

natural methods—its use for agricultural purposes and for the filling of low land.

Methods of Drying.—From what has already been said, we may conclude that the best system of sludge disposal is that in which the sludge is first dried. There are, of course, difficulties connected with this drying.

Science has, up to the present time, interested itself principally in artificial methods of drying. Of first importance in this connection is the pressing of sludge, which has been used for many years in England. The excess water in the sludge is pressed out through filter cloths. Sewage sludge can be pressed only when it is properly treated, for example, with lime or coal powder. This system is a good one, and for the foregoing reason is especially applicable to chemical precipitation works, where the chemicals necessary for the precipitation are added to the sewage. The cost of the system is, however, so high, that, outside of England, it has been used very little.

In comparison with sludge pressing, the centrifugal drying machines used in Germany (Frankfurt and Hanover), are a step in advance, since the fresh sludge is handled without the addition of chemicals. There is, however, the serious disadvantage that the water separated from the sludge is much more objectionable than in the case of sludge pressing. This water contains a very large part of the organic matter of the sludge.

A more natural treatment, and one especially applicable for small plants, is the mixing of the wet sludge with drying matter, which absorbs the moisture. Refuse and street cleanings are especially applicable for this purpose if the sludge is to be used for agricultural purposes.

The simplest of all methods of drying is just to discharge the sludge upon a drying bed, which should consist of 10 in. of porous material with a perfectly horizontal surface, and underlaid with drain pipes laid approximately 12 ft. c. to c. It must not be forgotten that there should be spread over the surface of the bed a thin layer of fine sand, which will have to be frequently renewed.

This simple natural arrangement for drying was formerly very little used, because all attempts to drain fresh sludge were unsuccessful. The sludge must first be made drainable. Without question, this can be done by artificial means, as with the addition of lime or coal powder, in the same way as with sludge pressing. But all these methods of drying are uneconomical.

Automatically, by itself, the sludge becomes drainable while undergoing a process or natural decomposition. We have known this fact for a long time from the "septic tanks," through which the sewage slowly flows, and as a result of being in contact with the decomposing sludge, becomes foul itself and smells. In comparison with these septic tanks, a step in advance was made by separating the decomposing sludge from the flowing sewage, by removing it into a separate tank.

This idea of separate sludge decomposition was, so far as I know, first brought forward by H. W. Clark, of Boston, in the year 1899. It was not possible, however, in the experiments made by Mr. Clark, as well as in other places, to effect, in a separate sludge tank as good a decomposition as with the ordinary septic tanks.

The first success along these lines was made in the year 1906 at the sewage-disposal works of the Emscher-genossenschaft in Essen. The type of works referred to are spoken of as Emscher tanks, a special type of double-deck tanks, which consist of an ordinary settling chamber and a sludge-decomposition chamber below, through which there is no flow.

After a short ripening time, there was found in these sludge-decomposing chambers a sludge black in color, and with a slight odor of tar. In spite of small water content, ordinarily of about 75 per cent., the sludge flowed easily through pipes, and when spread upon a drying bed to a depth of 10 in., became firm and spadeable in a few days. The decomposition was practically odorless, and the sewage flowing out of the settling chamber was totally unaffected by the decomposition of the sludge.

Since we know that it is possible with separate sludge chambers to have the principal advantage of the septic tank, namely, the drainability of the sludge, the septic tanks have lost their importance. Their disadvantages, especially the objectionable odor of the effluent, render them impossible for many purposes. They are to-day suitable only for very small plants.

In most cases, it is desirable to keep the sewage fresh; in other words, to treat it in ordinary settling chambers, and to remove into a separate chamber only the sludge, which requires decomposition, in order that it can be easily drained and dried. It is not to be assumed that the Emscher tank is the only arrangement for bringing about these results. It is possible, without question, to bring about the natural decomposition, which takes place in Emscher tanks, with any properly built tank, filled in the right way with sludge, and operated according to certain principles. I do not yet know of any plants with separate sludge tanks, however, where exactly these results have been obtained. And it seems to me as if all possible scientific methods of bringing about these results, with plants in which the sludge is pumped from the settling tanks to special decomposition tanks, will be much more expensive both for construction and operation.

Practical Tests of Sludge.—In the sense of what has been said, good sludge may be considered as sludge which dries quickly and has no objectionable odor. The following information shows the possibility of easily determining the character of sludge.

Appearance and Odor.—Good sludge is black, and uniformly granular. It moves easily, it has a slight odor of tar or burnt rubber. Bad sludge is grey, full of fibres, soapy, sticky, and has a bad odor.

Adhesiveness.—A white enamel-lined dish pan is filled with sludge and then emptied so that only enough sludge remains to just cover the surface of the enamel. Good sludge will separate itself at once from the water, so that in 10 or 15 sec. the surface is broken up by white lines. Bad sludge sticks to the entire surface. This experiment is especially important because it gives the information at once.

Gas Content.—Newly withdrawn sludge is placed in a measuring glass to a height of 1 ft. After six hours good sludge separates itself from the water which collects below the sludge. With bad sludge, the water collects on top.

Drainability.—Sludge is placed on a sand filter to a depth of 10 in. In the case of good sludge, considerable clear water will drain out in the first few hours. In three days, during dry weather, it will be firm and spadeable. With bad sludge, only a small amount of water drains out of the sludge, and this takes place very slowly.

Conclusions.—The two best methods of disposal of sludge are (1) its use for agricultural purposes, and especially (2) filling of low land. In both cases, the sludge must first be dried, and this is best effected upon a drying bed after the sludge has decomposed in an inoffensive odorless manner in a separate tank through which sewage does not flow.