PURIFICATION OF SEWAGE EFFLUENT.

By Gilbert J. Fowler and E. Moore Mumford.

IT will hardly be disputed that the most costly part of a modern sewage works, certainly in capital expenditure and often in revenue charges, is the filtration area. Just as the difficulty of land treatment of the sewage of large cities forced on the consideration of more compact processes, so these in their turn are becoming impracticable when great centres of population have to be considered. This conclusion was impressed upon the senior author of this paper when called upon recently to report on the proposals of the Metropolitan Sewerage Commission of New York for the disposal of the sewage of that city. This conclusion was shared by his colleague, Mr. J. D. Watson, who reported simultaneously from an engineering point of view.

The area and cost of filter-beds depends mainly, it will be found, on the amount of colloidal matter present in the sewage, and much confusion of ideas is probably due to the fact that the ordinary sewage filter, be it contact or trickling, is called upon to do two entirely different things at the same time—viz., on the one hand to oxidize, granulate, and finally discharge as humus the colloidal matters present, and on the other to oxidize and nitrify substances in true solution.

A very open grade deep filter is best suited for the first purpose, a shallow fine-grained filter is the most economical for the second. It is true that a tank effluent well clarified by sedimentation can, by accurate distribution, be very efficiently purified on filters of fine material, but even then the area and cost involved when exceptionally large works are under consideration make the problem a very serious one. For these and other reasons the thoughts of many workers in sewage treatment have been turned to the possibility of more efficient removal of colloidal matter before the filtration process.

Hitherto almost the only practical method has been heavy chemical precipitation. The cost and difficulty of this process when really efficiently carried out (and it should be emphasized that a mere perfunctory addition of a few grains per gallon of precipitant is money thrown away) become very great as the volume of sewage increases. Not only are enormous quantities of chemicals necessary, but the disposal of the vast volume of resultant sludge, without menace in some way to the community, becomes increasingly difficult and costly.

The thought which has been in the minds of the authors of the present paper has been to find a method of obtaining a thoroughly clarified effluent without the use of large quantities of chemicals and with the minimum production of sludge. By a thoroughly clarified effluent is meant one which will not eventually deposit solid matter either on the bottom of a stream into which it flows or in the interstices of a bacterial filter. It is clear that in a sewage filter a combined oxidation and coagulation of the colloidal matter must go on, resulting in the production of the so-called residual humus, which either is collected in humus tanks or is periodically washed out of the medium. If this oxidizing and coagulating process could be brought about by suitable open-tank treatment before the filtration process, it is obvious that the latter could be enormously accelerated, if not dispensed with altogether, and the whole operation of sewage treatment could be conducted on a much smaller area.

In the course of a research on another matter, one of the authors had occasion to study the reactions of an organism occurring in nature in pit water impregnated with iron. This organism is a true facultative organism, preferably an aërobe, and exercises a specific action on iron solutions.

The action of the bacillus on iron solutions proceeds in two stages, in which the aërobic and anaërobic actions appear to be symbiotic, at any rate under the conditions occurring in nature. The aërobic action is to precipitate ferric hydroxide from iron solutions, while the anaërobic action is to transform the hydroxide thus precipitated into bog ore, with partial reduction of the iron to a ferrus state. It was found that in order to precipitate the iron sufficiently the organism required a certain proportion of albuminoid organic matter. It was therefore natural to expect that ordinary sewage matter could be utilized in this way. Experiment, in fact, showed that a sewage effluent could be effectively clarified in this way when acted upon by this organism in presence of small quantities of ferric salts, aërobic conditions being maintained in the liquid by means of a current of air.

The process, therefore, by which it is proposed to clarify sewage is, in the first place, to remove the grosser solids, either in a plain sedimentation tank, an Emscher tank, or a Dibdin slate bed, in such a manner, i.e., as shall give rise to the least amount of putrefactive change in the liquid portion of the sewage. The effluent from this preliminary process would be led into a second tank, where it is inoculated with the organism, a small dose of ferric salt is added, and air blown through till clarification sets in. A period of settlement is then allowed for precipitation of the coagulated matter, and eventually the clear liquid is run off, either for rapid final filtration or for direct discharge into the stream. The precise mode of action of the organism is not yet fully worked out, but it seems likely that simultaneous precipitation and solution takes place, some of the organic matter being converted into amido derivatives, and some being coagulated and thrown down with the ferric hydroxide.

The ordinary methods of sewage analysis fail to reveal the change which has really taken place during this process, as they do not differentiate between organic and nitrogenous material in the colloidal and crystalloidal states respectively. It should be pointed out that a fairly strong solution of amido acids, which are the end products of protein degradation, is not necessarily putrefactive, though they require oxygen for their final conversion into nitrate. A recent unpublished research by Mr. R. M. Beesley, a co-worker of the authors, has shown that there is no great difference between the rate of oxidation of substances such as uric acid and glycin, and simpler bodies such as urea. It may be anticipated, therefore, on all grounds, that the clarified liquid resulting from the process as above described can be oxidized at a very rapid rate.

As the conditions during the process are maintained, as far as possible, aërobic throughout, and there is always a certain amount of ferric hydrate present to oxidize offensive sulphur compounds, it is not anticipated that the aëration can give rise to nuisance, and none has been observed in laboratory trials where these conditions have been fulfilled. Experiments in the laboratory with quantities up to four litres have shown that it is possible to clarify a strong fæcal emulsion in this way.

* From a paper read at the Exeter (England) Congress of the Royal Sanitary Institute.