that if septic action is allowed to go on indefinitely, that the amount of suspended solids will increase in the settled liquor by even 100 per cent., so that a size of material which may have been effective in the earlier stages of the tank action may be wholly inadequate to treat with the increase of solids and so result in a clogged filter.

One of the great difficulties in treating septic liquor in biological filters is this consequent increase of solids, and it is for this reason that attention is now being universally drawn to improved methods in immediate removal of sludge from contact with the supernatent liquor, so as to obtain a constant amount of solids in the settled liquor.

Where removal of putrescibility only is required, without any very high degree of purity, continuous flow sedimentation tanks will be probably adopted, as they require little attention apart from the regular removal of settled solids before putrefaction commences. As we have seen in previous articles on "Removal of Solids," given a definite character of sewage, and a certain velocity and period of flow in a tank, a fairly constant removal of solids can be obtained from an average domestic sewage of from 60 to 70 per cent. The 40 to 30 per cent. of remaining suspended solids being of a fine character can be satisfactorily dealt with in a biological filter with a coarse material.

When a greater degree of purity is required than above, quiescent sedimentation, that is, allowing the sewage to stand without movement in tanks for about two to three hours, will precipitate from 70 to 80 per cent. of the solids, and allow of a finer filtering material being used, resulting in a purer effluent.

When an even greater degree of purity is required, and it is intended to treat the liquor in a very fine material and produce a high class effluent, it is necessary to add a coagulant such as sulphate of alumina, lime or other reagent to the raw sewage, by which means over 90 per cent. of the suspended solids can be removed.

Assuming a domestic sewage representing a strength equal to about 30 gallons per head per day water supply on the separate system of sewerage for a water closet town; with an approximate analysis in parts of 100,000 of four parts ammoniacal nitrogen, oxygen absorbed in four hours 12 parts, suspended solids 30 parts, we may approximately conclude for the removal of putrescibility as follows: If 50 per cent. of the solids are removed three inch diameter material may be used at a rate of 100 gallons per cube yard, allowing a life period to the filter of from 10 to 15 years.

If 60 per cent. of the solids are removed, then three inch diameter material—150 gallons—life of filter ten to fifteen years. If 70 per cent. of the solids are removed, then three inch diameter—at 200 gallons—life of the filter from ten to fifteen years.

Filtering material as used for biological filters may be classed (as per the Royal Commission Report) into coarse, medium and fine. Coarse material represents diameters of 2½ inches to 3 inches. Medium ½ inch to 1 inch. Fine ¼ inch to ½ inch. The fine material should not be used except in cases of secondary filtration or in connection with a high degree of removal of solids by aid of a coagulant.

In all cases in treating sewage for the removal of putrescibility by biological filtration, the author is strongly of opinion that it is easy to err in adopting too fine a material, and that even if a high degree of purity is desired, it is much better to first treat the sewage liquor on coarse filters, and then continue the treatment on finer grade filters as secondary treatment, rather than attempt a very high degree of removal of solids in the first instance with a view to direct treatment in fine filters.

The question of the removal of solids, as we have seen, is a very important one indeed, in fact in many cases the whole success of a plant depends upon its efficiency, but just as soon as the engineer departs from the principle of natural unaided sedimentation by reduction of velocity flow, he is face to face with working methods which entail large sums in maintenance, and generally interfere with automatism and simplicity.

(To Be Continued.)

THE QUALITY OF EFFLUENTS IN RELATION TO STANDARDS.*

By Gilbert John Fowler, D.Sc., F.I.C.

(Continued From Last Week.)

The production of green growths, generally consisting of oscillatoria nigra, a green chlorophyllous alga, characterized by the vibratory movements of its filaments, is generally considered as evidence of satisfactory purification. The influence of sunlight seems to determine to some extent whether oscillatoria or carchesium appears chiefly in an effluent. A green organism (probably spirogyra) can, in fact, be seen developing at the Withington works just at a point where the outlet carrier is most freely exposed to the sun; the writer has also noticed that these green growths attain great luxuriance at certain effluent outfalls he has had experience of in India. Luxuriant growths of water-weed may also take place in some cases and become troublesome. . . .

The production of fungoid growths is, indeed, a very sensitive index of pollution, and it is possible, as the example just cited shows, to differentiate between varying sources of pollution by the character of growth developed. This was pointed out years ago by Santo Crimp, but it is doubtful whether the subject has received as much attention as it deserves in the meantime; thus it is well known that small leakages of unpurified sewage passing direct into the land drains of irrigation areas, may produce disproportionately large amounts of fungus, the species depending on circumstances. The growth of fungus in land drains may depend also on the character of the land and of the effluent applied to it, if—e.g., iron is present in the latter, there is a great liability to the development of crenothrix, a filamentous organism which collects large masses of hydrated oxide of iron around it. The effluent from the Birmingham Sewage Farm, according to Mr. Watson's description, had to be screened before passing into the river in order to remove this kind of debris.

Mention has been made of a few of the more typical organisms likely to come under the eye of the sewage works manager, and readily recognized either by inspection or by examination under a low-power microscope. There are, of course, countless other flora and fauna which are characteristic of different stages of purification, and their complete investigation will afford occupation for biologists for many years. Good work has already been done by Marsson, Hofer, and others on the Continent. According to Hofer, the self-purification of rivers is in the main a transmutation of dead organic matter into living organisms, and he shows that a river purifies itself more rapidly in a succession of still pools than when the water is broken. He cites several interesting cases showing the dependence of organic growths on specific pollution; thus the sewage fungus sphaerotilus natans requires small quantities of sugar for its growth in quantity, and consequently large volumes of tannery waste containing much organic matter do not cause a development of this organism, whereas small quantities