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INTERMITTENT SAND FILTERS

By Ernest Boyce

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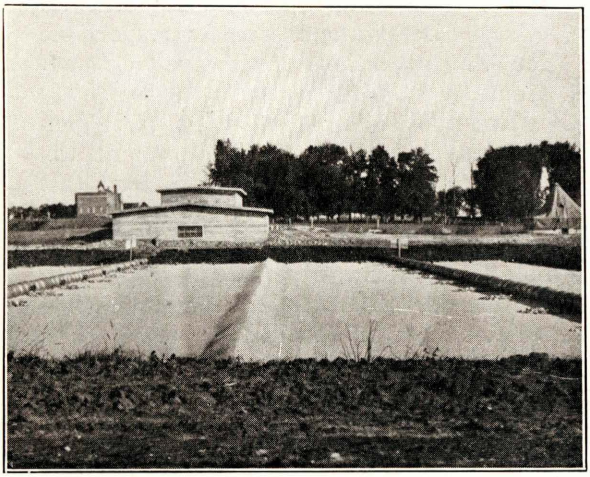

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CONFERENCES on sewage treatment are held annually at Iowa State College under the auspices of the Engineering Extension Department. These meetings are of a practical nature and are arranged for municipal officials and all others directly or indirectly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

This publication is one of the more general papers that were presented at the 1926 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.

INTERMITTENT SAND FILTERS

By Ernest Boyce
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The first use of intermittent sand filters in sewage treatment was for the whole process of treatment. The sewage was applied without preliminary treatment to remove suspended matter, and in the operation of these filters it was contemplated that the removal of the suspended solids from the surface of the sand would be a part of the routine operation.

The first sand beds used were natural sand deposits more or less completely underdrained. The filtering material being naturally in place, the removal of the surface of the sand filter with the removal of the deposits formed from the suspended solids was a matter of little concern. Practically the only cost was the cost of its removal when it became so badly clogged as to cause ponding.

Most of us are familiar with the sand filter as one of the several devices for the oxidizing of the liquid and non-settleable organic matter present in the effluent from the various types of settling tanks. When so used, surface clogging is still a problem that requires the regular raking of the surface and the periodic removal of the surface of the sand.

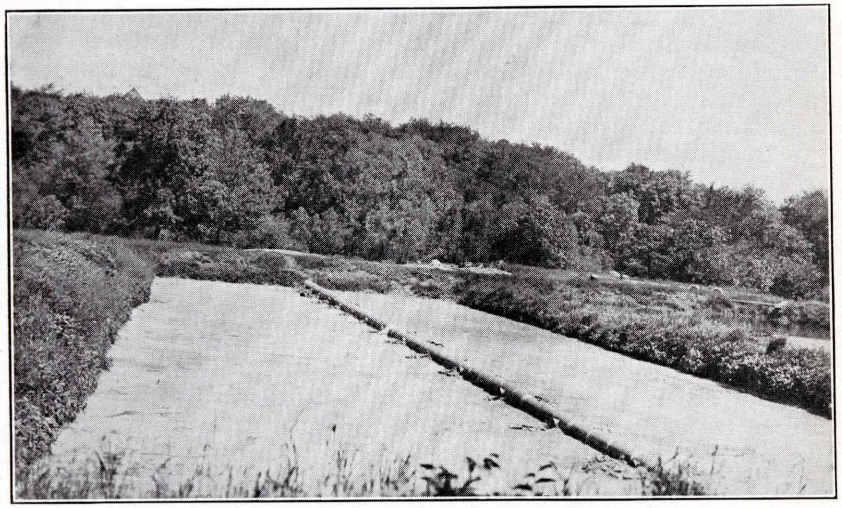
The other extreme in the use of the sand filter is to use it as a finishing process following sedimentation, sprinkling filter or contact bed, treatment and resettling. In this use, it serves to remove the last remaining part of the unoxidized dissolved organic matter and more important perhaps at this stage of treatment, it serves to bacterially purify the effluent. With the increasing popularity of the sprinkling filter as a mean of secondary treatment, there has been less emphasis given to the removal of bacteria as a desirable part of sewage treatment; most of the emphasis being placed on the removal or oxidation of oxygen consuming substances.

It is not at all improbable that in the future, at least on certain streams where the bacterial quality of the receiving stream must be protected, sand filters will be used along with chlorine as a finishing treatment following other processes intended primarily for oxidation.

Intermittent sand filters, while requiring considerable maintenance in order to prevent ponding, are capable of producing an effluent that is well oxidized and has a lower bacterial content than is obtained with the coarser grained biological filters.

Where small plants are to be constructed to discharge into dry waterways, the sand filter is less apt to fail through neglect than other secondary treatment processes in common use. If the sand bed is unbroken and ponding is prevented, there can hardly be a failure to oxidize the effluent to a nonputrescible state. The most common failure of a sand filter is the destruction of the biological aspect by ponding. This may be due to surface clogging or to a failure of the syphons to properly alternate, giving a continuous discharge of settled sewage onto one bed.

Too frequently the sand bed is regarded by the operator merely as a filter. The importance of the careful draining of the bed between doses of sewage cannot be too strongly stressed. Unless the bed drains so that air can carry the oxygen to the minute organisms living as films covering the sand grains, these organisms not only fail to have the oxygen necessary to combine with the organic content of the sewage and thus oxidize it as a part of their life process but being deprived of oxygen, they die and the filter bed becomes inert.



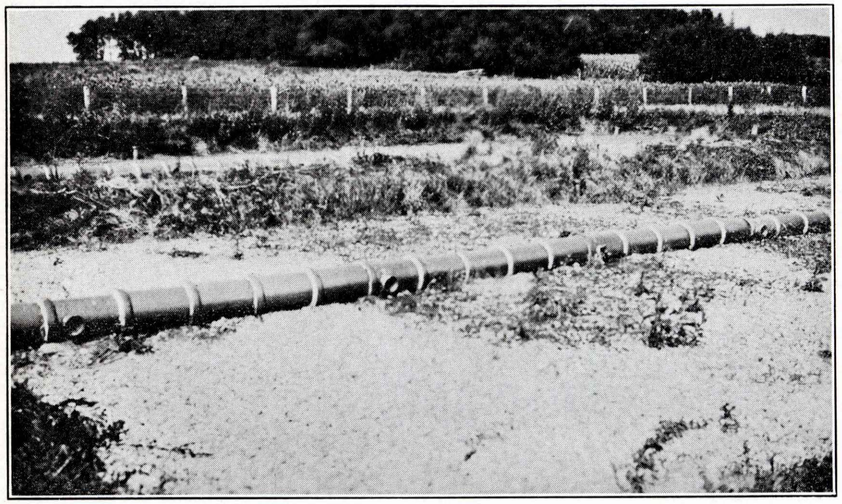
Typical intermittent sand filter.

Slight ponding is followed by reduced biological activity in the vicinity of the ponded area and unless corrected, the destruction of that section of the filter, insofar as oxidation is concerned, rapidly follows. The inert sand will tend to compact still more and the ponding increase until the filter must be taken out of service. It is not infrequent that a plant will be operating so near to capacity that the removal of one filter unit will seriously overload the others with a progressive failure of all the beds.

Sand filters are quite popular in Kansas and are to be found in 28 of the existing 93 sewage treatment plants, 62 of which have some form of secondary or oxidizing treatment. In all but two of the 28 plants, the filters follow Imhoff tank treatment. In one instance the sand filter follows a septic tank and in the other, natural sand

beds are available for the disposal of raw sewage, pre-treated only by coarse screens. In design they are doubtless very similar to those in use in Iowa.

Since the sand is in most instances shipped, more care is given to its selection than would be the case were it available locally. Usual specification requirements call for a sand having an effective size of not less than .3 mm. nor more than .45 mm. and having a uniformity coefficient of not to exceed 2.5. Since it is very desirable that the fine material be kept at a minimum, requirements as regards limiting percentages of fines are sometimes included. Some engineers specify that not more than 1% of the sand shall be finer than .13 mm. Where bank sands are used, it is very important that a turbity measurement be made and the permissible turbity sharply limited.



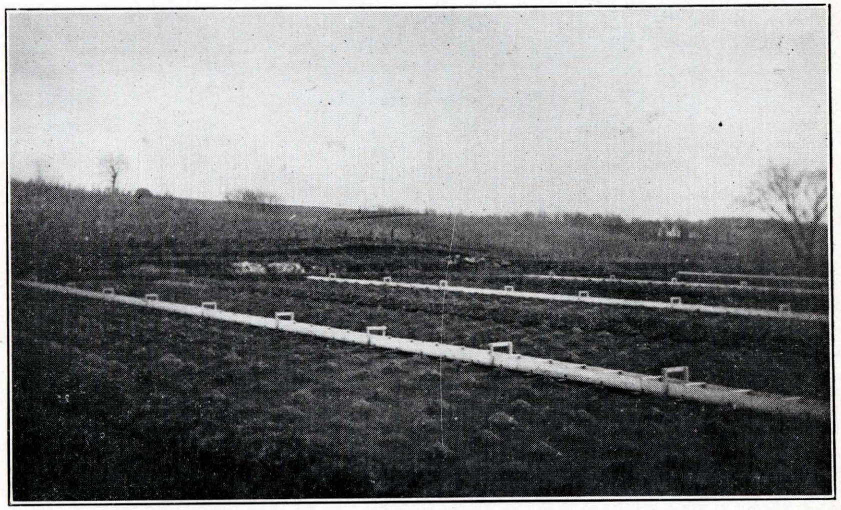
Neglected sand filter showing rank weed growth.

In one or two Kansas plants, an attempt was made to economize on first cost by using a locally available bank sand of satisfactory effective size and uniformity coefficient but having a high silt content. Subsequent operating experience at these plants would indicate that if such sand is to be used, it should be washed. By washing, it would also be possible to remove some of the undesirable fine sand particles. The presence of the fine sand and silt undoubtedly greatly decreases the size of the void spaces and consequently the capillary retention of sewage in the sand is increased, with a resulting loss of oxidation capacity.

In this connection, it is interesting to note changes that have taken place in the design of sand filters as regards underdrain spacing. Better underdrainage is now provided usually with gravel or broken stone covering the bottom of the bed at least to the depth of the drains, and many times, deeper. The reduction of the underdrain spacing from 10′ to 15′ spacing to 5′ or 6′ is also a desirable improvement. Six-inch tile are more frequently used than 4″ for underdrains and with ventilating risers at both upper and lower ends of the underdrain lines excellent aeration of the bed is secured.

It sometimes happens that during high water the outlet from a sand filter is submerged, backing flood water through the underdrains up to the bottom of the filter. The clogging from mud thus deposited can be very troublesome. Where there is any chance of back water damage, protection should be provided by flap valves controlled by a float or other device of positive action.

The banks around the sand bed should also be protected from ero-



Sand filter with wooden distributor. Surface of the sand mounded for winter operation.

sion and the resulting silting up of the edges of the filter. In all but two or three of the Kansas installations, the banks around the filters are surrounded by a concrete wall high enough to protect them from surface wash.

Because of the cost of sand, there is a tendency to reduce the depths of the bed below 36″ and even below 30″. Such reduction in depth must carry with it design that will provide for the uniform distribution of the sewage over the surface and the proper aeration of the filter for its entire depth or else we may expect less satisfactory results. While underdrainage has been improved, there has been perhaps less attention given to the securing of uniform distribution of sewage over the surface of the sand. The earlier elaborate systems of wooden flumes were difficult to keep in order and tile

lines placed on the sand surface are hard to maintain. It would seem well to plan the distribution system so that the operator can with little trouble change the rate of application of sewage to different parts of the bed. The use of an open concrete flume with adjustable lateral ports either discharging through overflow troughs of wood or half tile placed on the sand surface or onto well baffled platforms, seems to be a very satisfactory method of distribution. There are many types and arrangements of distribution systems in use and their satisfactory or unsatisfactory behavior under operating conditions is the determining factor of their success. Where climatic conditions make it necessary to ridge and furrow or mound a filter for winter use, it is desirable to be able to do this work with a minimum disturbance of the distribution arrangement.

The amount of sewage applied at one dose is somewhat varied in practice. If it were possible to secure uniform distribution of the sewage over the sand surface with a small dosage, then an application of 1″ of sewage at a time would be desirable. Because of the unevenness of a bed and other difficulties of uniform distribution, a larger dosage is more frequently used with a correspondingly larger interval between applications. Three inches is regarded by many as being a practical maximum limit for a single application of sewage. Such an application is at the rate of approximately 80,000 gallons per acre. In order that the sewage does not become over septic in the dosing tank, it is necessary to make the filter areas smaller when designing for large dosages. As to the amount of sewage that can be applied, much depends on the clarification of the sewage and the quality of sand used. In a sewage well clarified and containing only domestic wastes, good results have been obtained from filters operating at approximately 200,000 gal. per acre per day. Better operating practice would perhaps limit the maximum rate to 150,000 gal. per acre per day.

When used as a final process following other secondary treatment, the sand filter can be operated at rates much higher than are possible if the filter is to have the full oxidation load.

It is probable that sand filters for secondary or oxidizing treatment will continue to be popular, especially for the moderate sized plant or in places where odors prevent the use of sprinkling filters. The choice will depend largely on the availability of suitable sand, terrain limitations and other economic considerations.

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