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SOME SEWAGE-DISPOSAL PROBLEMS

By Earnest Boyce

Presented at the Sixth Conference on Sewage Treatment
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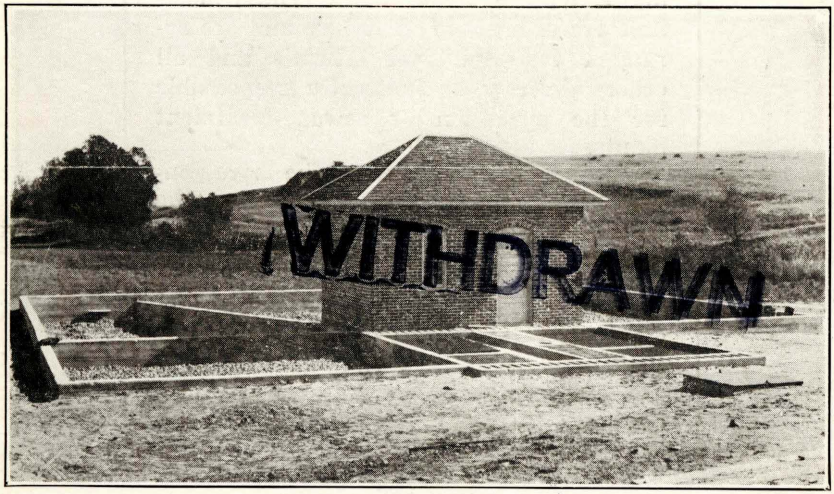

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CONFERENCES on sewage treatment are held annually at Iowa State College under the auspices of the Engineering Extension Department. These meetings are of a practical nature and are arranged for municipal officials and all others directly or indirectly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

This publication is one of the more general papers that were presented at the 1924 conference. Several others from this meeting are to be published. In addition to the more formal papers, considerable time on the program was devoted to the consideration of sewage-treatment plant construction and operation, as well as to the individual problems of those in attendance.

SOME SEWAGE-DISPOSAL PROBLEMS

By Earnest Boyce

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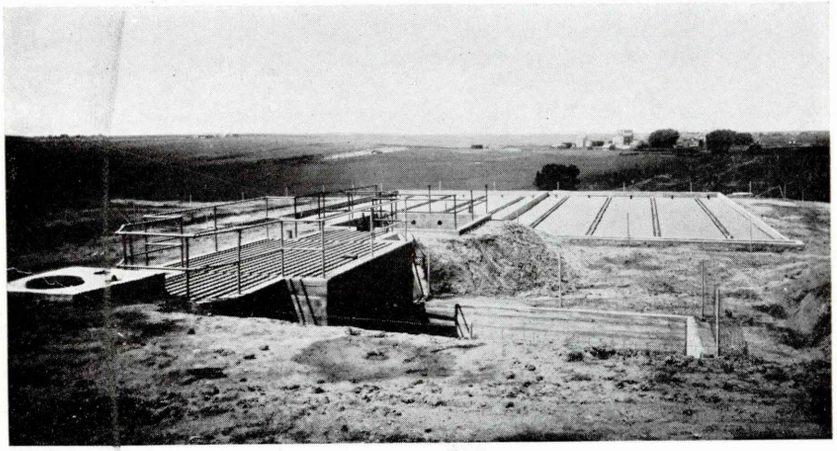
Kansas State Board of Health.

Sewage-disposal problems in Kansas are very similar to those encountered in Iowa. Our climate is not severe, however, and some of the operating difficulties incident to prolonged zero weather do not concern us so much.

Sewage disposal has for its purpose the realization of one of two objectives—either such treatment of the sewage that a local nuisance will not exist, or such treatment that water-purification plants



A sewage-treatment plant for a small municipality.

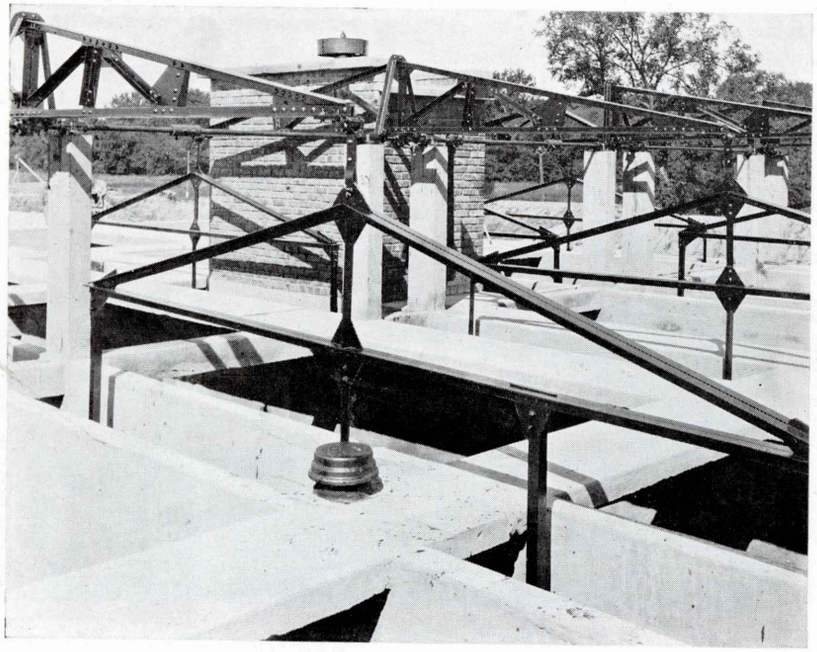
taking their supply from the receiving stream will not be compelled to remove an excessive amount of pollution. On a small stream, of course, both of these objectives may receive consideration. Where dilution can be used without local nuisance or detriment to other users of the stream below, it is considered to be a proper method of sewage disposal. Some Kansas streams have high seasonal variations of flow, which variations are greatly increased by the diversion of water from the streams for irrigation purposes. Because of this, rather complete sewage treatment is needed at certain seasons of the year, in order to prevent the creation of a local nuisance.

What Constitutes a Nuisance

One might digress to say that it is sometimes a bit hard to decide just when a nuisance exists. We consider that a nuisance exists

when sewage is discharged in such manner that the dissolved oxygen of the receiving stream is exhausted and the odors of putrifaction become offensive—also when, because of the location of the stream as regards residences, public roads, etc., there is objection to the physical appearance of the sewage-laden stream.

One popular idea that has to be combated continually is the erroneous belief that the effluent from a septic tank will not produce



Motor-driven walking beams actuate scum agitators in the gas vents at this sewage-treatment plant.

a nuisance when discharged without dilution or secondary treatment of some sort. We have a good many plain septic tanks in operation in Kansas. Sometimes they are so located that the odor of the putrescible effluent does not cause complaint, and the remote location precludes danger from flies, etc. In such cases there is perhaps a minimum need for secondary or oxidizing treatment. However, the city maintaining the plant is always subject to the complaints that may arise. When they do arise, the burden of proof rests with the city to show why the thing complained of should not be abated. As we see it, the discharge of putrescible sewage does not in itself constitute a nuisance, but it may easily become a nuisance when it interferes in any way with the public or individual health or comfort.

It is not impossible for a trickling filter in normal operation to cause just as much complaint as regards odors in its vicinity as may have been occasioned by the septic-tank treatment alone. It becomes in reality the occasion of a nuisance—and yet its effluent may be very well oxidized. One is reminded of the story of the tree falling in a forest without producing sound, because no ear heard it. A nuisance, in order to be a nuisance, must necessarily be the cause of a just complaint on the part of someone; and if no one is injured or complains and there is no potential danger of injury, then it perhaps would be difficult to show the existence of a nuisance.

Protection of Fish Life

The question of protecting the fish life in a stream, during low-water stages, from the exhaustion of dissolved oxygen caused by the sewage present in the stream, introduces a factor that does not come under public-health measures—nor does it appear to constitute a nuisance from a health standpoint. There are those who have a right to expect that the normal fish life of the stream will not be destroyed, and their riparian rights should be respected by the city discharging sewage into the stream. With our growing use of streams and rivers to carry away human wastes in large amounts, as well as industrial wastes of many kinds, this problem will be of increasing interest and importance.

Protection of Public Water-Supplies

When we take up the problem of treating sewage wastes in order that water-supplies may be protected, we are working toward a more definite objective. We must treat the sewage, not to prevent local complaint, but rather to hasten the mineralization of the organic matter contained in the sewage. Incidentally, we destroy the food materials in the stream upon which certain objectionable bacteria might feed. Due to a similar reason, we reduce the probable quantity of algae growing in the stream.

By doing these things we make it possible for properly-designed water-filtration plants to complete the purification process without bacterial overload.

When sewage is treated to eliminate a nuisance, the treatment is satisfactorily completed when the nuisance is eliminated. When we are concerned with the bacterial and organic quality of the receiving stream, in the interest of water users below the sewer outlet, the degree of sewage purification has no limit other than that imposed in the interests of economy. One might consider the quality of the water in the receiving stream above the sewer outlet as representing the practical limit to which the purification of the sewage might ultimately be carried. Such a result, however, is not probable unless chemical disinfection is employed.

Regulation of Water Pollution in Kansas

In 1907, with the passage of the law popularly known as the Water and Sewage Law, the Kansas State Board of Health was given authority to regulate the discharge of sewage into the waters of the state. In the passage of this act, Kansas acknowledged that fundamental function of government—the responsibility for protecting its citizens against injury to health. Because of the careful work of those who drafted the law, there has been little need for subsequent modification.

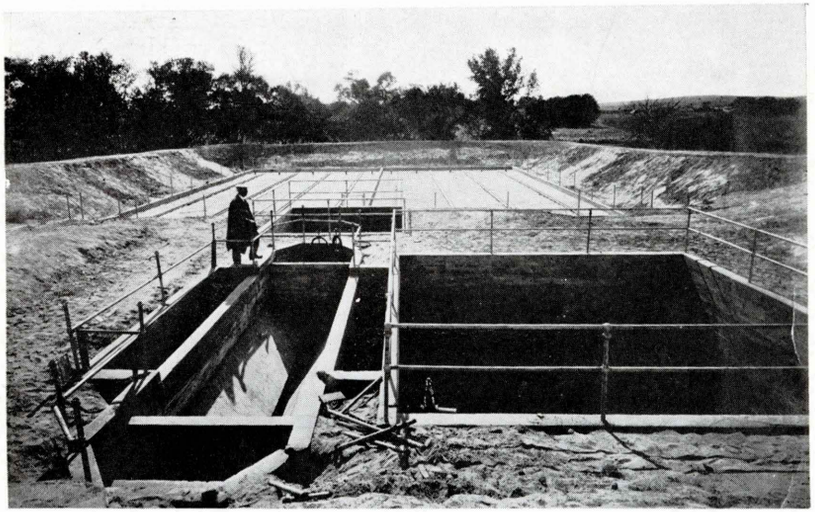
This law requires that before a city, corporation or person can discharge sewage into the natural waters of the state, a permit must be obtained from the State Board of Health. This permit must bear the signatures of the Governor, Attorney-General and the Secretary of the Board. Such a permit is granted only after plans are filed, together with the engineer's report, specifications and other pertinent material necessary to show that the proposed discharge of treated or untreated sewage will cause neither complaint because of local nuisance nor danger to the water-supplies below. The degree of sewage treatment required is decided upon after a study of the particular conditions that exist. Any sewer extension or any change in the method of treatment that would change the quantity of sewage discharged, requires the approval of the Board of Health and the issuance of a formal permit. A similar provision applies to public water-supplies.

Operating Reports

In order that information may be available at all times as to the amount and character of the pollution entering the waters of the state, it is provided that each municipality, corporation or person contributing sewage pollution shall furnish the State Board of Health with this information. This is done by means of monthly operating reports made on blanks furnished by the State Board of Health. These reports state the quantity of sewage discharged, with an indication of its degree of purification. They also give information as to the operating condition of the plant, and thus furnish to the city a record that is of value. The tests required are simple. The settling solids are determined by Imhoff-cone measurement, and the relative-stability by the methylene-blue test; but they serve to indicate the character of the treated sewage. In case no secondary treatment is required, the stability test is, of course, omitted, unless samples are required from the receiving stream in order to give an indication of its oxygen content—or rather of its possible absence during periods of low flow.

Annual Inspections

Under the rules and regulations of the Kansas State Board of Health, an annual inspection must be made of all public water-supplies. It has been convenient to include an inspection of sewage-disposal plants at the same time. The reports of these annual inspections, which are made by the sanitary-engineering department, together with the information given by the mouthly operating reports, give the complete record of that disposal plant.



Another sewage-treatment plant for a small town.

In Kansas, as elsewhere, the last ten years have seen a rapid increase in the number of sewerage systems in operation, and also in the use made of the systems already installed. Approximately 80 per cent of the people of Kansas who live in incorporated towns and cities have sanitary sewers available, or would have them available by nominal extensions of existing sewers. This means approximately 42 per cent of the total population of the state. Of this 80 per cent, approximately 43 per cent have some degree of sewage treatment. With the ever-increasing amount of sewage that is being discharged, it will be necessary, as time goes on, for this ratio to be increased.

With this rapid increase in the use of sewers to remove a city's human and industrial wastes, the problem of sewage disposal has sometimes been acute. Development has been quite rapid and research work successful in determining methods suitable for the economic changing of the biochemical nature of the sewage so that it

will break down its highly complex and unstable organic nature and change into inert earthy matter, the end of organic decomposition.

Principles of Sewage Treatment

The methods most commonly used to bring about these changes in sewage are those that make use of the natural bacterial action of decay. The best-designed disposal works are those that furnish, as it were, the best workshops for this bacterial action. Because of the small amount of organic matter present in sewage when compared with the volume of water to be handled, and because of some of the characteristics of the bacteria themselves, the design of an ideal working place for them presents some interesting problems.

The activated-sludge method of sewage treatment (of which there is one example in Kansas—a plant treating the sewage of a city of 10,000) is designed to oxidize the organic matter appearing in suspended form, in liquid, and in semi-liquid or colloidal form. This is done by bringing together, under the most favorable conditions possible, the floculent masses of oxidizing aerobic bacteria, the air necessary for their life, and the organic matter to be treated.

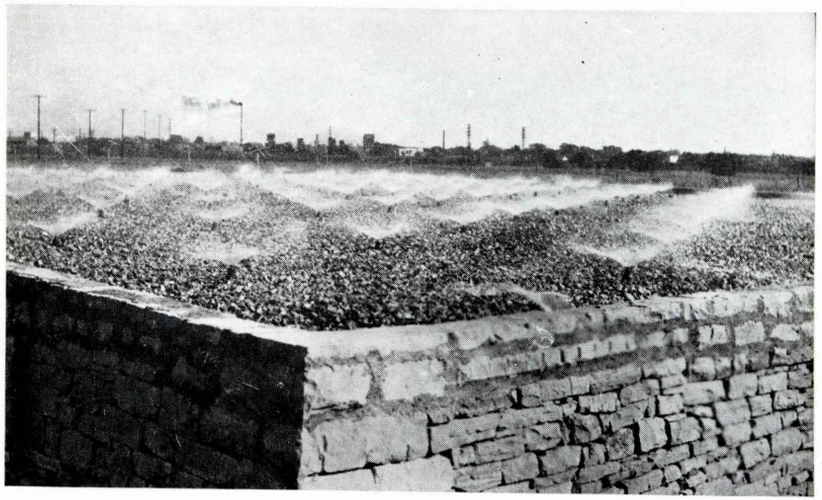
The great majority of disposal works, however, can have these major processes divided into two steps: (1) primary treatment, meaning those processes whereby suspended solids are removed from the sewage, and (2) secondary treatment, referring to that portion of the bacterial workshop where the organic matter which appears in the sewage in liquid form is mineralized by oxidation. Ideal results are obtained from a septic, Imhoff, or sedimentation tank, where there is complete separation of suspended matter from the sewage passing through, with little change in the liquid portion. With a clear conception of the purpose of these tanks and a realization that organic material in liquid form is little changed by the tank treatment, we are able to judge better when they can be used. If the putrescible effluent from the tank can be oxidized by the oxygen normally contained in the water of the receiving stream, and that done without damage to some other user of the stream, then secondary treatment may not be necessary. Otherwise, we need to provide a workshop where the oxidizing of the organic matter contained in the sewage liquids can take place.

It is not within the scope of this paper to discuss the various types of sand filters, contact beds, trickling filters, etc., that are used for this purpose. The problem in the past has been very largely one of suitable design—it is now rapidly becoming one of suitable operation. Suitable operation cannot be had unless sewage-treatment plant operators have a clear conception of the biological principles involved. Most of the disposal plants which are not operating properly are failing because they are operated in such a manner as to interfere with the normal life cycle of the microscopic life upon which their success depends.

Disposal of Industrial Wastes

We not infrequently find trade wastes which do not lend themselves to the mode of treatment that has proved satisfactory for domestic sewage. Many of these present new and somewhat complex problems. Perhaps one of the most troublesome trade wastes to be found in the average midwest town is sewage that carries milk wastes from a creamery or other milk-handling station.

In Kansas we have a number of municipal disposal plants that have been rendered useless, so far as effective action is concerned, by creamery wastes. We find that this and certain other trade wastes cannot be discharged into a system designed for domestic



An unusual wall construction for a trickling filter.

sewage without producing a condition in the disposal plant that not only inhibits the mineralization of the organic matter carried by these wastes, but also prevents the proper breaking down of the organic matter in the domestic sewage. We believe that the solution of the problem lies in the installation, at the source of these industrial wastes, of such treatment devices as may be necessary to change the characteristics of the particular waste so that it may enter ordinary sewage without causing difficulty in its treatment.

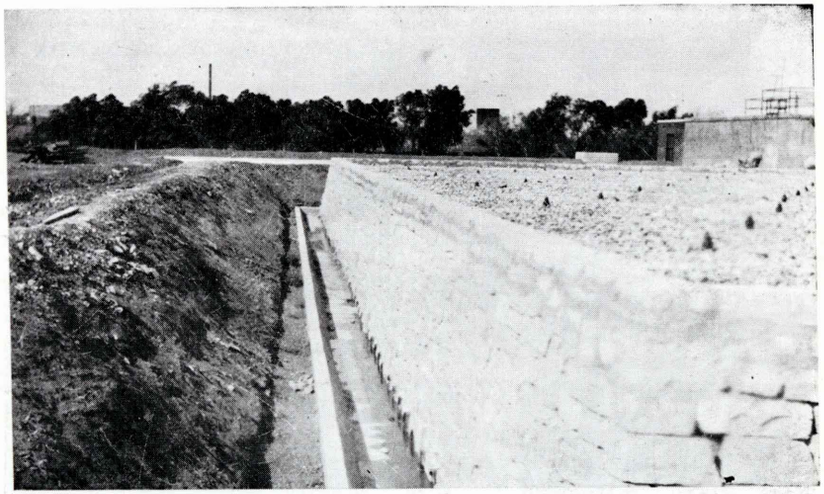
The handling of certain refinery wastes, which are particularly objectionable because of their odors and tastes, is a real problem and one that does not as yet have a general solution. In some instances large impounding reservoirs hold the refinery wastes for months and are emptied into the receiving stream at times of high

water. The salt-water pollution of streams from oil fields has also caused considerable trouble. This salt water is pumped with the oil and its disposal in the quantities produced has been difficult.

These wastes have great public-health significance, not because of danger in themselves, but because their presence in a city water-supply will encourage the use of private wells that may be dangerously polluted.

Protection of Plants Against Storm Water

Another frequent source of trouble in operation is the failure to protect the disposal plant properly from sudden disturbances due to



Another view of the trickling filter shown on the preceding page.

storm water. Roof drains, perforated manhole-covers and poorly-constructed manholes will never be entirely eliminated, and until they are reduced to a minimum there is need of a bypass weir at the entrance to a disposal plant. This practice is based on the theory that it is better for a little sewage to go without treatment during a storm period, when there is the least danger from it, than for the good operation of the plant to be prevented for a considerable period following the storm, because of the disturbance caused by passing an excessive volume of water through it.

Better Operation Needed

In concluding this paper, one other cause of operating failure will be mentioned, which should be of real concern in every state. The cause referred to is the choosing of men to have charge of disposal

plants who have little to qualify them for this work. They frequently lack interest in it. Often they are already employed by the city, this work having been added to their work to receive their attention at spare moments. No man can be expected to do creditable work unless he is interested in what he is doing, and he can hardly be expected to be interested unless he understands the work he is doing. Groups, such as these sewage-treatment conferences held here at Ames, that meet to discuss individual problems in the operation of sewage-treatment plants, add much to our general fund of information and revive individual interest in the work. In so doing, such meetings surely contribute in a material way to better plant-operation.

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