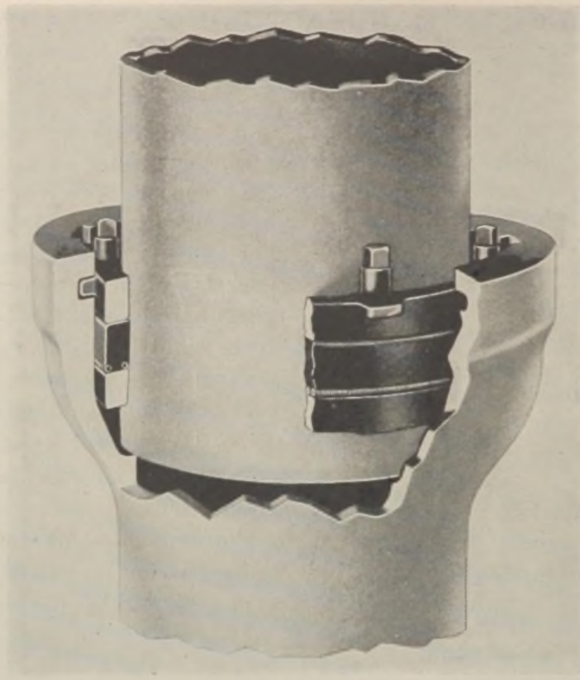
An outstanding product this year is the Style 85 Bellmaster Joint, which is the latest development in a mechanical joint for cast-iron pipe. This joint, first introduced in 1941, was withdrawn from the market temporarily due to wartime conditions, when cast-iron pipe makers were unable to change over and expand their facilities to make the Bellmaster pipe. Pipe has again become available, however, and the joint has been put back on the market.

The Style 85 marks a great stride in cast-iron pipe joining. It provides a ready-made, all-in-one Joint that is inserted into the bell face, locked in place and tightened in from one to four minutes, depending on size.

It consists of a resilient gasket, two light strong malleable rings and a number of capscrews. Compression of the gasket by the capscrews between the rings and against the bell and pipe effects a bottle-tight, flexible seal. Line contents are permanently leak-proof, and both joint and pipe are protected from stress and strains that would cause leaks or breaks in other types of connections.

An important feature of the Bellmaster is the fact that it is completely enclosed within the bell. Only the





heads of the capscrews are exposed. One result of this is that the joint is practically free from attack by electrolytic corrosion, as has been amply proven by exhaustive tests. Another result is that it requires no outside space for installation and may be installed in cramped quarters, up against a wall, and wherever bell-end pipe is used.

ECONOMY PUMPS, INC.

Hamilton, Ohio

Progress in terms of specially-designed precision tools, research and experimental equipment, testing laboratories where all types of actual service conditions are created, a design and engineering staff which is building centrifugal, vacuum and condensation pumps in the progress of three decades of successful experience in the Economy industry.

In participating in the war effort Economy has continued to manufacture products of the regular, peace-time line, many of which have incorporated not only the benefits of past experience, but also improvements designed especially to meet wartime requirements.

"SURE-FLOW" NON-CLOG SEWAGE PUMPS

Economy pumps have been consistently performing to high efficiency standards by virtue of improved features and sound engineering. In passing solids, rags, sticks and trash, high efficiency comes with the use of a heavy duty shaft to withstand shock of temporary unbalance from heavy objects entering the pump impeller, and oversize bearings, widely spaced to eliminate vibration and whip. Design permits use of vertical ball-bearing construction. Units are available in either vertical or horizontal design.

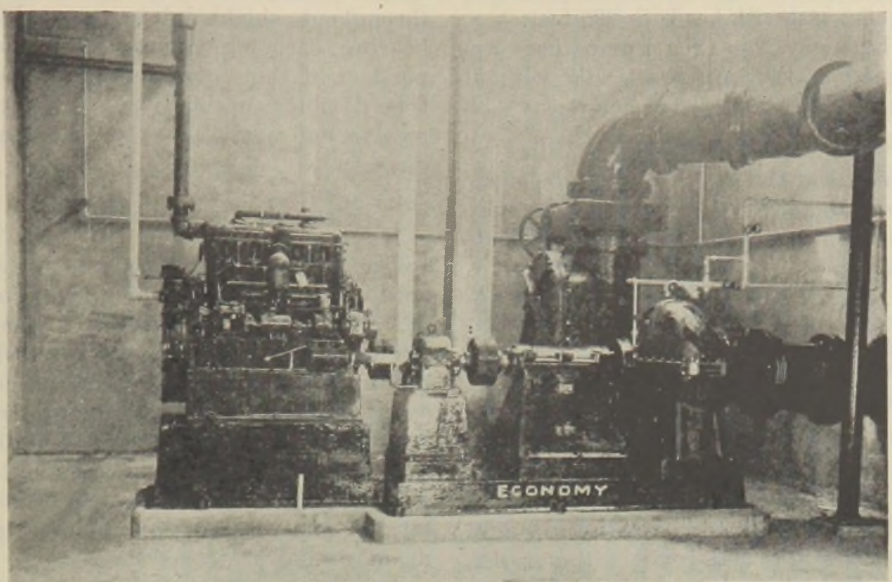


FIG. 1.—City of Battle Creek installation. Sixteen-inch sewage pump, capacity 8,000 g.p.m. at 24-ft. head, driven by gas engine through speed reducer.

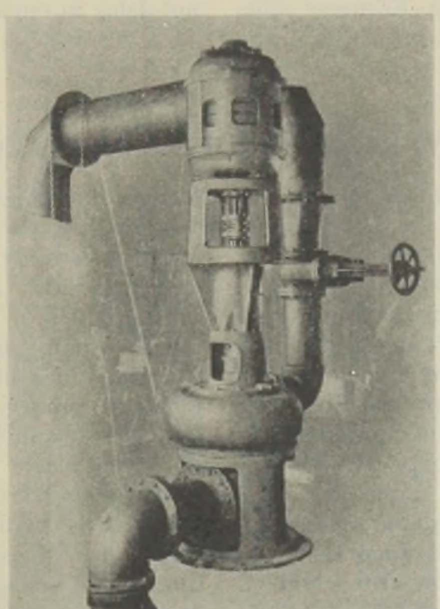


FIG. 2.—City of Houston, Texas. Twelve-inch by ten-inch connected sewage pump, passing 8-inch solids, 3,500 g.p.m. at 27.5-ft. head.

Capacities range from 50 to 20,000 g.p.m., and with heads to 200 feet.

Economy Non-Clog Pumps have applications that are practically without limit. A few are listed below:

Sewage Disposal	Paper Mills
Underpass Drainage	Sludge Removal
Food Industries	Overflow Service
Chemical Industries	Reduction Plants

Vertical Pumps are more economical in floor space, and because of the higher elevation of motor, having an extra factor of safety in the event of flooding.

ECONOMY HEATING SYSTEM PUMPS

Hoffman-Economy Heating Pumps, both vacuum and condensation types, are devised to keep a heating plant clear of condensate and air. The vacuum pump employs the Jet-type Vacuum Producer because of its simple and effective method of removing air and water. Hoffman Economy Condensation Pumps have bronze fittings throughout; shielded deep-groove, ball-bearing carrying pump shaft, independent of the motor bearings; heavy type flexible couplings; and a cast iron receiver, all available in a wide range of capacities and sizes.

NEW PUMP DATA BOOK

The new Pump Data handbook covers a wide field of pumping applications in municipal waterworks, sewage plants, power plants, general industrial requirements, irrigation and many other purposes. Revised and improved, with hundreds of handy tables and diagrams needed every day, it contains 256 pages of data governing the correct layout and installation of sewage, drainage and heating systems.

This book will be indispensable to executives, engineers, plant managers and maintenance men in the designing and operating field. The new edition is now in the course of preparation. Do not delay in requesting a copy.

EVERSON MANUFACTURING CO.

214 W. Huron St., Chicago 10, Illinois

The extent to which sewage pollutes streams is proportional to the B.O.D. of the sewage. Sewage having a high B.O.D. deoxygenates the water in the stream, thereby killing fish and other animal life. Also, putrefactive material in the sewage undergoes bacteriological decomposition, causing unpleasant odors and unpleasant and unsightly sludge deposits in the stream. It is to overcome these things that sewage treatment plants are installed. They are also necessary for safeguarding health.

Authorities are of the opinion that objectionable sewage odors are generally caused by the presence of hydrogen sulfide. Strictly fresh sewage contains little or no hydrogen sulfide, but it usually has a high content of sulfates, which in ordinary water supplies, are quite stable. However, certain sulfate-splitting bacteria present in sewage have the power to break down these sulfates and one of the end products is hydrogen sulfide. Obviously, then, there are two methods of controlling sewage odors. One is to destroy these sulfate-splitting bacteria while the sewage is still in a fresh condition and thus prevent the formation of hydrogen sulfide; the other is to decompose the hydrogen sulfide chemically once it has been produced, to some less objectionable compound.

The benefits derived from the use of chlorine in sewerage systems and treatment plants have been demonstrated so clearly and over so long a period that no arguments are needed to justify this method of treatment.

To review briefly:

(1) Chlorine will prevent odor nuisance and minimize corrosion in long outfall sewers, thus delivering the sewage at the treatment plant in such condition as to make it easier to handle.

(2) Introduced into the flow in the screen chamber, chlorine minimizes odor.

(3) In activated sludge plants chlorine is an excellent means of controlling bulking, thus promoting easier and better operation of the process.

(4) In trickling filter plants, chlorine has been demonstrated to be the best method of controlling the annoying *psychoda*, popularly called the "filter fly."

(5) In any type of treatment works, chlorine is the best known means of sterilizing the plant effluent. Such sterilization is always desirable and is necessary where the dilution factor is low.

There are several supplementary uses of chlorine in sewage treatment. The application of chlorine as a precipitant of certain industrial trade wastes, notably grease and packing house wastes, has been reported favorably. Dosages up to 250 p.p.m. produced as high as 98 per cent suspended solids removal, 95 per cent B.O.D. removal and 90 per cent organic nitrogen removal.

The Everson Manufacturing Company has developed and manufactures chlorine control equipment to meet any and all installation conditions.

Primarily, all Everson SterElators have a 10 to 1 chlorine feeding range—a very necessary feature in order to take care of the inevitable variations, both in rate of sewage flow and chlorine demand.

To meet special conditions, Everson SterElators having a feeding range of 110 to 1 can be furnished. An excellent example of the need of this wide range is found in the Pentagon Building in Washington, D. C., which has its own treatment works. The day flow is high, with widely varying chlorine demand and the night flow very low indeed. Without the 110 to 1 range in chlorine feed these extremes could not be met.

Often, one SterElator is used to feed chlorine solutions to several points of application. To meet this condition, Everson is prepared to furnish a meter solution manifold employing all rubber diaphragm type valves in contrast to the troublesome hard rubber stopcocks, so the operator can accurately proportion his dosage to each point of application.

Everson is prepared to furnish semiautomatic units, designed to start and stop chlorine feed in synchronism with the starting and stopping of sewage pumps.

Where chlorine dosage in proportion to sewage flow is desired, Everson can supply units controlled by any type of weir, by a Parshall flume, a Venturi tube or any other type of differential producing device. Again, when used with several sewage boosting pumps, the rate of chlorine feed can be automatically adjusted to the number and capacity of pumps in operation without the use of weirs, etc.

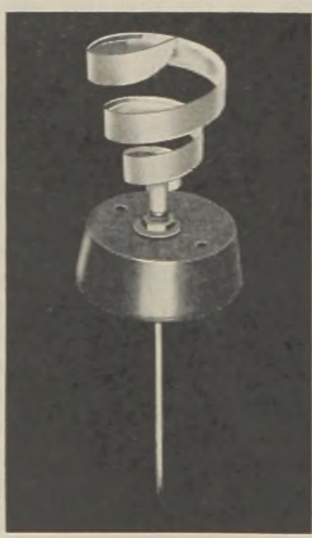
FLEXIBLE SEWER ROD EQUIPMENT CO.

9059 Venice Blvd., Los Angeles, Calif.

MANUFACTURERS OF A COMPLETE LINE OF UNDERGROUND PIPE-CLEANING TOOLS

Although the use of the Flexible Rubber Cup has met with tremendous favor for removing sand, gravel, mud and roots from underground lines in many sections of the United States, there are still many cities with considerable sand troubles that have never yet tried it.

The use of the sand cup depends on utilizing the head pressure in the upper manhole to force the loose matter down the line. It is necessary that the manhole immediately below the stoppages will be able to carry away water from a 2½ inch fire hose with approximately 60 lbs. pressure. If it will not do so, go down the line until you find one that will and clean that section first. If there is a complete stoppage, drill through the line with a 2-inch "corkscrew" until you have a good flow of water.



With this assured, attach an auger to the sand cup and insert into the line. The hydraulic ram, created by the head of water in the upper manhole is a powerful driving force. (The pressure on a 10-inch rubber cup with 10 feet of water in the manhole pushing it is equivalent to a 400-lb. ram—which is

equal to the driving power of several men.) The cup has jet holes which carry a nozzle directly to the load.

Do not crowd the cup. Start turning when the heavier sand begins to pile up in front of the cup. When the water starts rising in the upper manhole, pull back a few feet. This collapses the cup, carrying a nozzle directly to the load of sand which is washed ahead slowly but surely. When the sand builds up level with the sand trap in the lower manhole, remove the sand and continue until the job is complete.

While a 300-ft. section may seem to be entirely full of sand, the amount recovered often seems to be less than expected, even though the line is cleaned completely. The sand seems to act as a binder for semidigested sludge, oils, grease, etc. When the line is completely worked by the rubber cup, up to ¾ of the obstructing substances are often freed from the sand and carried away in suspension.

Scarcity of fire hydrants need not prevent the use of the sand cup. While it will take longer for the water to come down from a hydrant some distance away, there is a longer after flush and, when pressure is built up by manhole reservoir storage, it is just as effective as a close hydrant.

Of course, the best way to work a line that ordinarily carries little water, is to insert a Flexible Rubber Pipe Plug when hydrants are frequent. This eliminates the necessity of backfilling the entire line. When the sand has accumulated at the sand trap and the manhole properly washed, the bailing out process is far more pleasant than before the line has been so worked. It is also less dangerous from a gas standpoint since the gas has been forced off into the air.

The pipe plug illustrated is very useful in cupping a line for sand removal, for rebottoming manholes and for pipe line repair jobs. Many cities are using these pipe plugs in all sizes manufactured by Flexible.

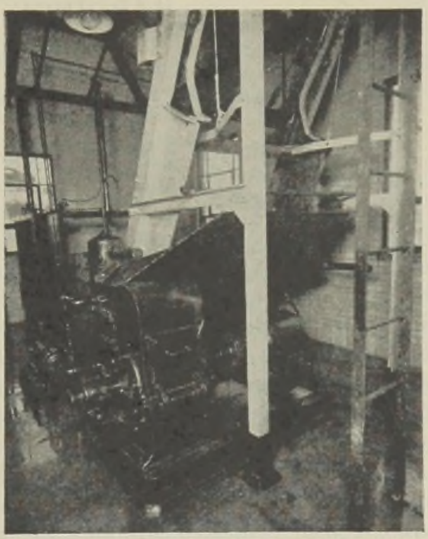
GRUENDLER CRUSHER AND PULVERIZER COMPANY

2915–21 North Market St., St. Louis 6, Mo.

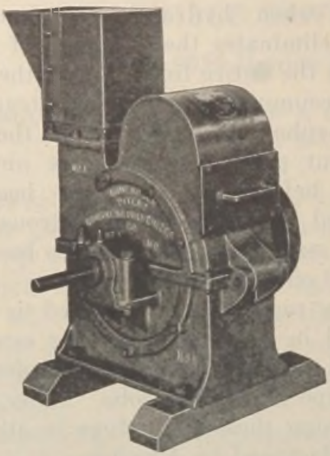
Modern municipal sewage plants install sewage shredders for efficient sewage disposal, and garbage and sludge grinders for by-product production.

Many municipalities in America today are operating Gruendler sewage shredders, garbage and sludge grinders in their sewage disposal plants. Gruendler sewage shredders, selected by sanitary engineers to eliminate the nuisance of undesirable material and waste products clogging valves, have proved successful in operation for many years, with a good record of performance. The U. S. Navy has installed this type of shredder, of smaller capacity, primarily for garbage disposal on battleships and merchant marine. Hundreds of these units were Gruendler garbage grinder installations. These machines operated to perfection in that the complete disintegration of garbage left no trace of floatables or waste on the waterways of shipping, as a tell-tale to lurking enemy submarines.

The new patented features of Gruendler shredders accomplish a complete disintegration of prevailing quantities of rag stock. The features such as non-clogging grate bars, safety tramp iron catchers and improved water sprays and flushers, are outstanding engineering developments of Gruendler. The Gruendler shredder is of the revolving swing-hammer design with



Gruendler No. 2 Peerless Sewage Grinder in operation in Appleton Sewage Treatment Plant at Appleton, Wisconsin.



Gruendler Sewage Shredder handling sewage screenings so that 100% passes bar screen. Disintegrates rag stock and similar materials without choke-downs. Handles garbage and rubbish for incinerator or for fuel.

reversible, double end, cutter hammers. The inside cylindrical, stationary, saw tooth ribbed shredder plate permits the swing hammers, revolving on a rotor at 1,200 to 1,800 r.p.m. against this plate, to disintegrate completely material fed to the shredder. The extra safety feature of the shredder is the tramp metal catcher, since ungrindable foreign material, cans, metal and abrasive pieces, may enter the shredder. This material is caught and trapped, allowing free performance for garbage and sewage disposal without troublesome shutdowns. The tramp metal catcher has an access door or gate so that foreign material can be easily removed.

Gruendler shredders, garbage and sludge grinders are built in all designs and sizes, taking up little space, to fit in with the most complex plant arrangements. The by-product of sludge (dried) for fertilizer, when ground to proper fineness, is efficiently handled by a Greundler sludge grinder.

Bulletin No. 0491, together with specifications and blueprints of suggested sewage plant layouts, are available without obligation at the General Offices of the Gruendler Crusher and Pulverizer Company, 2915 North Market Street, St. Louis 6, Missouri.

HARDINGE COMPANY, INC.

York, Pa.

HARDINGE CENTER PIER, CENTER DRIVE, CLARIFIER

Figure 1 below shows the general arrangement of a large center drive, center pier, 100-ft. Hardinge Clarifier, used for sludge collection in Oklahoma. A feature of this type of clarifier is that the centrally located drive unit is carried on top of the center pier or center steel column, which also supports the rotating mechanism. When the central steel support is used, it is firmly bolted by heavy anchor bolts to a concrete base in the bottom of the tank. Sewage enters the tank through a submerged influent pipe which terminates inside the central stilling well. Clarified sewage overflows a peripheral weir into a peripheral collecting trough while settled solids are collected by the rotating scrapers and moved to the center sludge well.

The line cut drawing (Figure 2) shows more details of the construction of this unit. The drive is enclosed and oil lubricated. The bearing which supports the rotating scrapers is a specially designed ring type ball thrust bearing, located beneath the rim of the main drive gear.

A bridge extends from the side of the tank to the center pier, to provide access to the center driving gear and driving motor. The influent pipe is

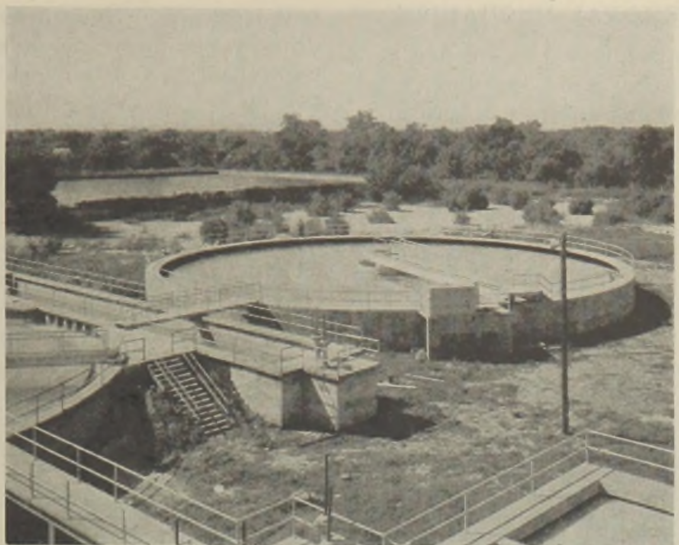


FIG. 1.—100-ft. Hardinge Clarifier in Oklahoma sewage treatment plant.

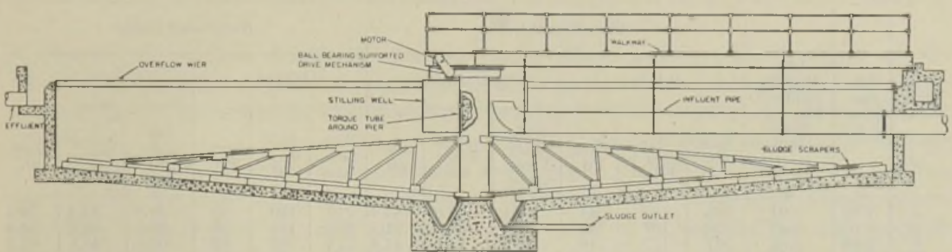


FIG. 2.—Sectional view of Hardinge type "CFCNR" clarifier.

carried by hangers from the underside of the access bridge, aforementioned.

When required, skimmers of the reciprocating type and operated by a separate motor, are provided to deliver scum and floating material into a scum well cantilevered from the side of the tank.

INFILCO, INC.

325 W. 25th Place, Chicago 16, Ill.

ACCELO-FILTERS, ACCELO BIOX PROCESS, ACTIVATORS, CLARIFIERS, SKIMMERS, ROTARY DISTRIBUTORS, AUTOMATIC DOSING SIPHONS, AUTOMATIC PROPORTIONERS, ACCELATORS, CHEMICAL FEEDERS, MIXERS, COAGULATORS, VENTURI TUBES AND CONTROLLERS

NEW DEVELOPMENTS

Active war work continues to hamper research, design and development of new equipment. However, during the past year some progress has been made in this direction and several improvements in present mechanical designs have been completed.

GRIT REMOVAL MECHANISM

Work has progressed on our new grit removal mechanism. Constant and favorable flow conditions maintained in this unit effect selective separation and grit removal from sewage or industrial wastes. This new equipment will be available for postwar sewage plants and will make a valuable addition to Infilco's list of sewage treatment equipment.

HYDRAULIC SKIMMER FOR WS CLARIFIER

Recent studies have been completed to provide the benefits and advantages of the hydraulic skimmer to purchasers of Infilco WS Clarifiers for primary sedimentation. Heretofore, the hydraulic Skimmer was available only with the Infilco PD Clarifier Mechanism.

DIRECT RECIRCULATION AND HIGH CAPACITY BIOLOGICAL TREATMENT

The advantages of direct recirculation of the effluent from either biological filters or activated sludge aeration tanks have been demonstrated at several plants during the past year. Army and Navy installations of the Accelo-Filter continue to show good B.O.D. reductions as indicated in Table 1.

TABLE 1.—*Single Stage Accelo-Filter Operation Results*

Date Oct.	Sewage Flow m.g.d.	Lbs. B.O.D. Applied/ Cu. Yd. Filter Media	Five Day B.O.D.						Suspended Solids					
			P.P.M.			% Removal			P.P.M.			% Removal		
			Raw Sewage	Applied to Filter	Final Eff.	Primary Treatment	Accelo-Filter & Final	Overall	Raw Sewage	Primary Eff.	Final Eff.	Primary Treatment	Accelo-Filter & Final	Overall
4	1.40	1.01	265	142	44	46.4	69.0	83.4	240	120	50	50.0	62.5	79.1
5	1.65	1.41	222	167	42	24.8	74.8	81.1	222	114	38	48.6	66.6	82.9
6	1.68	1.52	247	177	46	28.3	74.0	81.4	224	82	42	63.4	48.8	81.2
7	1.84	1.65	251	176	38	29.9	77.9	84.8	230	88	51	61.8	42.1	77.8
8	1.79	1.75	357	192	56	46.2	70.8	84.4	298	102	60	65.8	42.1	79.8
9	1.80	1.18	241	128	38	46.8	70.4	84.1	256	130	42	49.2	67.7	83.6
10	1.60	1.20	255	147	40	42.4	72.8	84.3	242	110	44	54.5	60.0	81.8
11	1.28	0.91	262	139	36	47.0	74.0	86.3	220	100	32	54.5	68.0	85.4
12	1.66	1.37	237	162	37	29.6	77.2	84.4	236	86	30	63.5	65.1	87.3
13	1.70	1.49	270	172	42	36.3	75.6	84.4	250	112	38	55.2	66.1	84.8
14	1.64	1.49	268	177	34	34.0	80.7	87.3	202	88	35	56.4	60.3	82.6
15	1.41	1.42	282	197	42	30.1	78.7	85.0	282	99	37	64.9	62.7	86.9
16	1.77	1.42	277	157	30	43.3	80.9	89.2	250	96	43	61.6	55.2	82.8
17	1.80	1.65	289	180	38	37.7	78.9	86.8	212	100	38	52.8	62.0	82.0
18	1.44	1.28	294	175	40	40.5	77.1	86.4	218	94	42	56.8	55.4	81.6
19	1.62	1.59	302	192	40	36.4	79.1	86.7	306	114	33	62.6	71.0	89.6
20	1.61	1.54	312	187	46	40.1	75.4	85.2	256	106	32	58.6	69.8	87.5
21	1.63	1.52	322	183	38	42.2	79.2	88.1	282	96	37	65.9	61.5	86.9
22	1.72	1.56	300	178	40	40.7	77.5	86.7	300	111	34	63.0	69.4	92.0
23	1.73	1.60	287	182	44	36.6	75.8	84.6	298	105	35	64.8	66.7	88.2
24	2.00	1.91	272	187	52	31.3	72.2	80.9	250	86	40	65.6	53.5	84.0
25	1.57	1.74	260	217	96	16.6	55.8	63.1	276	107	37	61.2	65.4	86.6
26	1.88	1.55	312	162	60	48.1	63.0	80.7	238	120	40	49.6	66.6	83.1
27	1.80	1.63	282	177	42	37.2	76.3	85.1	286	91	51	68.2	44.4	82.0
28	1.99	1.84	279	181	48	35.1	73.5	82.8	280	108	46	61.4	57.4	83.6
29	2.06	1.91	301	182	46	39.6	74.7	84.6	300	117	64	61.0	45.3	78.6
30	2.07	1.71	246	162	50	33.2	69.1	79.6	256	82	53	68.0	35.0	79.2
31	2.08	2.12	305	200	46	34.4	77.0	84.9	272	101	56	62.8	44.5	79.4
Tot.	48.22	42.97	7797	4878	1251	1034.8	2081.0	2346.3	7182	2865	1180	1671.7	1635.1	2340.3
Av.	1.72	1.54	278.2	174.2	44.7	37.0	74.3	83.8	256.5	102.3	42.1	59.7	58.8	83.6
Max.	2.08	2.12	357	217	96	48.1	80.9	89.2	306	130	64	68.2	71.0	92.0
Min.	1.28	0.91	222	128	30	16.6	55.8	63.1	212	82	30	48.6	42.1	77.8

An average of 2511 lbs. B.O.D. was applied to 1,630 cu. yds. of filter media daily or 1.54 lbs. per cu. yd. Filter effluent in an amount equal to the sewage flow rate (a 1 to 1 ratio) was recirculated directly to the filter. Thus the primary and secondary sedimentation tanks handled only the average sewage flow.

FIG. 1.—2.5 M.G.D. activated sludge plant at Columbia, Missouri, arranged for Accelo Biox operation.

Operating results from an Accelo Biox installation bear out the pilot findings of Mr. J. A. Logan as reported last year.

The return of aerobic organisms to an aerobic process while such organisms are in an aerobic environment and consequently in an active condition, is no doubt the fundamental reason for the success of *Direct Recirculation.* Bacteriologists tell us that the life span of an aerobic bacterium under favorable conditions of environment and food supply is 3 to 5 minutes. That is, within that short time interval an individual aerobe divides and thus multiplies. Kept in an unfavorable environment these aerobia become dormant, and if such adverse conditions persist they may die. The storage of material for recirculation in either primary or final sedimentation basins, where sludge containing these aerobic bacteria is settled under anaerobic conditions must be considered detrimental to any aerobic biological treatment process. Direct recirculation of filter effluent as practiced in the Accelo-Filter and direct recirculation of aeration tank mixed liquor as practiced in the Accelo Biox system affords proof of the theory that the direct return of hungry active aerobic organisms offers the best method of speeding up or accelerating aerobic biological processes. Since sedimentation tanks are designed on the basis of retention time and vertical velocities, direct recirculation offers the favorable advantage of smaller tank construction for these high rate or high capacity biological treatment plants.

Direct recirculation has also been advantageously and successfully used for conventional biological filters to provide increased plant capacity, to improve treatment results, and to eliminate gnat and odor nuisances. The sewage treatment plant at Rocky Mount, North Carolina using direct recirculation has obtained reductions of 96 per cent in the 5-day B.O.D.

Direct recirculation was also included in the design of a conventional trickling filter plant at Lake Geneva, Wisconsin, with the idea of recirculating only during periods of peak flow due to increased summer population load. Excellent operating results have been obtained during the relatively short period that recirculation has been em-

TABLE 2.—*Accelo Biox Operating Data*

Municipal Sewage Plant
Columbia, Missouri
April 1944

Day	Flow m.g.d.	Recirculation g.p.m.	Suspended Solids			5 Day B.O.D.		
			Raw	Final	% Reduction	Raw	Final	% Reduction
1	2.9	4050	114	0	100	70	7.2	90
2	2.8	4050	282	31	89	90	8.0	91
3	2.6	4050	106	10	91	145	11.4	92
4	2.6	4050	180	24	87	115	10.2	91
5	2.7	4050	256	17	93	310	14.4	96
6	2.2	4050	232	13	95	220	14.0	94
7	2.4	4050	188	13	93	160	16.2	90
8	2.2	4050	236	45	81	170	12.8	92
9	2.3	4050	282	72	73	160	3.6	98
10	2.1	4050	240	52	78	*	*	*
11	2.9	4050	256	40	69	*	*	*
12	2.9	4050	164	48	71	90	26.4	71
13	3.0	4050	60	44	27	50	11.4	78
14	3.1	4050	164	16	90	100	3.6	96
15	3.3	4050	*	*	*	*	*	*
16	3.1	4050	*	*	*	*	*	*
17	2.7	4050	120	18	85	15	3.0	80
18	3.2	4050	104	56	46	93	33.0	65
19	3.5	4050	40	48	−20	269	24.0	92
20	3.2	4050	128	20	84	95	0.8	99
21	3.0	4050	100	4	96	129	9.1	88
22	2.8	4050	144	3	98	120	4.4	97
23	3.1	4050	*	*	*	*	*	*
24	3.3	4050	88	14	85	*	*	*
25	3.3	4050	88	3	97	18	2.7	84
26	3.3	4050	76	9	88	*	*	*
27	3.2	4050	56	4	93	*	3.6	*
28	3.0	4050	*	*	*	*	*	*
29	3.4	4050	*	*	*	*	*	*
30	3.4	4050	*	*	*	*	*	*
Max.	3.5	4050	282	77	100	310	33.1	99
Min.	2.1	4050	40	0	−20	15	0.8	65
Av.	2.92	4050	154	25	79.3	127	11.0	88.6

* No determination made.

ployed at this plant. Anticipated peak flow rates have not been experienced due, perhaps, to reduced vacationing and traveling during the war.

The Accelo Biox installation at Columbia, Mo., has operated under adverse conditions of excessive flow rate, low available pumping capacity for activated sludge return, excessive suspended solids content of digester supernatant discharge to the primary clarifier and clogged diffuser plates which became progressively worse until the Accelo Biox tank had to be taken out of service for plate renewal. Consequently, during June, and most of July, the plant has operated as a conventional activated sludge plant. During early operation of the Accelo Biox unit, because of the limited pumping capacity mentioned above, mixed liquor in half of the aeration tanks which were being dewatered, became septic. This septic material had to be put through the Accelo Biox installation.

In spite of these serious difficulties, we were able to obtain satisfactory results during the month of April, as shown in Table 2.

These results compare favorably with those obtained from conventional activated sludge operation during June and July.

New diffuser plates for aeration tank No. 1 and additional return activated sludge pump capacity are being installed as quickly as existing material shortages will permit. These improvements together with better operation of the primary clarifier, digesters and sludge drying facilities will permit successful operation of the Accelo Biox system, and will provide us, we feel confident, with continuous operating data superior to that shown in the accompanying Table 2.

INNIS, SPEIDEN AND COMPANY

117 Liberty St., New York

FERRI-CL$_3$OR (ISCO FERRIC CHLORIDE) AS A COAGULANT FOR SEWAGE AND INDUSTRIAL WASTES

The chemical treatment of sewage and industrial wastes is an effective and economical method of increasing the efficiency of the ordinary sedimentation plant. Such treatment requires but little plant construction or capital investment. It provides a high overload capacity and flexibility in proportioning to produce the degree of purification required. Seasonal loads are readily handled with Ferri-Cl$_3$or treatment.

Ferri-Cl$_3$or coagulates sewage and industrial wastes, thus causing more rapid precipitation in sedimentation plants and faster filtering at vacuum filtration systems. It is most effective in the pretreatment of industrial wastes which change in characteristics almost hourly. Experience has shown that Ferri-Cl$_3$or is also an economical coagulant for sewage and a wide range of industrial wastes.

AMOUNT OF FERRI-CL$_3$OR REQUIRED FOR COAGULATING SEWAGE

Ferri-Cl$_3$or provides an inexpensive and efficient method of dealing with plant overloads, and reduces original plant investment by increasing the capacity of the sedimentation plant.

The accepted procedure in determining the dose of Ferri-Cl$_3$or required to coagulate a given sewage is to set up "jar tests" with sewage to be tested. Two-quart mason jars and stock solutions of Ferri-Cl$_3$or and lime, consisting of 10 grams per liter of distilled water, are used. Place one liter of sewage to be tested in each of several mason jars. Add to the sewage in each jar, successively larger doses of Ferri-Cl$_3$or stock solution. Stir all samples thoroughly for several minutes, and let stand for 1 hour. Observation of the several samples will determine the best dosage. If lime is required to provide sufficient alkalinity for satisfactory coagulation, follow the same procedure outlined for Ferri-Cl_3or. The amount in pounds of Ferri-Cl_3or or lime required equals the number of ml. used in the selected test times 10 times total sewage flow (m.g.d.) times 8.33.

AMOUNT OF FERRI-CL_3OR REQUIRED FOR SLUDGE CONDITIONING

Ferri-Cl_3or is accepted as the agent most efficient from the standpoint of performance and cost for the coagulation of sludge prior to its dewatering in the filter.

Using the Buchner funnel test, the time periods required for the vacuum to break with varying quantities of coagulant are recorded. Two to three minutes is satisfactory and 1 to 1½ minutes is very good and should be used for plants where the sludge is held, as in batch-mixing. Various combinations of Ferri-Cl_3or and lime should be tested until the relative quantities for optimum operation are determined.

The approximate quantities of chemical to be used in the plant can be determined from the laboratory tests, provided, of course, that the same strength chemicals are used in the plant. The quantity of Ferri-Cl_3or solution in gallons per 1,000 gallons of sludge will be 5 times the ml. used per 200 ml. of sludge in the test. Likewise, the quantity of lime in pounds per 1,000 gallons of sludge will be 42 times the grams used per 200 ml. of sludge.

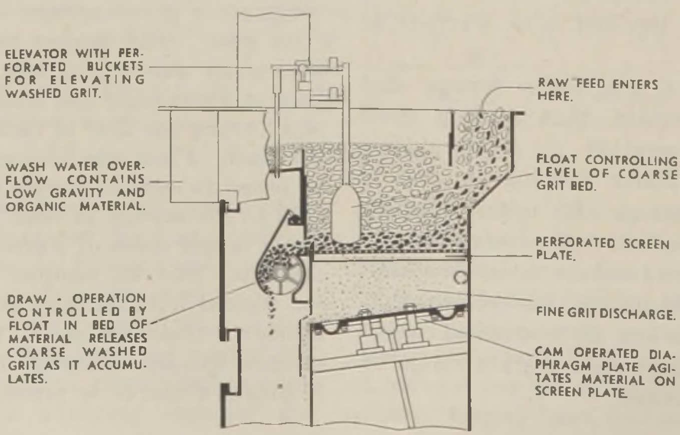
Ferri-Cl_3or is Innis, Speiden & Company's registered name for ferric chloride developed and manufactured especially for sewage and water treatment use.

THE JEFFREY MANUFACTURING CO.

Columbus 16, Ohio

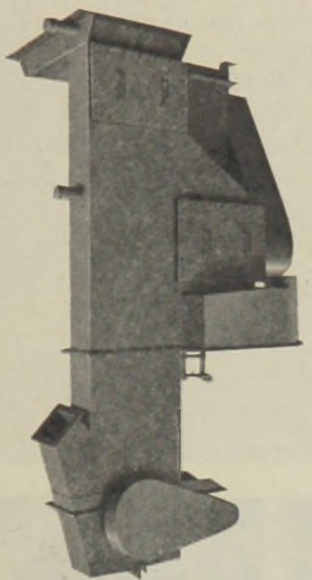
JEFFREY TYPE "S-B" MECHANICALLY CLEANED BAR SCREEN

During the past few years the Jeffrey Manufacturing Company has developed a new screen for sewage plants, based upon an entirely new principle of operation. With this screen the rake approaches the screen bars from the back side at the bottom, and by this means practically eliminates jamming troubles at the bottom of the screen as is so often encountered with screens where



the cleaning rake approaches from the front.

The line drawing and cut show the construction of this screen and several units have been in operation under extremely severe operating conditions for several years.



No. 4. Jigrit Washer.

The screen bars are made up of round rods or flat steel, and are supported only at the bottom and at the top are bent to conform to the travel of the rake. The rakes, attached to chains on either side of the screen, act both as rakes and as means of spacing the screen bars and holding them in line. This type of screen can be operated by time control or differential float.

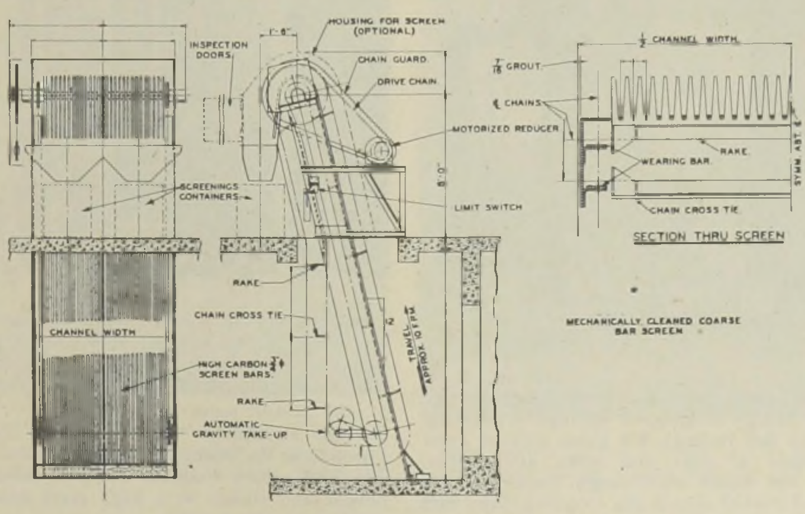
JIGRIT WASHERS

The Jeffrey Jigrit washers are now available in several sizes, to take care of small to the largest sewage treatment plants. These units have been simplified and streamlined in design so that today they are simple, dependable, and outstanding in performance.

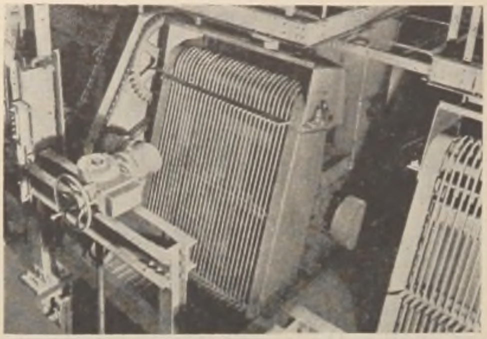
Removals of putrescible solids up to better than 90 per cent are easily accomplished and recovery of approximately 90 per cent of the 100-mesh grit is obtainable.

The line drawing indicates just how this machine operates.

The washer consists of a plate steel tank of all welded construction mounted on a structural steel support. The bottom of the tank is a steel diaphragm plate, circular in shape, which is flexibly connected to the side walls of the tank by a seal-tight rubber ring. Spaced above the diaphragm is an inclined screen plate having ⅜-inch diameter perforations upon which the bed of material is formed. These perfora-



MECHANICALLY CLEANED COARSE BAR SCREEN



Jeffrey Type "S–B" Mechanically Cleaned Bar Screen.

tions permit the passage of the wash water and the discharge of fine grit.

The overall depth of the bed of material is maintained by an overflow weir placed at the end of the tank opposite the feed. An underflow weir at the same end of the screen permits discharge of coarse grit, under control of the float mechanism, to the elevator.

Movement of the diaphragm vertically, in timed cycles, through a connection with a power operated eccentric, causes the alternate opening and then closing of the bed of material formed on the screen plate.

The capacities and other operating data are given in the following table.

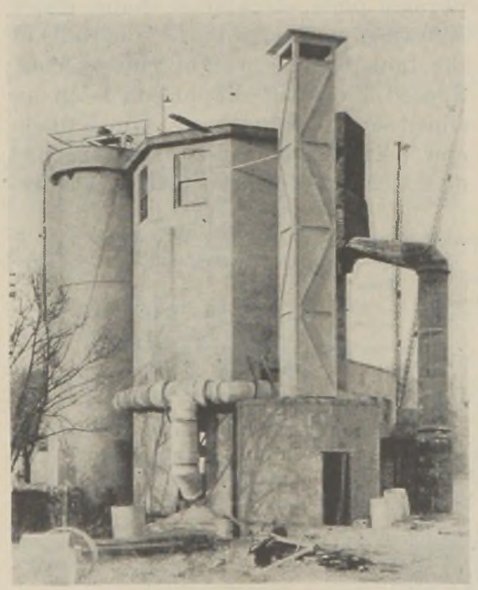
Size	Capacity (Tons Per Hr.)	Wash Water (G.P.M.)
1	1	15
4	6	70
9	14	150

JOHNS–MANVILLE

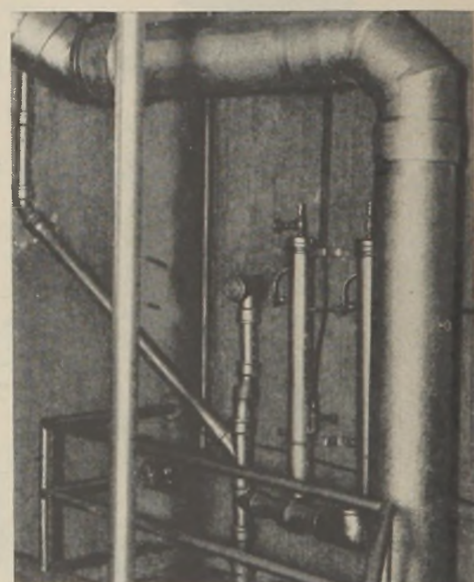
22 East Fortieth St., New York 16, N. Y.

DIVERSE USES OF TRANSITE PIPE

The properties of J-M Transite Pipe that make it an ideal material for sew-

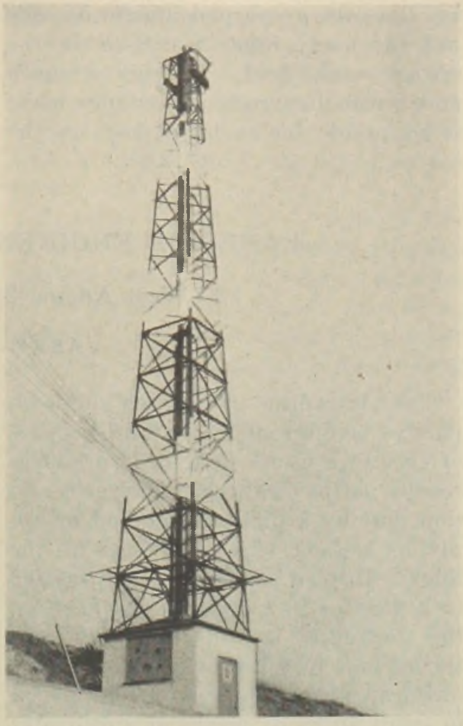


Sludge spray tower in New Jersey sewage plant. Sludge is sprayed through a rotating nozzle to fall through hot gases derived from combustion of coal and some dry sludge. Vapors are drawn off through Transite "S" pipe and vented into a silo to precipitate dust before vapors enter stack.



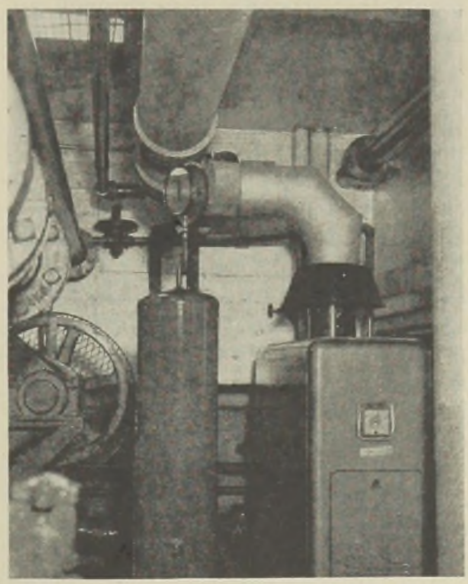
Ventilation of sewage pumping station in Far West is provided by a system of 12-inch Transite "S" pipe. One pipe extends from the lower pit levels to a point above the roof of the motor room where gases are vented through a Transite ventilator top. Exhaust pipes from the pump room, comminutor chamber, and screen chamber are connected to a blower and thence to a high stack some distance from the building.

Long 13-ft. lengths of Transite sewer pipe are quickly and easily installed in Long Island. Tight, sleeve-type joints reduce infiltration to a minimum.



Fourteen-inch Transite stack, 80 ft. high, used to ventilate sewer on West Coast. Pipe is guyed to supporting steel tower. Pipe painted in alternate red and white sections to increase visibility from low-flying airplanes.

Class 50 Transite pressure pipe with Simplex couplings used as distribution piping for sewage filter beds in Ohio sewage treatment plant.



Gas-fired boiler at sewage plant in New York State, vented with 7-inch Transite "S" pipe.

age lines also are responsible for its wide use for many other functions in the sewage works field. Its high strength and unusual corrosion resistance make it adaptable for such purposes as the venting of sewers, the venting of gas-fired boilers and pump rooms, distribution piping in filter beds, and many additional uses, a number of which are illustrated on these pages.

LAKESIDE ENGINEERING CORPORATION

222 West Adams St., Chicago 6, Illinois

AERO-FILTER

The Aero-filter (low-rate,* high-capacity) is different from all other types of trickling filters in that it produces results not by heavy parallel recirculation, but by a different method of applying sewage to the surface of the filter. Instead of flowing the sewage in a sheet or in a hose-like application, the Aero-filter spreads it evenly over the surface in a raindrop spray. This uniform distribution is accomplished in small filters by means of a centrally located motor driven disc, and in larger installations by rotating arm distributors equipped with centrifugal nozzles.

It has been proved in a number of plants that a single pass through an Aero-filter using an ordinary distributor with slotted or round orifices will not produce results comparable with those produced by a single pass using the Aero-filter distribution. In the Aero-filter each radius is dosed at least once every ten seconds (actually every two or three seconds). The Lakeside Engineering Corporation has recently improved its multiple arm distributor so that today it is almost 100 per cent proof against nozzle clogging. This enables a continuous, uniform distribution, day and night, without constant daily servicing of the nozzles. Aero-filter distributors are now available for average flows up to 9,000 gallons per minute and any filter diameter necessary to accommodate such a volume.

Aero-filters usually range in depth of media from 6 to 8 feet. Generally, forced draft ventilation is used at the rate of 1 cu. ft. of air per minute per square foot of filter surface. However, there are some Aero-filters less than 5 feet in depth and some which do not use forced draft. Recirculation is carried on from the effluent of the final clarifier back to the filter during periods of low raw sewage flow. Only sufficient returns are made to keep all of the distributor orifices in proper operation, which requires a minimum flow of two-thirds the average daily design flow. Initial and operating costs of a sewage plant incorporating an Aero-filter (low-rate, high-capacity) are lower than those plants (high-rate, high-capacity) which use a standard distributor and heavy recirculation.

* See SEWAGE WORKS JOURNAL, page 905, Sept., 1941.

SPIRAFLO CLARIFIER

The Spiraflo clarifier, marketed by the Lakeside Engineering Corporation of Chicago, is unique in certain advantageous features not found in other types of clarifiers. It consists of a round, hexagonal or octagonal tank in which a circular metal skirt is suspended adjacent to the tank wall. This vertical skirt extends 6 or 8 inches above the water level and down to within about 18 inches from the bottom of the tank. Thus, a race is formed between the tank wall and the skirt, which race provides 10 to 15 minutes detention for the incoming water or sewage.

The liquid is introduced into the race in a tangential direction by means of an inlet box located at the surface of the liquid in the tank. The liquid flows around the race and at the same time moves downward at approximately 0.5 foot per minute; hence the name, *Spiraflo.* The rotational velocity in the race is sufficient to sweep the scum, oil, and other floating materials completely around the race and against a baffle just behind the inlet box. Periodically this scum is withdrawn through a gate into a small compartment where, during a quiescent period, the scum rises to the surface and is drawn off. The excess liquid can then be returned to the clarifier. The Spiraflo does a good job of skimming. However, if desired, air diffuser tubes may be installed within the race, just beyond the point of liquid entrance, to increase the efficiency. The liquid content of the whole tank is set into a slow rotation by the flow within the race.

All the heavier materials which fail to rise to the surface within the race are gradually carried downward to the bottom of the skirt and are deposited on the tank floor and swept to the center by the scraper mechanism. The liquid, after passing under the skirt, ascends through the sludge blanket into the main section of the clarifier and finally passes over the inner and outer V-notched weirs of the effluent launder located at the water surface in the tank. This launder is concentric with the tank wall and so designed that the total length of its two weirs is approximately equal to the total length of the bottom of the skirt.

The outlet pipe leading from the effluent launder to the outside of the tank is suspended below the liquid surface and carried through the race at a point close to the inlet box. Such location reduces to a minimum interference with the rotation of the liquid in the race.

A series of tests were recently run on a 56 ft. diameter primary Spiraflo clarifier having a 9 ft. s.w.d., handling an average of 1.95 m.g.d. (detention time 2.1 hrs., overflow rate 790 gal. per sq. ft. per 24 hrs.), the sewage being fairly stale. These tests showed an average B.O.D. removal of 65 per cent, and a suspended solids removal of 76 per cent without the use of diffused air to assist in grease removal.

Sewage plants designed for primary treatment only can greatly improve their efficiencies by using a Spiraflo clarifier. Secondary treatment is also improved if floating materials, such as sticks and oil, are taken out in the primary clarifier and if the B.O.D. and suspended solids are reduced by the percentages possible with a Spiraflo clarifier. This is especially true of trickling filter installations. Operating data show that the strength of the final effluent of a trickling filter plant depends, to a large degree, upon the strength of the sewage applied. In general, based on a given pounds of B.O.D. load to a filter, the weaker the sewage applied, the lower will be the B.O.D. in the plant effluent. Thus the Spiraflo clarifier makes a perfect complement to a trickling filter.

For further information write for Bulletin 120, Lakeside Engineering Corporation, Chicago 6, Ill.

LAMOTTE CHEMICAL PRODUCTS CO.

Towson, Baltimore, Md.

LAMOTTE CHLORINE CONTROL UNITS

(New Series)

The LaMotte Chemical Products Co. of Towson, Baltimore, Md., has completed a thorough survey of the improved application of chlorine in the forms of free chlorine, hypochlorites and chloramines as a sterilizing agent in the treatment of water for municipal supply, swimming pool, condensing, cooling, etc., as well as sewage and a host of industrial uses. As a result of these studies a complete new line of LaMotte Chlorine Control Units has been made available, paralleling the recent advances in the more effective chlorination procedures. This new equipment embodies the results of the latest developments in the use of the o-Tolidine Method for the determination of active chlorine.

New Standards—Improved Procedure

The factors contributing to the accepted standardization of the new method, such as control of color development, pH, etc., have been incorporated in the LaMotte procedure along with a new series of interchangeable 15 mm. chlorine color standards embracing the entire useful range. These achievements simplify the actual tests, as well as the apparatus, since the standards are not only of uniform dimensions for the complete range but are interchangeable in all LaMotte Chlorine Comparators (excepting the Colorimeter Outfit for extremely low values) as well as in the standard LaMotte pH Comparators.

The LaMotte Chlorine Colorimeter Outfit, an indispensable instrument for the precise measurement of concentrations below 0.2 p.p.m. of chlorine, is retained for this range. It employs the LaMotte sealed Nessler Tube Standards wherein the depth of solution permits clearly discernible color differences when determining low chlorine concentrations. All other units (whether block or roulette comparator type) are equipped with the new 15 mm. standards and comparator tubes.

New Single Reagent For All LaMotte Units

LaMotte standardized o-Tolidine Reagent is furnished with each LaMotte Chlorine Control Unit. This solution is prepared according to the most recent recommendations and is packaged in special protective containers. The one standard reagent solution is used with all LaMotte units and may be purchased separately in package sizes.

LAMOTTE CHLORINE COLORIMETER

(For Low Chlorine Concentrations 0.02 to 0.3 p.p.m.

This set was developed for determining small amounts of chlorine and is especially adapted for work on drinking water.

LAMOTTE CHLORINE BLOCK COMPARATOR

(Standard Model)

(For Medium Chlorine Concentrations 0.1 to 1.0 p.p.m.)

Developed for determining residual chlorine in treated water, swimming pool water, sewage and industrial wastes.

LAMOTTE H–C CHLORINE BLOCK COMPARATOR

(For High Chlorine Concentrations—1.0 to 200 p.p.m. and above)

A Special Chlorine Unit designed to be used in the prechlorination of water and for other purposes, such as chlorination in food and beverage plants, sterilization of water mains and all other uses where a residual of 1.0 p.p.m. or more of chlorine is maintained.

LAMOTTE STERILIZATION OUTFIT

While the LaMotte H–C Chlorine Comparator is the most satisfactory instrument for the control of chlorine in high concentrations, there are certain special conditions where it is only necessary to control chlorine concentrations within fixed limits. To fill this need the Chlorine Sterilization Set has been designed.

LAMOTTE WIDE RANGE CHLORINE BLOCK COMPARATOR

Designed to cover the combined ranges of the Standard, and the H–C Chlorine Comparators just described. This wide coverage of chlorine concentrations is a feature not to be found in any other single piece of equipment for the determination of residual chlorine. The LaMotte Wide Range Chlorine Comparator is especially useful for investigational work, whether in the laboratory or in the field, since it is readily portable.

LAMOTTE ROULETTE CHLORINE COMPARATOR

(A Wide Range Unit)

Designed as a permanent installation in the control of chlorine dosage. The roulette element is 13 in. in diameter and 8 in. high. It contains an internal dalite reading arrangement, and all standards are in the revolving drum, permitting the operator to obtain readings in a minimum of time and under uniform light conditions, day or night.

LAMOTTE SLUDGE pH OUTFIT

A special outfit for accurate determination of the pH of sewage, sludges and similar substances by the dilution method.

LAMOTTE POMEROY SULFIDE TESTING SET

For the accurate determination of (1) Total Sulfides; Dissolved Sulfides; Hydrogen Sufide in Sludges and Solutions, and (2) Free Hydrogen Sulfide in Air and Gases.

The methods of testing employed in this outfit are those of Dr. Richard Pomeroy, with whose co-operation this apparatus has been developed.

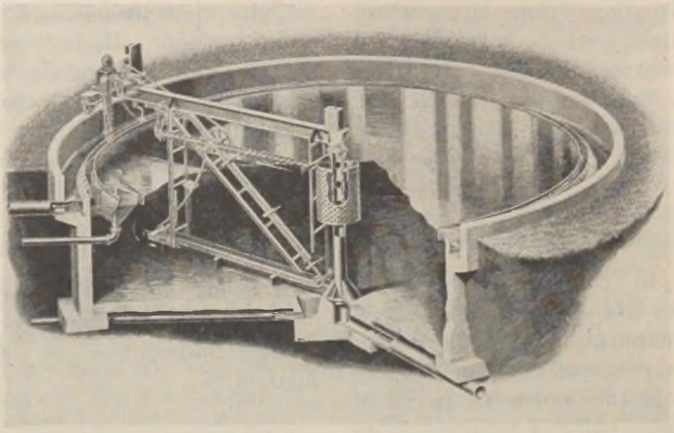
LINK–BELT COMPANY

2045 W. Hunting Park Ave., Philadelphia 40, Pa.

A NEW LINK–BELT SLUDGE COLLECTOR FOR ROUND SETTLING TANKS

A new sludge collector for the smaller-diameter settling tanks, to be known as the Link-Belt Type "B" Circuline Collector, is announced by Link-Belt Company. Also announced is the completion of a new 24-page illustrated data book No. 1982 in which photographs, dimensions, capacity tables and other pertinent engineering data are given for both Type "A" and Type "B" Circuline Collectors.

Where average domestic sewage is



The New Link-Belt Type "B" Circuline Sludge Collector.

treated, the new Type "B" collector is recommended for tanks of up to 55-ft. diameter. Installations of Type "A" collectors in tanks of up to 115-ft. diameter, are illustrated.

It is pointed out that for clarifying and thickening problems encountered in industrial processes and waste treatment, each problem must be considered separately; and that variations in the design of both Types "A" and "B" collectors are possible, to suit special conditions, unusual sludges or wastes.

In Circuline collectors, the settled sludge is collected and continuously moved radially, inwardly, on tank floor by a slow-moving scraper flight type conveyor and sludge plow, into a sludge hopper from which the sludge is withdrawn.

The conveyor is mounted on a power-rotated, centrally pivoted bridge spanning half the diameter of tank and having anti-friction-bearing equipped, resilient rubber-tired wheels at outer end of span, for smooth, easy travel on top of tank wall.

The entire floor area of the tank is cleaned of settled solids during each complete revolution of the bridge. This permits very slow rotation and insures that there is but a minimum of disturbance to the settling process and to the settled solids.

The sewage is introduced into center of the tank through a conduit under floor of tank to assure an even distribution of flow throughout tank.

The drive, located at outer end of bridge span, consists of a motorized speed reducer carrying a sprocket wheel which engages a heavy galvanized tow chain located and anchored in the effluent trough. The outer end of bridge is pulled by this chain, or it might be said to "walk around" the chain.

When used in primary settling tanks, a screw conveyor is supported along the one side of bridge span, for the purpose of confining and more effectively moving the scum and grease to a scum trap. This feature prevents wind pressure from blowing the collected scum out of reach.

A copy of the new Book No. 1982 will be sent to any interested reader upon request, which may be addressed to Link-Belt at Philadelphia, Chicago, San Francisco or other office of the company.

MABBS HYDRAULIC PACKING CO.

431 So. Dearborn St., Chicago 5, Ill.

PACKING SLUDGE AND SEWAGE PUMPS

The satisfied user's recommendation is the best advertising a manufacturer can hope to get for his product; for that reason we would like to quote from a letter received recently from the superintendent of a sewage treatment plant where they are using Rawhide Packing on their sludge pumps:

"In answer to your inquiry concerning our experience with the use of Rawhide Packing on our sludge pumps, I think the best testimonial is that we have continued to use it for over two years. We had tried most other types before we tried Rawhide because it seemed more expensive but we are firmly convinced that it is the cheapest packing in the long run. Flax packing and other types soon get hard in sludge pumping service and complete repacking must be done quite often to insure a fairly tight joint and to prevent undue wear on the plunger. We know this to our sorrow as we have had to renew both pump plungers in about five years of service. With Rawhide Packing we never have to do a complete repacking job, only add an additional strand occasionally. There has been no noticeable wear on the plungers since using your packing. I cannot give you any figures on any power saving but I am sure there must be some because of the ease with which the pumps seem to run as contrasted to their previous sound."

The advantage of Mabbs Rawhide Packing for sewage purposes is clearly shown in the record this packing made on the largest sand-sucking boat in the world, the *Sensibar*. To start with, the 14-inch centrifugal pump shafts were packed with flax packing. These shafts became so badly cut that the boat came very nearly shutting down before the end of the season. Next year these shafts were packed with Mabbs Rawhide Packing. The *Sensibar* handled twelve thousand cubic yards of sand per day, pumping it twice. It sucked up the sand at the south end of Lake Michigan and discharged it at Lincoln Park in Chicago. They ran the entire season and on Labor Day they opened up one stuffing box and the 14-inch sleeve on this shaft was not marked except where it went through the housing. A remarkable performance.

The reason Mabbs Rawhide Packing is able to handle very gritty or sandy water without injury to the plungers and shafts is that it always remains too soft to hold any of the particles of grit upon its surface. They either wash away or work back into the body of the packing, thus protecting the metal surfaces from wear and cutting.

The sewage plant operator can save himself the annoyance of frequent repacking; can save repairs, labor and power by using Mabbs Rawhide Packing in his sludge and sewage pumps. For further information write to the Mabbs Hydraulic Packing Company, Chicago 5, Illinois, the originators of Rawhide Packing.

MERCO NORDSTROM VALVE COMPANY

Subsidiary of

PITTSBURGH EQUITABLE METER COMPANY

Pittsburgh, Pennsylvania

NORDSTROM LUBRICATED PLUG VALVES

Nordstrom Valves are well adapted to the requirements of Sanitation Departments for use in sewage disposal plants because of their leak-resistant, non-sticking and positive shut-off construction. Made in a wide range of sizes and for various pressures.

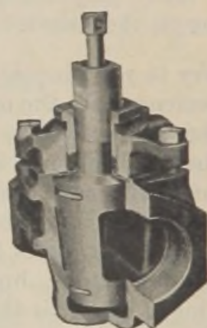
Phantom View

"SEALDPORT" LUBRICATION

The ''Sealdport'' method of valve lubrication forces Nordstrom Lubricant under high pressure between the plug and body, making the valve leak-resistant and freeing the plug to assure easy operation. Simply turning a screw at the top of the valve completely covers both seat and plug surfaces with a film of lubricant.

Lubricant grooves in the valve body and plug are so arranged that the lubricant cannot be blown from the valve by the fluid or pressure in the line. The Nordstrom method of ''Sealdport'' lubrication has made practical the use of plug cock valves as large as 30 inches in size and assures the most satisfactory service for sewage disposal plants.

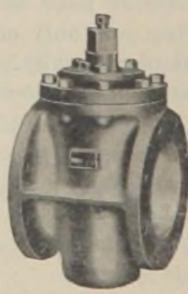
In the phantom view, shown above, the lubricant grooves on the plug and in the valve body may be clearly seen. These grooves form an interconnecting system which conducts the lubricant to the lower end of the plug in either open or closed positions of the valve.



Cutaway Model

The principle of high pressure ''Sealdport'' valve lubrication may be easily traced through the entire valve in the phantom view.

At right is shown plug assembled within valve body and with the especially designed gland and yoke in place. Should neglect to lubricate occur, valve will remain tightly seated because all unbalanced pressure is in a downward direction and can be readily freed by inserting a stick of Nordstrom Lubricant and turning down the screw.



Emco-Nordstrom Type

EMCO-NORDSTROM Lubricated Plug Valves

These valves have standard gate valve face to face dimensions and embody all the advantages inherent to the general Nordstrom line, including the patented "Sealdport" method of lubrication and plug lifting features that make operation easy and positive at all times. It is now economical to replace valves of other types with these lubricated plug valves since they can be installed without altering existing pipe dimensions.

NICHOLS ENGINEERING AND RESEARCH CORP.

ENGINEERS, CONTRACTORS, MANAGEMENT

60 Wall Tower, New York, N. Y.

NERCO ACTIVITIES, 1943–1944

Due to war conditions the number of new sewage sludge installations made, over those installed in the 39 cities handling sewage sludge the Nichols Way before the war, has not been large.

However, the Nichols Engineering

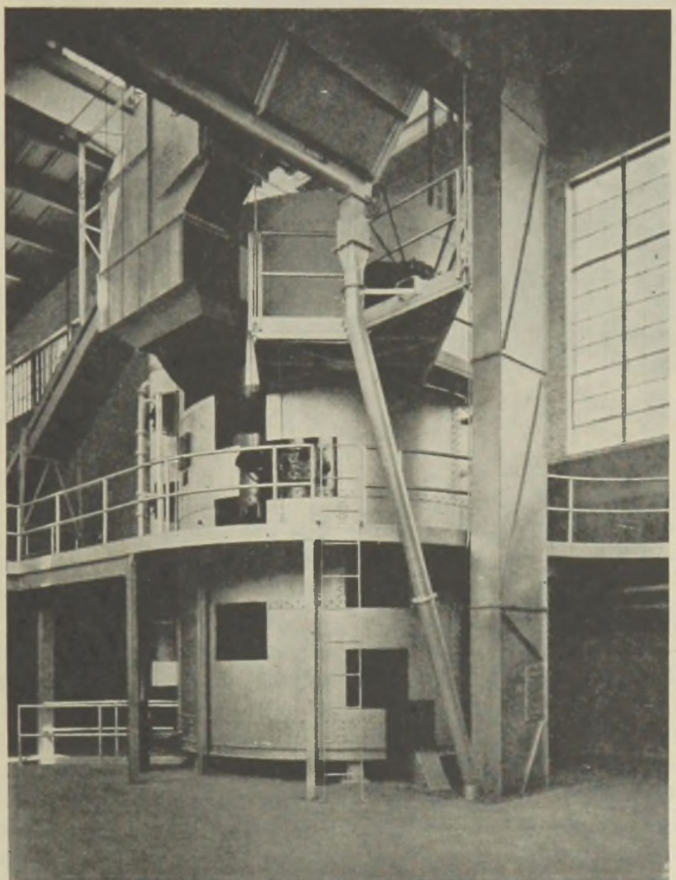


Fig. 1.—The 16 ft. 9 in. O.D. 8-hearth Nichols Herreshoff incinerator at Wyandotte, Michigan.

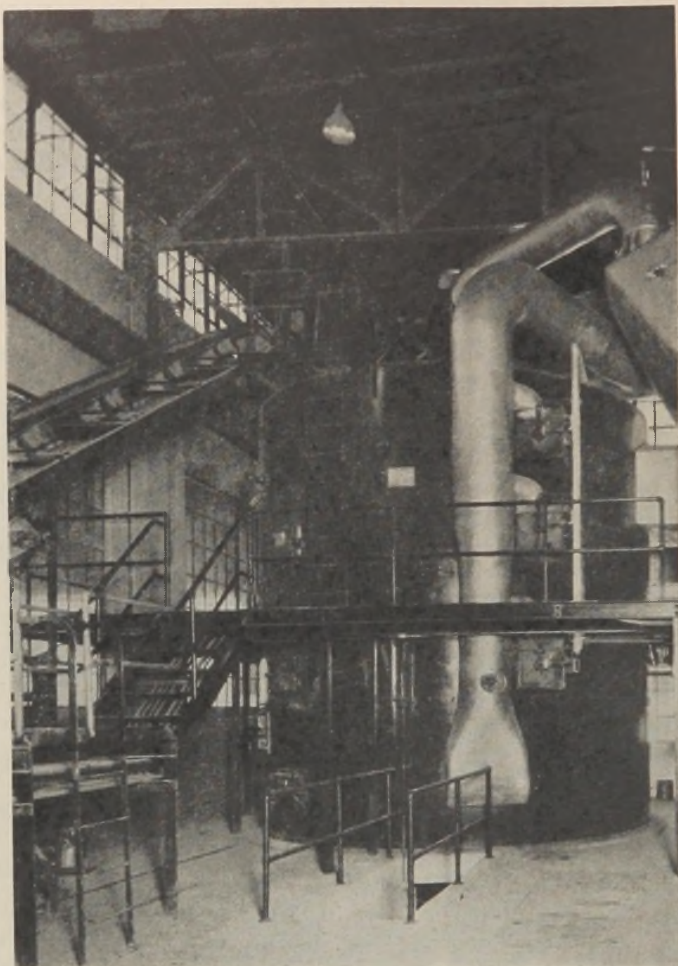


FIG. 2.—Battery of twelve 22 ft. 3 in. O.D. 17-hearth Nichols Herreshoff furnaces during construction in Cuba.

and Research Corporation has been active in designing equipment and building plants for the production of strategic metals. During the year, a great many Nichols Herreshoff multiple hearth roasters were installed in chemical and metallurgical plants here and abroad. Among the larger installations are the four 22 ft. 3 in. O.D. fourteen-hearth furnaces for the Basic Refractories installation, calcining magnesium carbonate rock for the production of MgO which is the raw material for the world's largest magnesium plant.

At the Nicaro Nickel Company plant in Cuba, which is a Defense Plant Corporation project, we designed and furnished twelve Nichols Herreshoff furnaces, each 22 ft. 3 in. O.D. with sixteen hearths, plus a covered top hearth, making these the largest individual furnaces ever constructed.

During the past year, there have been some modernizations and additions to Nichols Herreshoff sludge incineration installations which demonstrate the soundness and thoroughness of the complete engineering service offered by "Nerco." The ability to

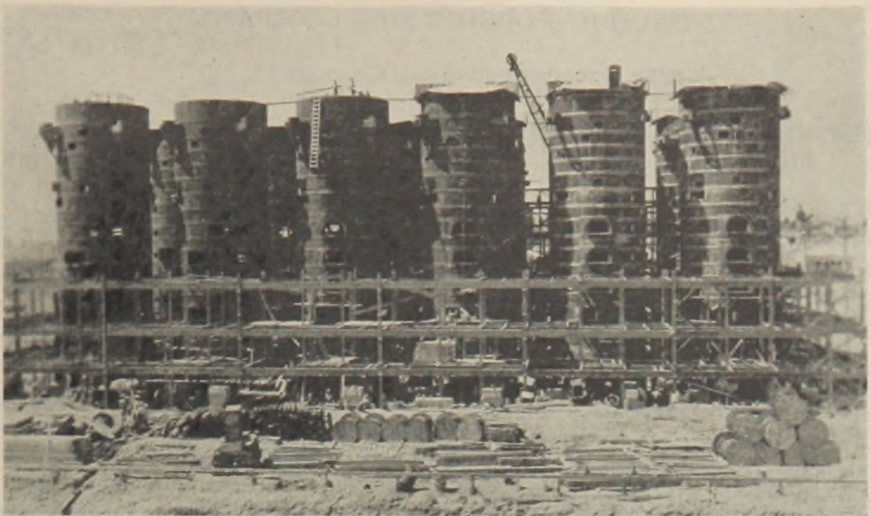


FIG. 3.—Original Nichols Herreshoff sludge incinerator unit at Dearborn, Michigan, which now starts its second decade of continuous service.

place in operation these additions, during wartime, is the outgrowth of the continuous research conducted by "Nerco" to increase the efficiency and economy of all types of incinerating plants for the disposal of municipal wastes.

It is of particular interest to note that the city of Dearborn has just installed a second Nichols Herreshoff incinerator 16 ft. in outside diameter, equipped with seven hearths. This installation has been made exactly ten years after the installation of the original six-hearth Nichols Herreshoff unit, which was the first sewage sludge incinerator of any type to handle the entire sludge production of a municipality. Both the original and new incinerator units will be kept in operation to handle the increased quantities of sludge now being produced by the East Side and West Side sewage treatment plants at the city of Dearborn.

A Nichols Herreshoff sludge incinerator 16 ft. 9 in. O.D., eight-hearth size, has also been recently installed at the new sewage treatment plant constructed for the city of East Chicago, Ind. Cake from the vacuum filters is conveyed to the incinerator and the plans contemplate, at some future date, the addition of a garbage grinder unit so that ground garbage can be discharged directly onto the inclined belt conveyor running over to the incinerator.

The incineration of liquid sludge containing 88–90 per cent water has been continued throughout the year both at the Ashland, Ohio, and Piqua, Ohio, sewage treatment plants with very satisfactory results. Undigested, unfiltered liquid sludge is fed by bucket elevator directly into the Nichols Herreshoff multiple hearth incinerator.

The great simplification in sludge disposal operations and savings in chemicals, maintenance, etc., by incinerating liquid sludges without any mechanical dewatering, unquestionably has wide application. Only one man per shift is required to operate the entire sewage disposal plant, including sludge incineration and ash disposal.

PACIFIC FLUSH TANK COMPANY

4241 Ravenswood Ave., Chicago 13, Ill.

DIGESTER SUPERNATANT SELECTION AND GAUGING

In addition to the effective treatment of supernatant liquor from sludge digesters by means of the "Atomized Aeration Unit" described in this section a year ago, the P.F.T. Company has developed a simple means of removing from the digester only the best supernatant liquor at the desirable slow and continuous rate.

The conventional practice in the design of digestion tanks has been to provide one or more valued pipes at the side or at the center of the tank throughout the depth in locations where supernatant liquor is normally expected to be found. Withdrawal of the best supernatant liquor with such fixed drawoff arrangements is dependent almost entirely upon the judgment of the plant operator. With a fixed covered digester, it is necessary for the operator to remove supernatant liquor at the same rate and at the same time that raw solids are added to the digester, plus the necessity for removing such liquor even though the best material which can be selected is of poor quality. With a floating covered digester, the operator has more flexibility of operation and can withdraw supernatant at rates and during periods independent of sludge additions, omitting such supernatant liquor withdrawal when it is of poor quality. In either case, however, it is necessary to give careful attention to manual control of the drawoff, observing continuously whether the material is of such character as will permit its return to the treatment plant. Even with the most careful manual control, it is not always possible to obtain the best liquor available for withdrawal. In addition, with such manual control, supernatant must be withdrawn at a relatively high rate which increases the size of a supernatant treatment unit or concentrates the load of high B.O.D. material being returned to the treatment process.

The P.F.T. "Supernatant Selector" consists of a slotted tubular device mounted vertically at the central portion of the digester and extending throughout the portion of the depth from which supernatant liquor is normally withdrawn. The tube is made with slots that are sufficiently narrow to hold back liquid containing large amounts of suspended solids. It is desirable to provide the digestion tank with a safety overflow but no other points of drawoff of supernatant are required.

The slotted portion of the selector is 7½ inches outside diameter and is provided in a standard 10-foot length. It is supplied with a receiving casting provided with a 6-inch standard pipe flange to connect with the single supernatant pipe from the digester. Figure 1 shows the general arrangement of the selector which is designed to be readily removable from the tank without dewatering or throwing the digester out of service. Such removal from the tank might be necessary only every few years for general maintenance.

The "P.F.T." supernatant gauge, sight glass and sampler as shown in Fig. 2 is used with the supernatant selector to control the rate of withdrawal by providing an indication of the rate by the head showing in the unit for a selected gauging orifice. Samples of supernatant can be easily obtained with the sampling provisions incorporated in the unit.

When the rate of withdrawal of supernatant liquor drops below the rate established, the supernatant selector must be backwashed either with treatment plant effluent, treated supernatant

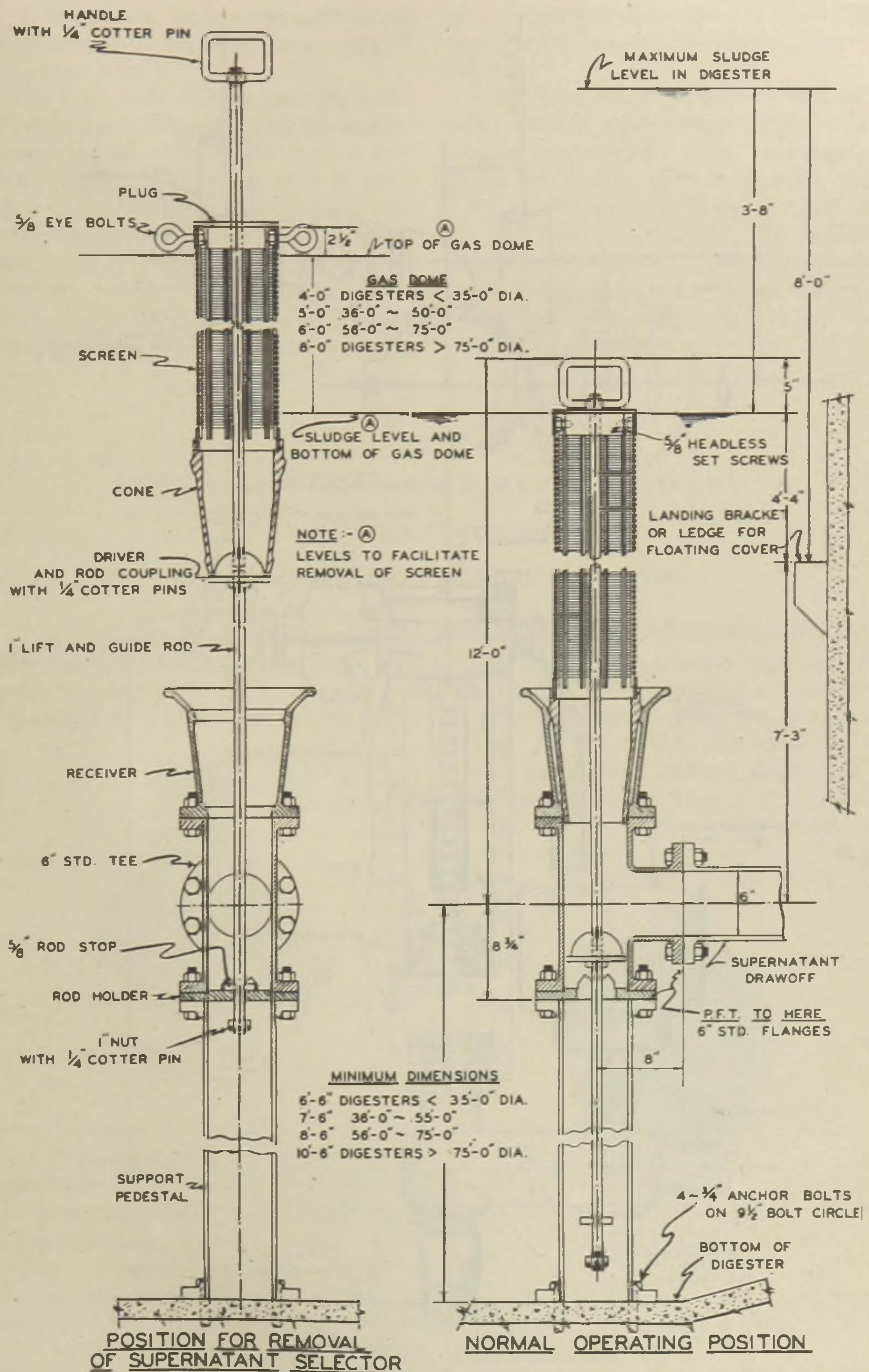


FIG. 1.—Details of removable type supernatant selector showing operating position and method of removal.

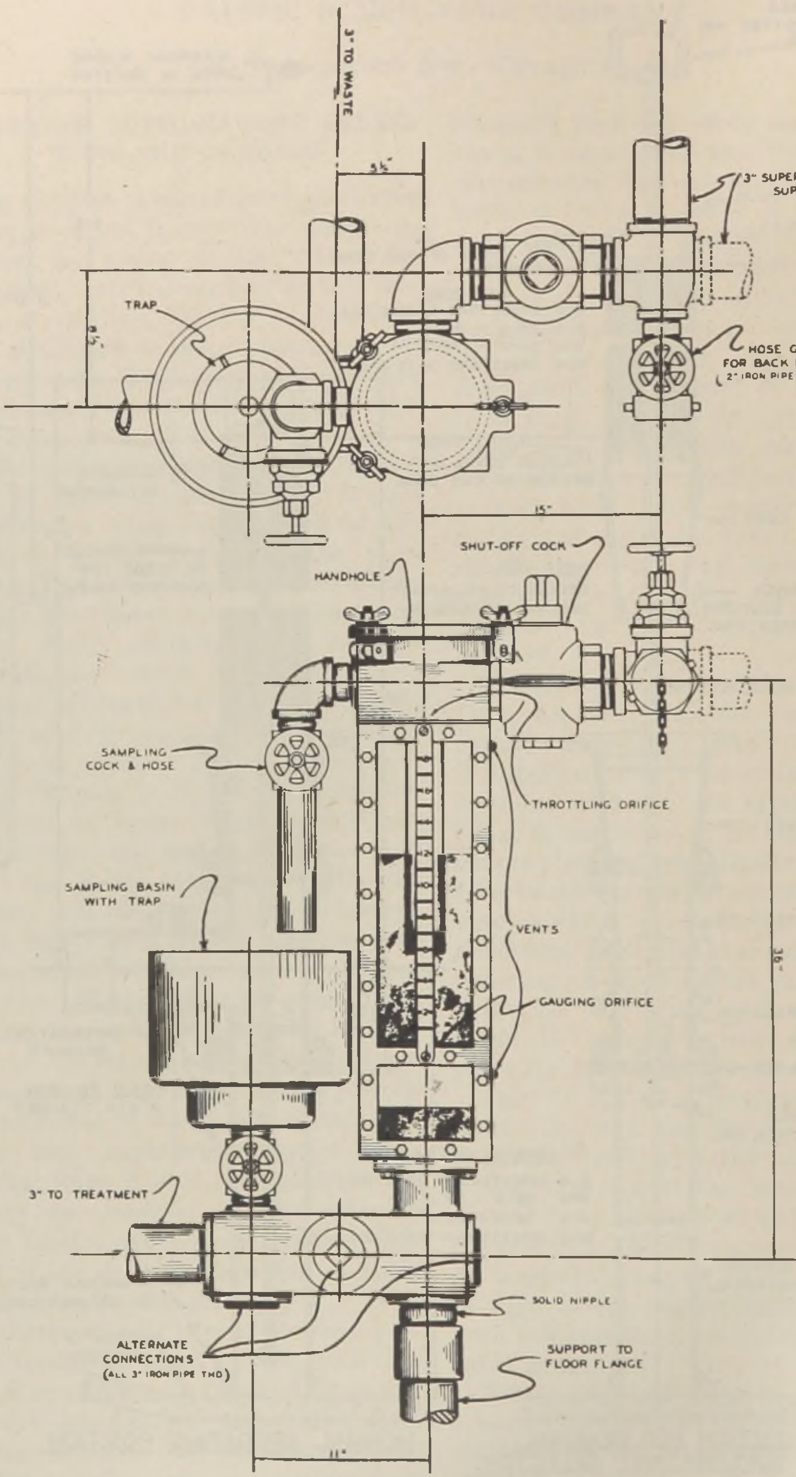


FIG. 2.—Details of supernatant gauge, sight-glass and sampler.

or a temporary water connection. A backflushing is provided as a part of the gauge unit.

The frequency of backwashing is dependent upon the nature of the supernatant liquor. Observations of a few of the twenty installations now in service indicate that for an overloaded primary digester, a short period of backflushing may be desirable on a daily schedule, while at one plant, an installation in a secondary digester need be backflushed only every few months, with practically no attention from the operator in between backflushing operations.

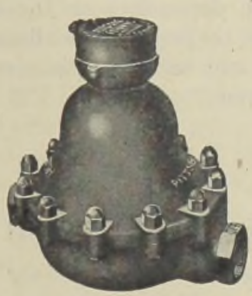
It has been found possible to consistently obtain supernatant liquor containing suspended solids averaging about 500 p.p.m. with the use of the P.F.T. "Supernatant Selector" but it is desirable to consider the device merely as a means of effectively selecting the clearest liquor to be withdrawn from the digestion system and not as a means of treatment.

PITTSBURGH EQUITABLE METER COMPANY

Pittsburgh, Pennsylvania

PITTSBURGH-NATIONAL WATER METERS

Pittsburgh-National Water Meters have for years been used by large and small municipalities alike throughout the country. Their excellent construction, maintained accuracy, and long life have been thoroughly proven on hundreds of thousands of installations. In sewage disposal plants they are recommended for measuring the heated water circulated through digestion tanks, and all cold water piped for various uses throughout the plant. Hot water meters are of a special construction to operate under high temperatures.



Pittsburgh-National
Water Meter

EMCO METERS FOR SEWAGE GAS

It has become common practice in the design and operation of sewage disposal plants to utilize the gas generated during sludge digestion as a source of heat and power. Since modern engineering methods have demonstrated that accurate measurement is a necessary part of the control of any process, the metering of this gas is an important matter and the choice of meter, one that should be given careful consideration.

Emco Sewage
Gas Meter

Experience has proven that the conventional meter used for measuring

Specifications of Emco Meters for Sewage Gas

Meter No.	Size of Conns., Inches	Length, Inches	Width, Inches	Height, Inches	Weight, Pounds	Capacities, Cu. Ft. per hour of 0.6 Specific Gravity Gas	
						½-inch Pressure Absorption	2-inch Pressure Absorption
0	¾, 1 or 1¼	9 7/16	8¾	11⅜	38	175	350
1	1, 1¼ or 1½	11⅛	9⅛	14¼	46	275	550
2	1¼ or 1½	12¾	10⅛	16⅝	67	350	700
2½	2	20⅜	14	25⅛	227	850	1800
3	2 or 3	22½	16½	27 13/16	305	1200	2500
4	3 or 4	27¼	19¾	32⅞	506	1700	3800
5	4	40	20¾	51⅛	1000	5000	10000

* Note: Capacity ratings of gas meters are usually based on a gas of 0.6 specific gravity. To correct for gas having a higher or lower gravity, the following formula should be used:

$$R_g = R\frac{\sqrt{0.6}}{\sqrt{G}}$$

where: R_g = rating for gas having specific gravity G
G = specific gravity of gas
R = rating in table above

manufactured and natural gas will not operate satisfactorily on this type of service due to the destructive effect which sewage gas has on materials commonly employed in the construction of gas meters. For this reason EMCO Meters for sewage gas are especially constructed from materials which laboratory tests have proven resistant to the action of this gas. The outer case is of heavy cast iron with interior coated with a special preparation. The working parts are made from stainless steel, lead nickel silver, tinned brass, or illium, depending on the operation each has to perform, while a special tannage and treatment is given to the diaphragms.

ROOTS–CONNERSVILLE BLOWER CORPORATION

Connersville, Indiana

LOW COST SLUDGE AERATION WITH ROTARY POSITIVE BLOWERS DRIVEN BY SLUDGE GAS ENGINES

Since the cost of electric power used by blowers in an activated sludge type sewage treatment plant is frequently the largest single item of operating expense, the elimination of this power cost by installing gas engine driven blowers using sludge gas for power makes this complete sewage treatment type plant less expensive to operate than plants giving only partial treatment.

The type of bacteria that do the work in the digestion tanks are a kind that live without air. In the fermentation that takes place in digestion tanks, a considerable volume of volatile gas is produced that can be used as generated, or stored in gas holders. This gas is around 600 B.T.U., and has definite value as gas engine fuel. It is most efficiently used in gas engines direct-connected to Roots-Connersville

ACCEPTANCE TEST

20,000 C.F.M., 8 lbs. G., Gas Engine Driven Blower Size 36 inches x 41½ inches, Rated Speed 300 R.P.M.

Capacity	110%	100%	69%	50%
C.F.M.	22,042	20,267	13,685	10,130
B.H.P.	852	776	547	412
Blower Eff.	77.6%	77.2%	73.8%	73.0%
Engine B.T.U. per cu. ft. air delivered	6.25	6.25	6.5	6.58

Rotary Positive Blowers. Approximately 25 per cent more air can be delivered per cubic foot of gas available when used in this manner than where gas is used in engines to generate electric current to drive the blowers by motor.

Note in the Standard Acceptance Test for a gas engine driven Roots-Connersville Blower that fuel consumption per horse power or per cu. ft. of air delivered is practically constant for any capacity from 50 per cent to 110 per cent capacity. This is because of the constant torque of the "R–C" Positive Displacement Blower. In comparison, the fuel curve of a gas engine used with electric generator shows approximately 40 per cent increase in B.T.U. consumption per H.P. from 100 per cent to 50 per cent load.

An increasing number of plants are using this economical, reliable, and satisfactory method to obtain air for their complete activated sludge sewage treatment. Figure 1 shows a partial view of the blower room at Springfield, Illinois. Originally they had three motor-driven "R–C" Blowers. In 1940 one of these units was changed over to sludge gas engine drive. At the same time a fourth "R–C" Blower was installed and direct connected to a sludge gas engine. The utilization of sludge gas in driving these two blowers is saving the City of Springfield close to $6,000 per year in purchased electric power.

The first Roots blower was built in Connersville, Indiana, about 90 years ago. While the fundamental principle remains unchanged, the details of construction have been constantly improved. The words "Positive Displacement" used to describe this type of blower indicate its characteristics. Twin impellers alternately suck in, momentarily entrap, and then expel definitely measured amounts of air or gas, resulting in the delivery of four equal volumes each revolution of the drive shaft. Impellers need no seal

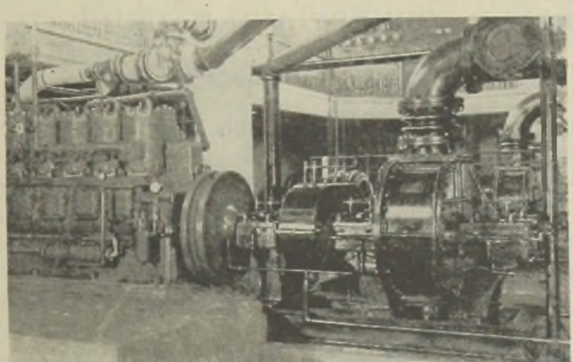


FIG. 1.

or lubrication. Capacity varies with speed. Pressure automatically builds up to overcome resistance on discharge side.

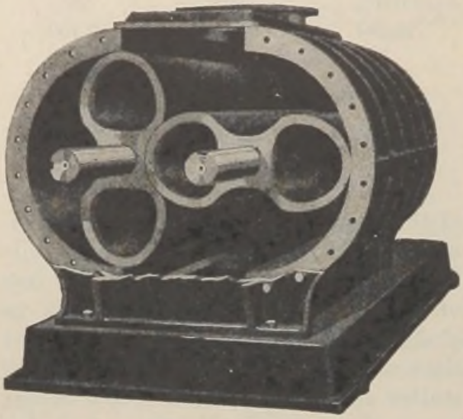


FIG. 2.

Note in Fig. 2 the extremely simple construction of the Roots-Connersville Rotary Positive Blower. There are no restricted passageways, valves, springs, or small wearing parts to require adjustment or replacement. There is no metal-to-metal contact between the impellers and casing. Their contour and finish is such that a clearance of a few thousandths of an inch is precisely maintained by a pair of accurately cut timing gears which operate in a bath of oil. The only wearing parts are the bearings and gears which are all oversize.

The most efficient "R–C" Blower speeds match up well with sludge gas engine speeds, permitting direct coupling without step-up gear. The easy speed control of gas engines direct connected to "R–C" Rotary Positive Blowers makes this arrangement ideal for variable air volume requirements.

Air requirements vary greatly, depending on many factors local to each plant, but the average data tabulated below may be of assistance in blower selection. It has been gathered from nineteen activated sewage treatment plants in ten states, serving communities with populations ranging from 4,000 to 140,000.

Connected Population		47,570
Air per Capita, Cu. Ft. per Min.		0.063
Air per Gallon of Sewage, Cu. Ft.		1.04
Sewage Flow per Capita, Gal. per Day		87.3
Kw. Hrs. required by Blower per Capita per Month		0.92
Sludge Gas per Capita, Cu. Ft. per Day		1.01
B.O.D. Reduction, Per Cent		0.93
Pressure at Blower, Lbs. Gauge	Average Low	6.5
	Average Normal	7.1
	Average High	8.3

ROYER FOUNDRY AND MACHINE CO.

158 Pringle St., Kingston, Pa.

SEWAGE SLUDGE TAKES TO THE WARPATH

Like the preceding year, 1944 has been marked by the greatly increased use of fertilizer made from sewage sludge. The demands on American food production have exceeded all precedents, with increasing millions of people overseas to feed in addition to our own population. In the face of this demand, certain mechanical fertilizers widely used in the past are available today only in limited quantities, if at all.

The "miracles of conversion" for war production do not, as far as we know, include the transformation of any sewage treatment works into ord-

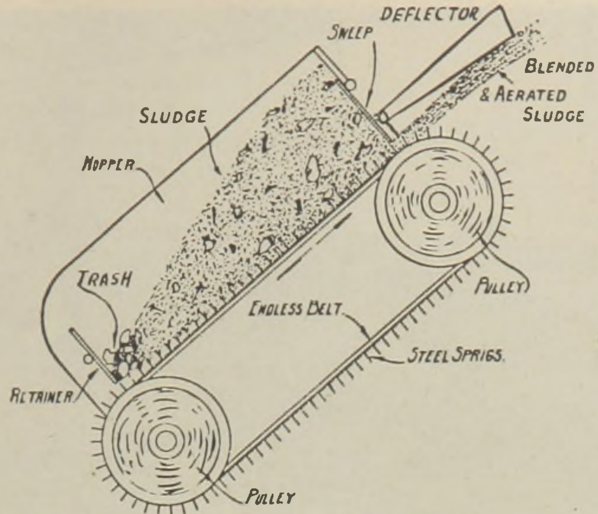


FIG. 1.—Sectional diagram of the Royer Sludge Disintegrator.

nance plants, yet a rapidly growing number of sewage plants are making a most important contribution of America's war effort in the form of sludge, which they have converted into an effective and ready-to-use fertilizer. While the fertilizing value of sewage sludge for food crops has long been recognized, it literally took the war to bring sludge fertilizer into its own. This fertilizer is in demand everywhere, on the part of Victory gardeners and the growers of commercial food crops.

It is true that the sludge cake as it comes from the drying beds is not in condition for use as a fertilizer, though it has been used to some extent. It must be broken up to fine size, aerated, thoroughly mixed and further dried. Growers do not have the time or facilities for this processing. At sewage plants, the manpower is likewise lacking, if the work had to be done by manual labor. This problem has been eliminated by means of the Royer Sludge Disintegrator, which is enabling a large number of sewage plants to convert their sludge, with a minimum amount of labor, into a valuable fertilizer which they are selling at a substantial profit. The cost of burying or incinerating the sludge is completely eliminated.

The Royer is a compact, ruggedly constructed, portable or stationary machine for the rapid, economical disintegration of sewage sludge from the drying beds.

The Royer uses an endless belt of tough, resilient composition upon which are mounted rows of steel teeth or sprigs to accomplish the thorough shredding, mixing and aerating of the sludge cake. This belt travels at an angle of 45°, and the teeth are so shaped and the rows so closely spaced that caked, lumpy or matted material deposited upon the belt does not become impaled but cascades on the rapidly moving teeth, rolling over and over. The material is shredded, mixed and aerated, until finally it is small enough to drop between the teeth.

It is then carried up to the discharge opening and is ejected so that all particles are thrown clear of the machine. The arc of fall of the discharged material can be regulated so that it can be loaded directly into trucks, wagons or onto a stock pile.

An adjustable sweep at the discharge

FIG. 2.—Converting sludge into fertilizer with a Royer at the Menominee, Michigan sewage treatment plant.

opening prevents the passage of any material that is not of the desired size. Sticks, stones and other trash gravitate to the bottom of the belt where they are retained by a gate which is opened occasionally to remove the accumulated trash. Sludge with a moisture content as high as 51 per cent can be readily disintegrated.

First cost, maintenance cost and operating cost are low, and even where the machine is used but intermittently the investment is small in proportion to the returns.

Royer Sludge Disintegrators are available in twelve portable and stationary models, and in a wide range of capacities; electric motor, gasoline engine or belt-to-tractor drive.

A comprehensive book, "Sewage Sludge Utilization Datalog," will be mailed on request by the Royer Foundry and Machine Company, Kingston, Pa.

W. A. TAYLOR & COMPANY

York Road and Stevenson Lane, Baltimore 4, Md.

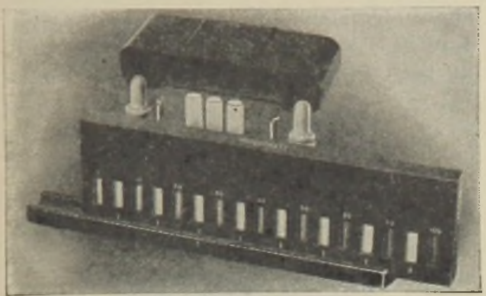
SPECIALISTS IN COLORIMETRIC CONTROL EQUIPMENT pH—CHLORINE —PHOSPHATES—WATER ANALYSIS

TAYLOR LONG RANGE pH SLIDE COMPARATOR

The Long Range Comparator is a portable outfit which contains all equipment necessary for making pH tests. It is flexible since it can be obtained with any 3 to 9 color standard slides within the range pH 0.2–13.6. In addition to the slides it contains a base, vials of indicator solution with pipettes and fourteen 5 cc. test tubes; all contained in a wooden case $11\frac{1}{2} \times 5\frac{7}{8} \times 9\frac{1}{4}$ inches.

All color standards are enclosed in

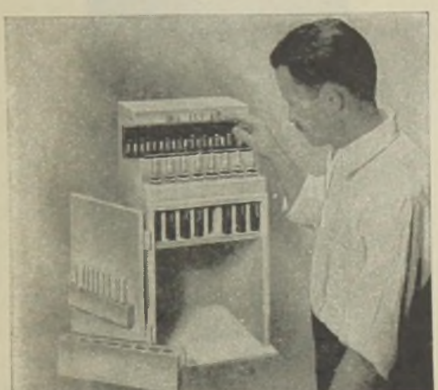
plastic slides and carry an unlimited guarantee against fading. A determination is made by filling the 3 test tubes to the mark (5 cc.) with the sample, adding 0.5 cc. of indicator solution to the middle one, matching the sample



with the standards and reading the pH from the values on the slide. Ideal for sewage sludge since the test tubes and standards are only 11.5 mm. in diameter.

TAYLOR DALITE pH SLIDE COMPARATOR

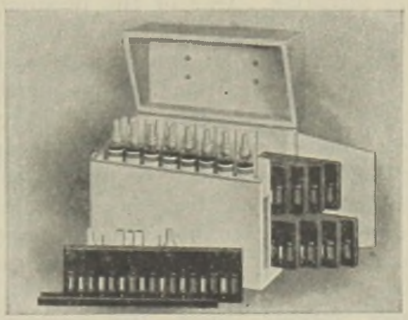
This outfit was originally designed for making determinations at night or in dark places but it has proved ideal for all routine tests even in daylight.



The contents of the set are the same as the Long Range pH Slide Comparator. The case is 12 × 12 × 21 inches. The comparator base sits on the shelf in front of a dalite glass and special bulb. The operation of the set is the same as the Long Range outfit.

TAYLOR PHOSPHATE SLIDE COMPARATOR

Phosphates are added to boiler water to decrease corrosion and scale formation. The concentration of these phosphates can be accurately controlled by means of Taylor Phosphate Comparators. The High Phosphate Comparator consists of a base and color standard slide and all reagents and accessories required for making the test. The 9 standards represent 5, 10, 20, 30, 40, 50, 60, 80, 100 p.p.m. of phosphate as PO_4. The presence of 10,000 p.p.m. of silica as SiO_2, 100 p.p.m. of ferrous or ferric iron or 1,000 p.p.m. of sulfites, causes no error. Results check closely



with the gravimetric method. Reagents are stable for several years.

The Low Phosphate Comparator is similar except that the standards represent 0, 2, 4, 6, 8, 10, 15, 20, 25 p.p.m.

Increasing use of low concentrations of glassy phosphates, meta, pyro, septa, etc. (threshold treatment), in water conditioning, to prevent feed line deposition, to stabilize water supplies and to reduce corrosion, makes it imperative that a rapid, simple and accurate method of analysis be available. The Taylor Poly-Phosphate Comparator is ideal for this purpose. Previous methods required boiling the sample for several hours. With the Taylor outfit a complete determination can be made in 20 minutes.

TENNESSEE CORPORATION

Atlanta, Georgia

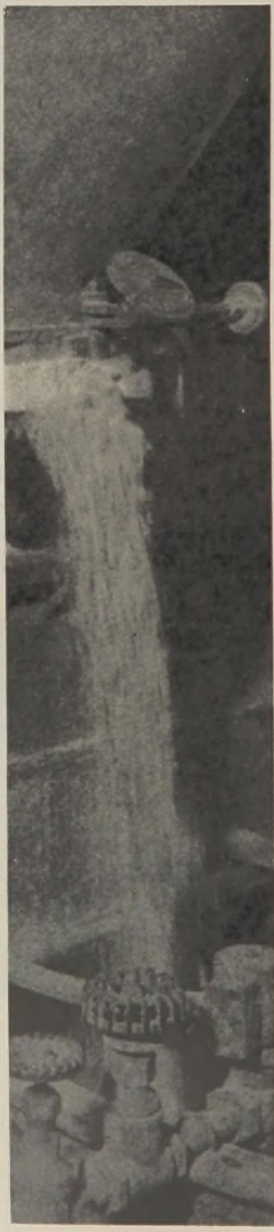
FERRI-FLOC IN SEWAGE TREATMENT

"Ferri-Floc," commercial ferric sulfate, finds numerous applications in sewage and industrial waste treatment. These uses have increased considerably over the past few years due to the extremely large quantities of industrial wastes from many of the various war plants, which must be treated, as well as to the addition of coagulation to many overloaded municipal sewage treatment plants.

One of the most interesting uses has been for sludge conditioning for vacuum filtration. One of the peculiarities of ferric sulfate in such a process is that it frequently can be used without lime. Several such plants in the United States are now using "Ferri-Floc" alone for their sludge conditioning, and the results have proven this treatment to be extremely economical and much more trouble-free than previous treatments using lime. The success of this treatment apparently depends largely upon the ammonia content of the sludge. The greater the ammonia content, the greater the quantity of "Ferri-Floc" required to produce proper coagulation of the sludge. Rapid mixing for a period of only five minutes is required. Longer mixing tends to break down the coagulated particles at a rapid rate.

In the event of elutriated sludge, from which the ammonia has been almost completely removed, "Ferri-Floc" should give good coagulation at a ratio of about two per cent by weight of dry solids. This treatment will not work at all on sludges containing relatively high ammonia as the buffering action of the ammonia itself prevents the rapid lowering of the pH. The pH of sludge so coagulated usually varies from 6.2 to 6.4.

It does seem that any plant faced with the problem of sludge filtration should consider the use of ferric sulfate as a sludge coagulant and should at least experiment in the laboratory



to determine whether or not it would be possible to condition their sludge without the use of lime.

For the past several years municipal sewage treatment plants in many sections of the country have been so grossly overloaded as a result of increased population and added industrial loads that severe pollution of the receiving stream has resulted. Many such installations have installed chemical precipitation as an aid to their plants and have so found it possible to increase the apparent capacity of the plants by as much as 50 per cent without the addition of major structural improvements. Such sewages normally will vary greatly in pH through the course of the day, and one of the prime requirements of satisfactory coagulants has been coagulation over a very wide pH range without major changes in the coagulant dosage. Ferric sulfate has proven to be the ideal coagulant for such installations as it will coagulate over a wide pH range without affecting the dosage; most other coagulants require constant pH correction.

Most of the cities which have resorted to this type of treatment have been so well satisfied with results that they contemplate improving their chemical precipitation facilities in the days following the war rather than making major structural changes to their existing plants. Such treatment has proven very inexpensive and dosages range from 20 parts per million to 60 parts per million depending upon the clarification required. In fact, experience has shown that it is possible to clarify the primary sewage to the point that the secondary treatment processes will not receive sufficient organic material and bacteria to function properly. Therefore, the degree of treatment afforded in the primary tanks depends entirely on requirements of the secondary units. Primarily, chemical precipitation should be employed to level out peak B.O.D. loadings.

Industrial waste problems have likewise become of increased complexity during this war period. Most of these industrial wastes are very low in organic content, or bacteria, and do not lend themselves readily to biological processes of sewage treatment. As a result of this, many of the industries have been forced to turn to chemical precipitation to effect anything like satisfactory treatment. Again, due to its ability to flocculate over a wide pH range, "Ferri-Floc" has come into wide use. It is now finding application in the oil fields, in refineries, in synthetic rubber production, powder plants, etc., and has lent itself to these widely differing wastes with a minimum of operating difficulty and equipment required.

"Ferri-Floc" can be rapidly put into solution without elaborate dissolving equipment. A number of standard model feeders are on the market today to handle properly this coagulant, or any standard dry feeder can be converted to handle "Ferri-Floc" by slight changes to the dissolving equipment which usually cost less than $100 per feeder. In the dry state, the product is non-corrosive to metal and concrete and can be stored in bulk without difficulty, regardless of climatic conditions.

The Tennessee Corporation maintains a staff of technically trained field men with the sole object of giving the users and potential users of "Ferri-Floc" technical assistance in their water and sewage treatment problems. These men are available for your particular problems without any obligation whatsoever. We are proud of the record "Ferri-Floc" has made in the many large plants in which it is being used and invite you to write us for additional assistance, or information.

UNITED STATES PIPE AND FOUNDRY COMPANY

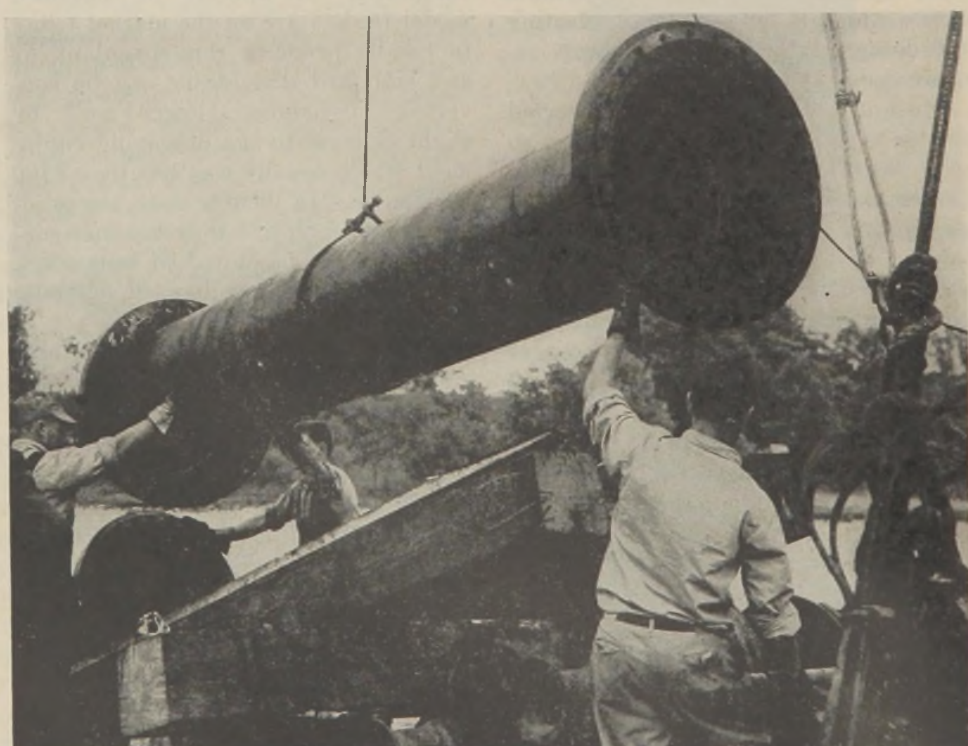
General Offices: Burlington, N. J.

CAST IRON PIPE FOR SEWERS

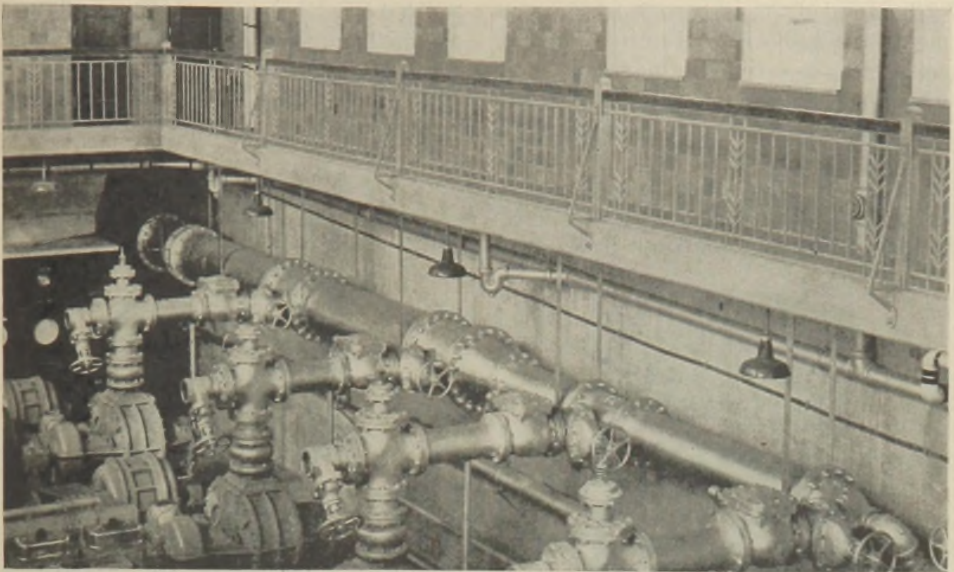
The use of cast iron pipe for sewers is steadily increasing throughout the country. Many new sewage treatment plants are being built, some in conjunction with a new sewer system and others to augment an already existing system. Furthermore, major revisions are being made in large numbers of existing treatment plants, not only to increase their capacity but to provide more complete treatment that will produce an effluent of better quality. Treatment costs money; the amount of money is almost directly proportional to the volume treated. Logically, therefore, every gallon of water that seeps into the mains through leaky joints, cracked pipe or from other sources not only crowds the sewer but costs good money to convey it through the various treatment stages.

Cast iron pipe possesses three outstanding properties that are most important for present day sewer construction:

1. Tight pressure type joints that prevent infiltration, thereby reducing treatment costs and incidentally eliminating trouble with tree roots.
2. Compressive strength to resist heavy earth loads due to deep fills over the pipe. Beam strength to withstand stresses caused by earth movement. Bursting strength to resist internal pressure when used as a force main or when pressure



20-inch Usiflex Joint Pipe for sewer force main across river.



Cast iron pipe and fittings installed in a sewage treatment plant.

might temporarily occur due to floods.

3. Long life that has been proven by years of satisfactory service, consequently permitting a low annual amortization charge on the original investment.

There are many instances in various parts of the country where cast iron pipe has been installed in sewage disposal systems for flow mains, force mains, stream crossings, outfall sewers and in treatment plants.

Cast iron flow lines are generally installed where the pipe are laid in water saturated soil to eliminate troublesome and costly infiltration.

Cast iron force mains are being installed at a steadily increasing rate due to the growing demand for sewage treatment. Treatment plants are usually located some distance away from the more densely populated sections of a community. Frequently, it is not possible to have gravity flow to the plant. In those cases the sewage flows into a sump and is then pumped through a force main to the treatment plant. Illustrated here is a cast iron flexible joint force main being laid on the bottom of a river.

Cast iron outfall sewers have been widely and satisfactorily used to convey sewage, in most cases treated and in some cases untreated, out into a body of water for final disposal.

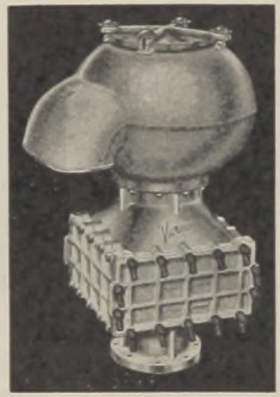
Cast iron pipe and fittings are used extensively to transport the sewage through the various treatment stages. One of the illustrations shows these products installed in a recently completed sewage treatment plant.

THE VAPOR RECOVERY SYSTEMS COMPANY

2820 North Alameda Street, Compton, California

CONSULTANTS, DESIGNERS, AND MANUFACTURERS OF GAS CONTROL AND TANK EQUIPMENT

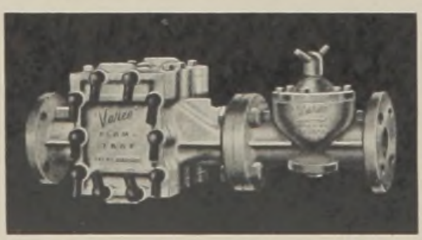
Keeping abreast of the rigid requirements of modern sewage treatment plants, "VAREC" designers and engineers have a definite conception of the utilization of its sewage works equipment. Sewage disposal units today incorporate operating gas control refinements comparable to the most highly specialized process plant installations in the world. With many years experience in gas control and safety equipment manufacture, The Vapor Recovery Systems Company has devel-



"VAREC" approved Pressure Relief and Vacuum Breaker Valve with Flame Arrester.

oped a line of gas control safety devices for sewage treatment plants that embody the latest engineering designs in this field.

In the multiple digester gas system, "VAREC" approved Pressure Relief and Vacuum Breaker Valve with



"VAREC" approved Flame Trap Assembly.

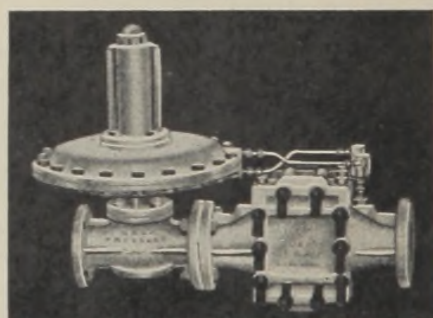
Flame Arrester is installed on the digesters and gas storage tanks to maintain system operating pressure and to protect the units in case of fire from without. Being constructed of aluminum throughout, they are noncorrosive, easily inspected and maintained.

"VAREC" approved Flame Traps are installed throughout wherever there is a possibility of fire inside the plant piping. These units are made of corrosion resisting aluminum and afford

"VAREC" approved Sediment and Drip Trap Assembly.

a positive flame stop. All "VAREC" Flame Arresters are approved by the Underwriters' Laboratories.

To maintain system pressure at the waste gas burner, a "VAREC" Pressure Relief and Flame Trap Assembly is installed. This unit consists of a sensitive diaphragm-operated regulat-



"VAREC" approved Pressure Relief and Flame Trap Assembly.

ing valve in conjunction with a "VAREC" Flame Arrester, into which a thermally operated bypass valve is built. In case of fire in the system, this bypass valve automatically closes the regulating valve, providing a positive flame check.

"VAREC" approved Waste Gas Burners are manufactured with a wide capacity range and are furnished either with or without pedestal mounting, as required. The pilot valve gas line is protected by the installation of a "VAREC" approved Flame Check.

To handle sudden surges in pressure due to explosions or momentary plant fluctuations a "VAREC" approved Explosion Relief Valve is installed in the system. Being dead weight loaded, it insures a positive and foolproof relief valve.

"VAREC" approved Waste Gas Burners.

In plants where the gas is used to operate boilers, engines or other equipment, a "VAREC" approved Pressure Regulating Valve is installed in the gas line to each piece of equipment. These valves are set to operate at a lower pressure than the "VAREC" Pressure Relief and Flame Trap Unit, thus making sure that all the gas required is available for useful work before any is allowed to go to the waste gas burner.

"VAREC" approved Manometers are used through the plant for indicating system pressure. They are obtainable in single or triple reading units with or without push button control. This latter feature is a built-in push button type valve that keeps the manometer shut off until the button is pushed. It is another "VAREC" engineered feature incorporating safety devices, for should the manometer glass break, no dangerous gas is allowed to escape from the system.

One of the basic design fundamentals in gas plant engineering is to keep the lines drained and free from moisture. A full line of "VAREC" approved sediment traps and condensate drip traps is available to meet this requirement.

The "VAREC" approved Check Valve is required in a system operating at low pressure. Designed for this purpose, its aluminum clapper reduces the pressure required to keep it open..

"VAREC" non-sparking and gas tight manhole covers, installed on all tanks, provide a quick entry into the tank.

"VAREC" Gauge and Sampling Hatches are also gas tight and non-sparking and have a foot pedal design to facilitate taking samples and gauges.

All "VAREC" Regulating and Control Equipment is flow tested in the most modern type laboratory. Curves are published for each piece of equipment and can be used to determine the most economical size for each specific installation.

Due to government restrictions on critical material, The Vapor Recovery Systems has developed a new Pressure Relief and Vacuum Breaker Valve. These valves incorporate the standard features of the regular relief valves plus many engineering features developed especially to meet war time needs, viz.: hyperbolic, static-balanced pallets insure less "blow-down"; pallet guides are not exposed to corrosive tank vapor; expanding streamlined passageways eliminate directional changes and eddying currents; wind drift is eliminated by scientific design; materials are used having best thermal, electrical potential, and noncorrosive factors in combination; replaceable seats guarantee minimum maintenance expense.

All "VAREC" equipment is pretested to actual field installation; the pallet guiding system positively prevents binding or freezing, drainage throughout the unit is complete—no condensate can accumulate.

Twenty years' experience is built into every unit.

WAILES DOVE–HERMISTON CORP.

Westfield, New Jersey

UNIQUE COATING FOR SEWAGE PLANT MAINTENANCE BITUMASTIC NO. 50

Bitumastic No. 50 is a unique black coating especially designed to protect metal and concrete against strong corrosive or destructive forces, such as acid fumes, salt or fresh water and extreme moisture. It is a coal tar base product, and, as it is not an emulsion, contains no water.

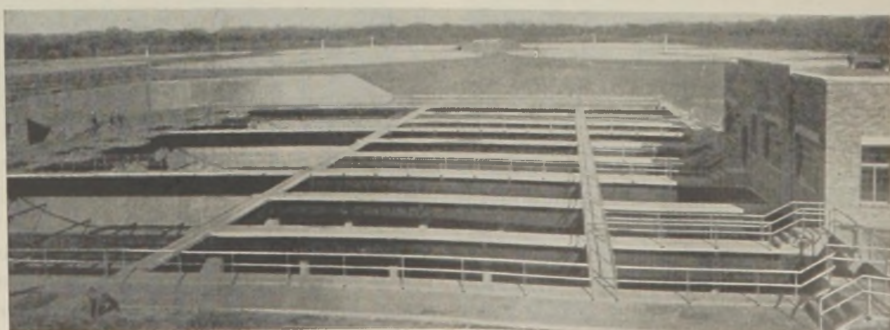
Bitumastic No. 50 is as unique in its physical characteristics as it is in unusual protection qualities. In the container it has the appearance of a plastic material too heavy to be applied. When stirred, however, it quickly changes to a painting consistency and brushes out with no more effort than ordinary paint. For very severe corrosive conditions, it can be applied to a thickness of $\frac{1}{16}$ inch in multiple coats on a vertical surface without any appreciable running or sagging of the coating while wet.

After drying, Bitumastic No. 50 will stand an atmospheric temperature of about 140° F. without sagging and — 10° F. without cracking.

Because of the many unusual characteristics of Bitumastic No. 50, sewage works engineers were among the first to appreciate its value in protecting sewage plant surfaces from corrosion. It has been used by such plants as the Ossining Sewage Treatment Plant, the Dallas Sewage Plant and the plants of Kutztown, Pa., and Hudson Falls, N. Y.

In applying Bitumastic No. 50, the coating is thoroughly stirred until it thins out to painting consistency. The coating then is scooped up on the side of the brush, which is used like a trowel to spread the coating onto the surface in a heavy film of uniform thickness. An inexpensive or old but clean brush can be used, as applying the coating is likely to misshape the bristles.

In spite of the apparent heaviness of Bitumastic No. 50, it spreads very



Largest sewage treatment plant of the southwest at Dallas, Texas. Here Bitumastic No. 50 protects sedimentation tanks, weir plates, grit channels and aeration tanks. Waste from industrial plants causes a particularly treacherous flow of sewage.

easily and care should be taken not to brush the coating out to too thin a film. To do so defeats one of the principal advantages of Bitumastic No. 50—a very heavy film.

Bitumastic No. 50 should be used only on metal, concrete, stone or brick surfaces. It should not be applied over freshly painted surfaces, although it can be put on a painted surface which has thoroughly weathered. Oil base paints should never be applied on top of Bitumastic No. 50. No primer is required.

WALLACE AND TIERNAN CO., INC.

Newark 1, New Jersey

APPLICATION AND CONTROL OF CHLORINE

While the better known use of chlorine in sewage plants is for effluent disinfection, many additional functions can be accomplished by the use of this chemical at other points throughout the plant.

Included in these are ponding elimination in trickling filters, control of activated sludge bulking, B.O.D. reduction and odor control.

A recent study of prechlorination of sewage has disclosed that one of the most valuable effects of this type of treatment has been the elimination of slime throughout piping, walls, appurtenances and in the sludge itself. Two plants were operated with and without prechlorination. In a control plant which did not use the treatment, slime formations one-half to one inch thick would form on all parts of the settling tank and in the lines, piping and equipment. The tank was odoriferous due to the putrefaction of this material. Another plant which received prechlorination had no odor and was entirely free from slime. Comparatively no labor was necessary to keep this tank and its equipment in good condition, clogging difficulties were reduced and the sludge drawn from it was superior in quality to that which had not been chlorinated.

Another advantage to prechlorination is that certain pathogenic organisms which are resistant to chlorine for short periods receive longer contact time with the chlorine.

With strong trends indicated by: (1) the demand for cleaner and more efficient sewage plants, (2) the larger number of new plants planned for postwar construction and (3) the increased availability of chlorine from accumulated reserves and enlarged manufacturing facilities built during the war, there is no doubt that the proportion of plants using prechlorination will steadily increase.

Accurate control of the larger quantities of chlorine involved can be obtained by use of the W&T Master Visible Vacuum Type Chlorinator. This type of equipment is widely used in the municipal water supply, power generation and industrial fields, and it has particularly outstanding advantages for application in the sewage treatment field.

One of these valuable features is that maximum economy in water consumption is achieved. Either effluent or fresh water may be used to operate the injector of the chlorinator. Where fresh water must be used, automatic controls are provided which vary the injector water quantities in proportion to the chlorine dosages, as contrasted with other types of chlorinators which require a constant volume of water, regardless of the amount of chlorine fed through the apparatus.

Duplicate W&T Master Chlorinators used for prechlorination.

W&T Master Visible Vacuum Type Chlorinators are provided with multiple safety features to guard against accidental leakage of chlorine into the chlorinator room. These devices include the positive hydraulically operated chlorine pressure inlet valve which automatically shuts off the supply of chlorine gas upon failure of the bell jar vacuum, the float operated chlorine relief assembly which conveys the chlorine to the outside of the building in the event of failure of the other safety devices, and in the case of semi-automatic installations, the use of a low vacuum limiting system which cuts off the chlorine supply in the line ahead of the unit itself in the event that the vacuum in the bell jar drops below a predetermined minimum.

The extreme accuracy of feed shown by these machines is achieved by precise control over the orifice differential through the use of a hydraulically operated meter vacuum control assembly.

Many cities are at present drawing plans which specify prechlorination in sewage plants to be built after the war. The Wallace & Tiernan technical staff will be pleased to assist in preparation and estimates for this type of treatment as well as the other phases of sewage chlorination.

YEOMANS BROTHERS COMPANY

1433 Dayton Street, Chicago, Illinois

YEOMANS "RIM-DRIVE" CLARIFIER

A saving in torque demand up to 95 per cent is achieved with the new Yeomans "Rim-Drive" Clarifier tank mechanism which was presented to the sewage treatment field within the past year. Motor and drive mechanism are mounted on the rim of the tank and take full advantage of the lever arm principle to secure a noteworthy saving in torque demand.

Lower first cost is secured because of the elimination of half-diameter bridges or walkways which are necessary with the old-fashioned center-drive clarifier mechanisms. Moreover, costly reduction gear assemblies are replaced by a simple inexpensive worm gear at the rim of the tank. Other miscellaneous parts are also eliminated by the simplicity of the "Rim-Drive" design.

A typical example of load reduction is as follows: For a 40-foot diameter primary clarifier with an automatic skimmer and using a center shaft drive, good practice would indicate a gear reducer of 30,000 inch-pounds torque capacity, including allowance for the safety factor. The "Rim-Drive" would require only 25 inch-pounds—a saving of over 95 per cent!

Available also on the "Rim-Drive" clarifier are the newly designed Yeomans Auto-Skimmer and Auto-Flusher, a fully automatic scum collector. The Auto-Skimmer concentrates the scum into a very restricted area near the periphery of the tank and then, by means of a spring loaded knife-edge scraper blade wipes the scum over a scum apron into a scum trough. No scum trough valve is needed as the Auto-Flusher opens automatically before the scum is deposited in the scum trough and continues to flow until the scraper blade has left the trough.

THE YEOMANS "AERIFIER"

Packaged treatment of municipal sewage and trade wastes by the activated sludge process is the achievement of the Yeomans "Aerifier" which pro-

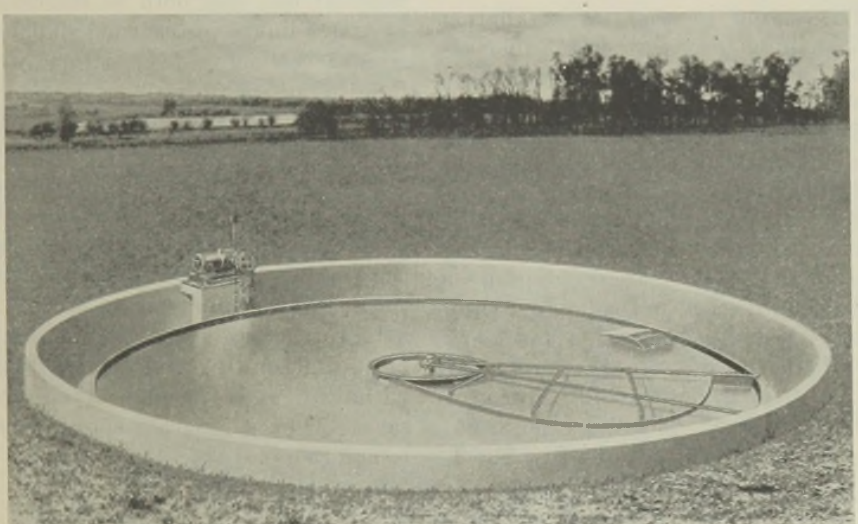


FIG. 1.—Yeomans "Rim-Drive" Clarifier Mechanism with the "Auto Skimmer" and Flusher.

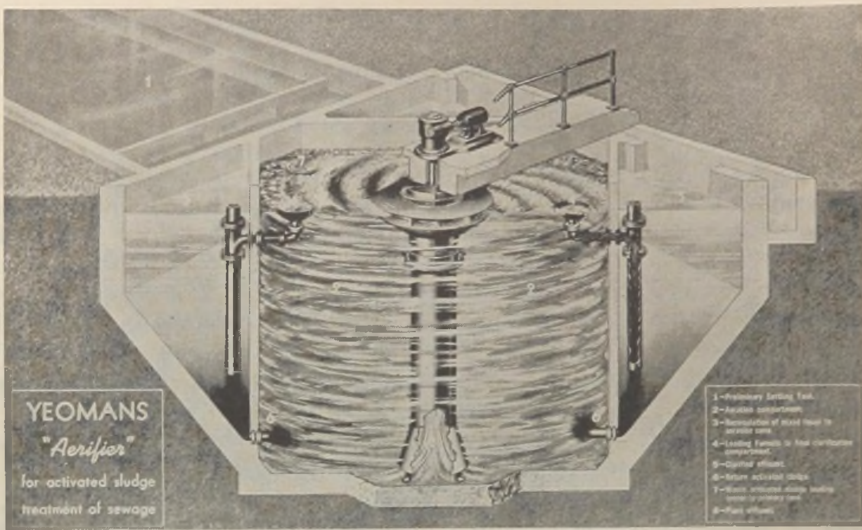


FIG. 2.—Cross-section view of Yeomans "Aerifier." Aeration and final settling in one concrete structure.

vides aeration and final settling in one concrete structure.

Essentially, the "Aerifier" is composed of a Yeomans "Spiralflo" mechanical aerator, adjustable loading funnels, angular corner clarifier compartments, mechanism for the automatic return of activated sludge from the settling compartments, and for the removal of excess sludge, all in one compact concrete structure.

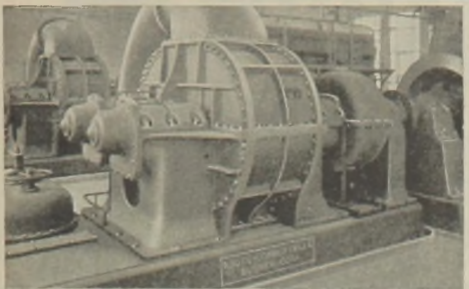
The saving secured in installation and maintenance cost which derives from combining two steps in the treatment process in one concrete tank makes possible fool-proof activated sludge purification of sewage for all communities, large and small.

Fool-proof all-concrete construction is the oustanding characteristic of the "Aerifier." There are no baffles or steel walls to rust and collapse. Only connection between aeration and clarifier compartments are the pipes for loading mixed liquor and return of activated sludge. There are no annular or other openings to allow short-circuiting of treatment. Moreover, the concrete walls make for lower first cost and will show dividends on maintenance.

With the "Aerifier" design, a smaller aeration tank is needed because all excess liquid is eliminated on the return of activated sludge from the settling compartments to the aeration compartment. Power costs are reduced too, due both to the absence of excess liquid in returned sludge and to the economy of operation of the "Spiralflo" aerator.

Exclusive features of the "Aerifier" are the loading funnels which, along with piping, deliver the mixed liquor to the clarifier compartments. These funnels are under complete control of the operator who can regulate flow into the settling compartments at will. A fifth funnel leads to the adjacent primary tank and permits the operator to withdraw excess sludge when necessary. Thus a separate sludge hopper is not required.

For ECONOMICAL and EFFICIENT Operation of Sewage Treatment Plants

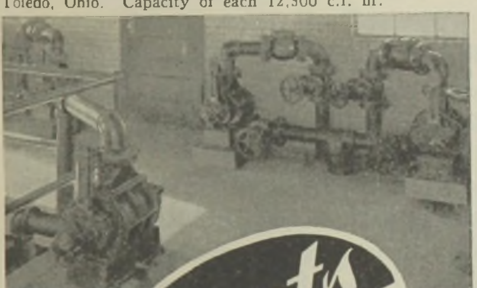


Two "R–C" Rotary Positive Blowers gas-engine-driven installed at Cleveland, Ohio. Capacity of each 10,000 c.f.m., 400 r.p.m., 7.5 lbs. pressure.

Three "R–C" Centrifugal Blowers driven by slip ring motors, installed at New York City. Capacity of each 15,000 c.f.m., 3,565 r.p.m., 7.75 lbs. pressure.

"R–C" Vacuum Pump installed at a New Jersey Sewage Treatment Works. Capacity 120 c.f.m., 20″ mercury vacuum.

Four of eight "R–C" Meters for measuring sludge gas at Toledo, Ohio. Capacity of each 12,500 c.f. hr.



ROTARY POSITIVE BLOWERS

For over 90 years, on every type of application, "R–C" Positive Displacement Blowers have made outstanding records for economical and trouble-free operation. Their ability to deliver constant volume against variable pressures at moderate speed enables these standard blowers to meet Sewage Works aeration requirements as though custom made for the job. Roots-Connersville Rotary Positive Blowers offer you *overall* LOWEST COST air supply because of their exceptionally rugged construction, few moving parts, minimum maintenance requirements, and proved record for delivering more air per horsepower than any other type.

CENTRIFUGAL BLOWERS

"R–C" Centrifugal Units are especially suitable for the larger Sewage Treatment plants, and where air requirements call for variable volumes against fairly constant pressure. The smooth, quiet, high-efficiency performance of Roots-Connersville Centrifugal Blowers attests their rugged construction and excellent design.

VACUUM PUMPS

The highly efficient positive displacement design of "R–C" Vacuum Pumps makes them ideally suited to the requirements of vacuum filters for sludge dewatering. Made in capacities from 5 to 10,000 c.f.m., and vacuums up to 25″ Hg.

SLUDGE GAS METERS

Utilization of sludge gas (generated in the sewage digester tanks) for power is one of the most effective ways of reducing plant operating costs. Accurate gas measurement is necessary —for which the "R–C" Rotary Displacement Meter is unsurpassed. In this meter, all parts coming in contact with the gas are of heavy cast iron which resists corrosion. There are no diaphragms or light metal parts to be easily injured by such impurities. "R–C" Meters have lowest power absorption, and are of tamperproof design.

Write for Bulletin No. 23-B-12

ROTS-CONNERSVILLE BLOWER CORP.

400 Illinois & Mount Sts., Connersville, Ind.

Roots CONNERSVILLE SINCE 1854

Rotary Positive & Centrifugal AIR and GAS HANDLING EQUIPMENT

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