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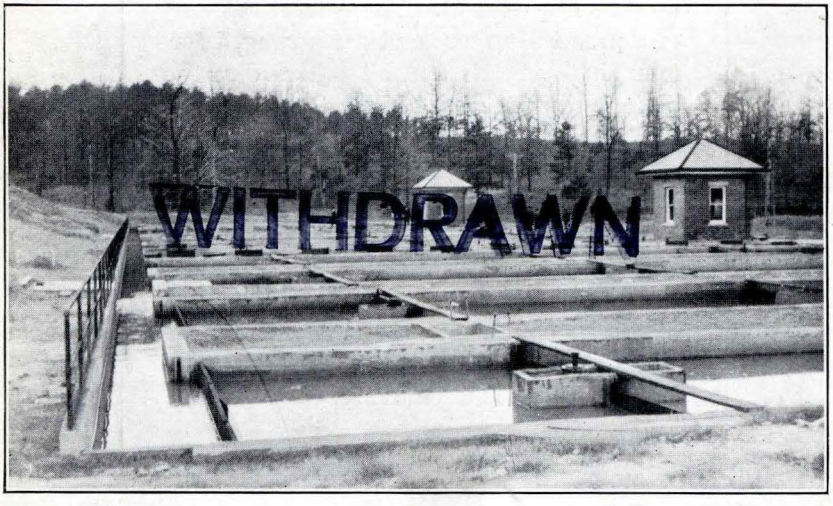

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CONFERENCES on sewage treatment are held annually at Iowa State College under the auspices of the Engineering Extension Department. These meetings are of a practical nature and are arranged for municipal officials and all others directly or indirectly responsible for the operation of sewage-treatment plants.

This publication is one of the more general papers which were presented at the 1923 conference. Several others from this meeting will be published soon. In addition to the more formal papers, considerable time on the program was devoted to the consideration of the individual problems of those in attendance.

SOME PROBLEMS IN THE OPERATION OF IMHOFF TANKS

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There are 185 cities and towns in Iowa which, according to a bulletin issued in 1922 by the State Board of Health have sewage-treatment plants. In 61 of these the Imhoff tank is used as a part of the sewage-treatment process. It is the purpose of this paper to discuss briefly the principles on which the Imhoff tank is designed and to outline operating procedure with particular emphasis on some of the problems which the men charged with the operation of an Imhoff tank have to solve.

Principles of Design

The Imhoff tank is a two-story settling tank originally designed by Dr. Karl Imhoff and first constructed in 1905 by the Emscher Drainage Board in the province of Westphalia, Germany. After several years of successful operation in Germany the Imhoff tank was introduced into America. The first of this type to be built in the United States was installed in 1911 at Madison-Chatham, New Jersey. Since that date Imhoff tanks have been built in nearly every state in the Union. It is estimated that about one-third of all sewage settling tanks used in municipal plants in the United States are of the Imhoff type.

The essential features of an Imhoff tank are the settling chamber, sludge compartment and gas vents. Sewage entering the tank flows through the settling chamber (Fig. 2) at such a low velocity that about 60 percent of the heavier solids sink down to the sloping bottom of the settling chamber and then slide down through slots into the sludge compartment. The slots are so arranged that the gas, which is a by-product of the sludge digestion, cannot rise through them and into the settling chamber. In a septic tank, which is a one-story tank, the gas does rise through the sewage which fills the tank and in doing this lifts some of the partially digested sludge back into the sewage. As a result the effluent (water flowing away) from the septic tank contains a higher percentage of suspended matter than that which leaves an Imhoff tank. Thus we see one of the important reasons for having a two-story tank.

Besides preventing the re-suspension of settled solids in the sewage, the design of an Imhoff tank also prevents the liquid as well as the gaseous products of sludge digestion from coming into contact with the sewage as it passes through the settling chamber. Experience

has shown that by preventing such a mixture an effluent is obtained which is more readily treated in subsequent processes.

The compartment underneath the settling chamber, into which the solids fall as they pass through the slots, is called the sludge compartment. This is a storage space in which digestion or rotting of the organic matter which has settled from the sewage takes place. Digestion of this organic matter is very largely the result of the activities of innumerable bacteria. As the fresh particles of suspended matter come into the sludge compartment the bacteria attack it and break it up into different products, some of which they utilize as food. During this process considerable quantities of gases are formed—the principal one being methane, which is the same gas that is used for illuminating and heating purposes. Recently the engineers of

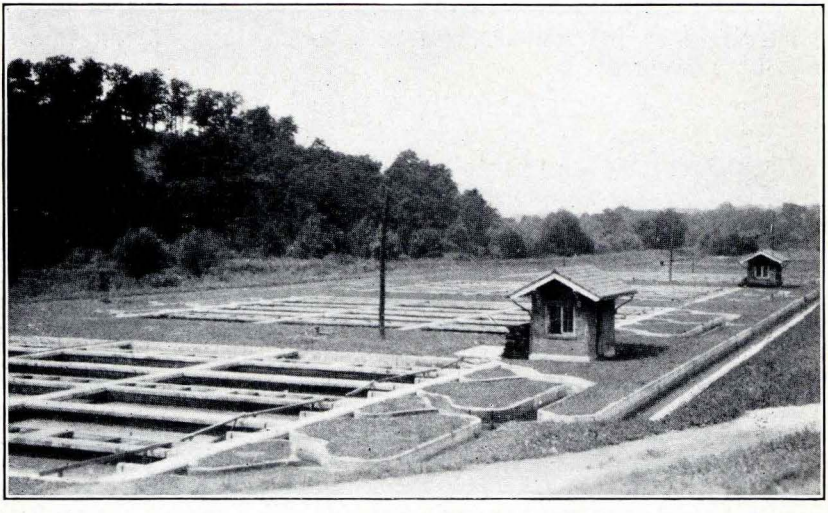

FIG. 1—Imhoff tanks at Akron, Ohio. Photographs furnished by Maj. Edward Rich, State Health Department, Lansing, Michigan.

the Emscher Drainage Board in Germany have devised a method for collecting the gas from Imhoff tanks so that it may be used. In one instance, the supply collected is sold to the municipal gas company and is used in the same way as that manufactured in the company's own plant.

In the Imhoff tank the gases which form during the process of sludge digestion rise until they strike the sloping bottom of the settling chamber which deflects them into the gas vents from which they discharge into the air above the tank. As the gas rises some of the finely divided sludge is lifted by it to the surface of the gas vent and in time a scum of considerable thickness is formed. If this scum is allowed to accumulate it will act as a cover on the vent and will

be gradually lifted as the pressure of the gas below it increases and will eventually be forced out over the sides of the vent and fall back into the settling chamber. In order to prevent this it is essential that the scum be broken up frequently so that it will fall back into the sludge compartment and allow the gas to escape freely.

A considerable portion of the solids which fall into the sludge compartment is left after the bacteria have completed their work on it. This is now what we called digested or ripened sludge and contains a very large percentage of moisture. As the tank continues in operation there is a gradual accumulation of ripened sludge and eventually the amount becomes so large that it is necessary to draw it out of the tank through the sludge pipe. Properly digested sludge as it is drawn from the tank has the appearance of thin black mud. It usually flows readily and is allowed to run out onto sludge-drying beds. In fair

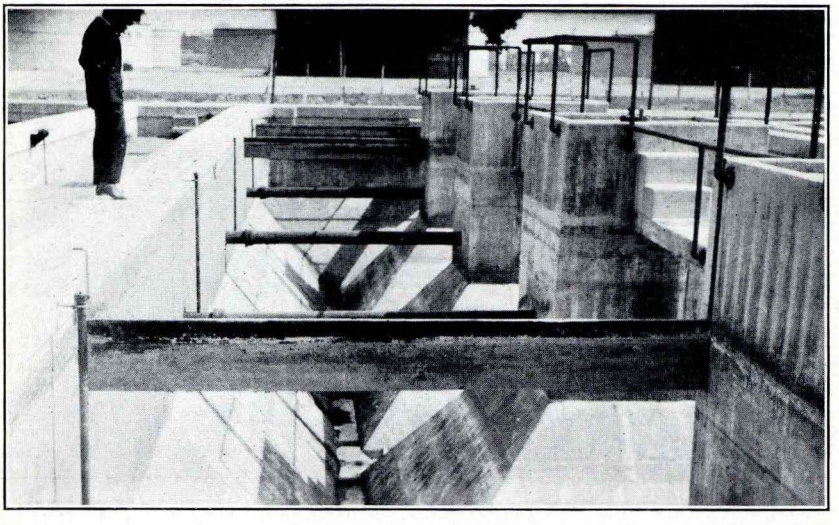

FIG. 2—Imhoff tank unit at Albany, New York. The sewage has been drawn down to the sludge-slot level.

weather it will drain and dry in a week or ten days so that it can be easily handled with spades. It should then resemble dark garden soil and have about the same physical characteristics.

Operating Procedure

If Imhoff tanks are to accomplish the results for which they are designed, namely—give an effluent comparatively free from suspended solids and the products of sludge digestion and produce a sludge which is free from disagreeable odors and which will dry readily—careful and systematic operation of the tank is necessary. Experience has shown that attention should be given to the following schedule of operation.

1. Cleaning screens and grit chambers. Coarse screens are usually installed for the purpose of removing coarse material such as rags, pieces of wood, and other foreign substances from the sewage before it enters the Imhoff tank. These screens should be cleaned daily and the screenings buried. Where storm water is handled by the same sewer that carries the domestic sewage, grit chambers are built for the purpose of removing the sand and other heavy material from the sewage before it flows into the Imhoff tank. Grit chambers should be cleaned after every heavy rain.

2. Cleaning sides and bottom of the settling chamber. Once every week the sides and bottom of the settling chamber (Fig. 2) should be cleaned. Very frequently growths attach themselves to these surfaces and serve as miniature catch basins for the settling solids. Unless they are removed undesirable septic action may be

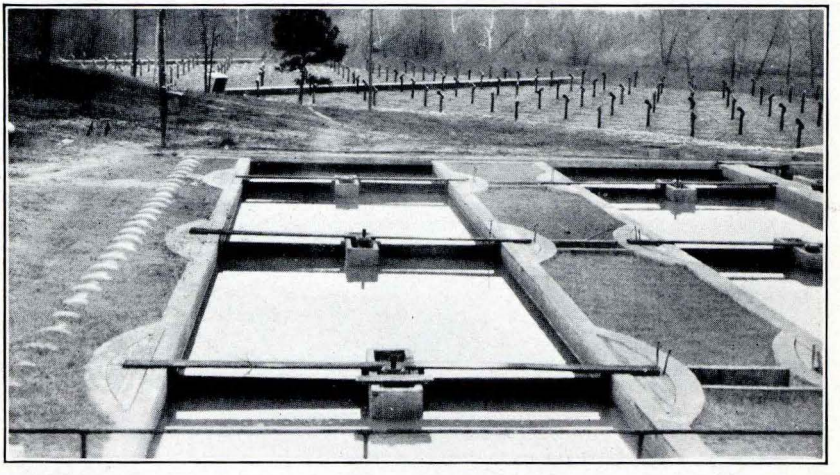

FIG. 3—Imhoff tanks at Atlanta, Georgia, with trickling filters in the background.

started in the settling chamber. This cleaning should be done with a squeegee (a hardwood board 12 to 15 inches long and 3 to 4 inches wide having rubber edges and attached to a handle which is of sufficient length to reach down to the slots in the bottom of the sedimentation chamber). A heavy chain attached to the end of a rod may also be used to clean the slopes and slots in the bottom of the settling chamber.

3. Removing floating material from the sedimentation chamber. Material such as grease, matches, corks, etc., and sometimes scum, which floats on the surface of the sedimentation chamber, should be removed with a skimmer and placed in the gas-vent chamber. If this is not done septic action may start. As we have already noted, septic action is undesirable in the sedimentation chamber. A very

satisfactory skimmer may be made from woven wire having about ten meshes to the inch. A hoop of one-quarter inch iron rod is attached to a long wooden handle. The woven wire is bound to the hoop in such a way as to form a dish-shaped skimmer.

4. Equalizing the deposit of sludge. If the construction of the tank permits it is advisable to reverse the direction of flow through the sedimentation chamber. As the sewage flows through the tank a large part of the suspended matter settles out near the inlet. This results in building up a sludge deposit which is higher near the inlet than it is at the outlet. By reversing the direction of flow once every month a more even distribution of the sludge deposit can be obtained.

5. Treatment of scum on the gas-vent chamber. The scum which forms on the surface of the liquid in the gas-vent chambers should be broken up at least once a day. If this is not done the action of

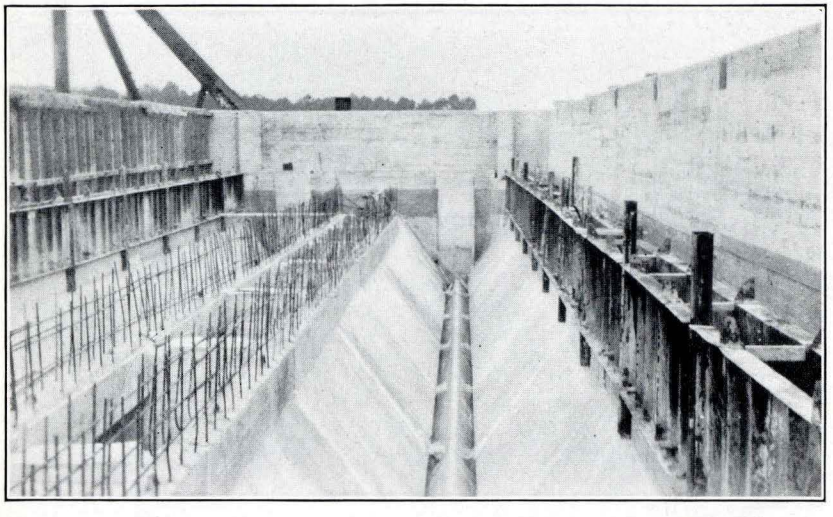

FIG. 4—Sedimentation chamber of the Imhoff tank at Rochester, New York, under construction. The sludge slots and the gas-vent chambers can be readily seen.

wind and sun will form a tough leathery surface through which gas cannot pass. The result is that the scum is lifted by the confined gases and is sometimes pushed over the sidewall of the vent chamber and falls into the sedimentation chamber. Even in Imhoff tanks where housing protects the scum from weather action there is often a tendency toward consolidation of the scum on the surface. The breaking up of the scum may be accomplished with hoes or by water from a nozzle (Fig. 5). In one case which has recently been reported a walking beam has been arranged so that continual agitation of the scum in the vent chambers is obtained. This of course required some kind of power but in the case referred to the results have apparently justified the expenditure for equipment and power. This matter of

keeping the gas vents functioning properly seems to require more attention on the part of the operator than any other single phase of Imhoff tank operation.

6. Observing depth of sludge. It is important to know the depth of sludge in the sludge compartment. Observations to determine this depth should be made at least once a week. If the sludge compartment is divided into two or more pockets the depth of sludge should be determined in each pocket. This may be done by means of a sheet-iron plate 12 to 18 inches square attached to a wire or cord or long, light, wooden rod in such a manner that it will sink in a horizontal position. When it reaches the top of the sludge the rate of sinking will be checked and at this point the depth should be observed. This observation can generally be made through the gas-vent chambers.

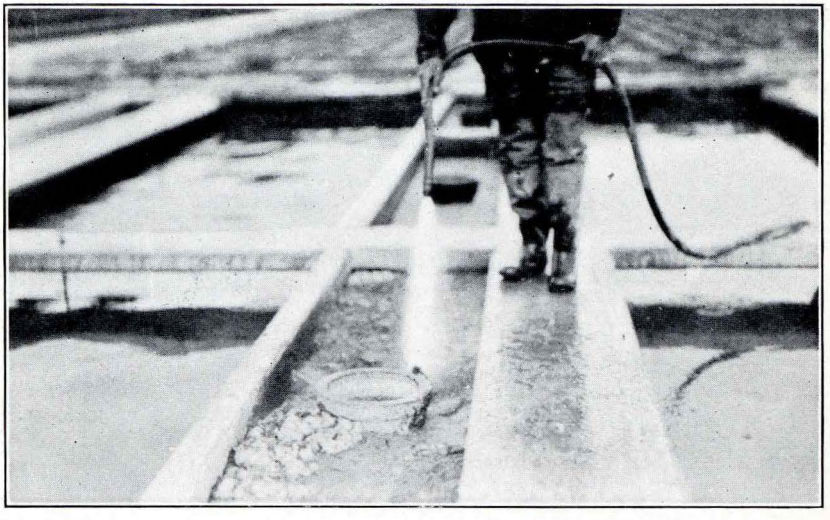

FIG. 5—Hosing the gas-vent chamber of an Imhoff tank to break up the scum layer. This will allow the gas to escape and the solids to settle into the sludge compartments.

7. Drawing sludge. In a normally operating Imhoff tank, sludge should be drawn when the sludge compartment is filled to within 20 inches of the slots. The valves in the sludge-outlet pipes should be opened very slowly. As the sludge begins to flow freely close the valve, let it remain closed for 2 or 3 minutes and then slowly open it again. By doing this a chance is given for the heavy sludge in the bottom of the sludge pockets to start moving toward the sludge pipe. Quick opening of the valves may result in drawing sludge from the top instead of the bottom of the compartment. If there is water supplied to a perforated pipe near the bottom of the sludge compartment the valve controlling it should be opened just before sludge is to be drawn.

There is danger of drawing too much sludge at one time. The partially-digested sludge should be left in the tank to seed the sludge compartment. Otherwise the process of sludge digestion will be temporarily retarded each time the sludge is drawn. No fixed rule for determining the proper amount of sludge to draw at one time can be given. It is the writer's practice to close the sludge valve when the outflowing sludge begins to change from a black to a gray color. However, this rule probably will not be applicable to all tanks and each operator must learn from experience when to stop drawing the sludge.

In addition to drawing sludge when the sludge compartment is nearly filled, it is often advisable to draw it in small amounts when there is any evidence of "foaming" in the gas vents. The writer

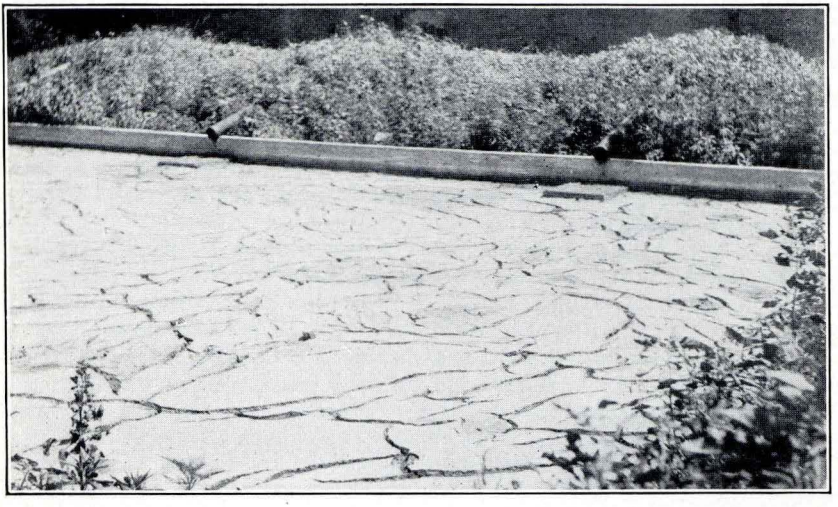

FIG. 6—A sludge-drying bed containing partially-dried sludge.

believes that it is better policy to draw small quantities of sludge frequently rather than large amounts at long intervals.

8. Drying sludge. A well-drained sludge-drying bed (Fig. 6) is a necessary accessory to an Imhoff tank. Sludge drawn from the tank is either pumped to or flows by gravity to the sludge bed. It is not advisable to cover the bed to a depth greater than 12 inches. In from ten days to two weeks after it is applied to the sludge bed (during fair weather) the sludge should dry enough to be easily removable with hoes and shovels. This should be done promptly so that the bed may be ready for the next application of sludge. In some cases the drying of the sludge may be hastened by mixing a solution of alum with the sludge just before it enters the drying bed.

Recent experience at Plainsfield, New Jersey, where 1.35 pounds of alum per cubic yard of wet sludge was applied to the sludge, indicates that a considerable saving of sludge-drying time can be effected. The method of applying the alum is very simple.

Operating Problems

The difficulties encountered in the operation of Imhoff tanks may be summarized as follows:

1. Occurrence of septic action in the sedimentation chamber which results in a cloudy, odorous effluent.
2. Clogging of slots which prevents proper disposition of sludge.
3. Clogging of sludge pipes.
4. "Foaming" at the gas vents.

In a well-designed Imhoff tank most of these difficulties arise as the result of inefficient operation and may be overcome by carefully following the operating procedure outlined above. In some instances, however, troubles are the result of faulty design. It may be that the designer has not fully understood the principles which control the operation of an Imhoff tank, but more often trouble arises from the fact that the tank is called upon to do more work than the designer planned. Whatever the reason for operating difficulties it is surprising to see what can be accomplished by a careful, conscientious, and skilled operator.

Prevention of septic action in the sedimentation chamber, clogging of slots and sludge pipes may all be prevented by following the suggestions which have been made. When the sludge pipes do become clogged, however, there are different ways of getting them cleaned out. If water under pressure is available, a hose with attached nozzle may be dropped down the sludge pipe. A stream of water from the nozzle will frequently dislodge the obstruction. If this does not succeed a soil auger attached to a shaft of sufficient length to reach the bottom of the sludge compartment should be tried. By twisting the auger and lifting it carefully the obstruction may be removed. If an auger is not available a hook will serve the same purpose. Usually the obstruction is formed by rags and this fact should be kept in mind when attempting to clean out the sludge pipe. In some cases, however, the clogging is due to the solidification of sludge.

"Foaming" is an abnormal boiling of the gas vents. Under certain conditions gas seems to be produced in large quantities in the sludge compartment and rises so rapidly in the vent chambers, carrying finely divided sludge with it, that the scum on the vent chambers is lifted until it overflows. The causes of foaming seem to vary. Overloading of the plant, excessive accumulation of sludge, inadequate gas-vent area, oil from garages, septic sewage, and wastes from creameries have all been charged with causing foaming conditions.

During the past summer the writer had some experience with "foaming" in an overloaded tank and has seen the gas vents boil over five times in one day in spite of thorough hosing of these cham-