MUNICIPAL DEPARTMENT

THE SCIENTIFIC BASIS OF SEWAGE TREATMENT.*

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The question of sewage purification has now reached a stage at which old ideas are being rapidly replaced by new, based upon the advances which have recently been made in the direction of treatment by natural agencies, concentrated and controlled by art. It must not be considered that the authors, in attempting to formulate the present position, desire it to be thought that they are able to set forth the whole of the factors which are brought into play in the course of the destruction of waste matter; their object is rather to show the broad principles which have been established as the result of no little practice. That, speaking generally, all sewage operations of a successful character must be carried out in accordance with these principles, the authors are convinced; they are, however, fully aware that a large number of questions remain to be solved, before knowledge on the subject can be in any sense complete. It is by following the general lines laid down, and by avoiding those which by many have been hitherto considered as essential, that the complete solution of the problem may be found.

Before dealing with the manner in which purification is to be effected, it will be advisable to consider what it is that has to be done. Sewage is a mixture of a most varying and complex character, of animal and vegetable derived substances, in different stages of decomposition; and contains also in many cases, besides ordinary mineral salts, considerable quantities of trade refuse matters of both organic and mineral nature. The organic matters derived from excreta are, insoluble remnants of food and soluble albuminous matters, fatty acids, bile decomposition products, colouring matters, fat, sugar, excretin, etc., and substances derived from the destruction of the constituents of urine, including urea, which is the principal product of the metamorphosis in the body of nitrogenised food. Since a healthy man secretes from 30 to 40 grammes of urea per diem, this substance may be taken as an example to show what work has to be effected in completely oxidising nitrogenous animal matter; and more especially as urea has long been known to be capable of rapid alteration and decomposition under the influence of a ferment resembling yeast, or those derived from putrefying animal matters, like albumin. Urea (CH_4N_2O) is first changed under these circumstances by the addition of the elements of water to carbonic acid (CO_2) and ammonia (NH_3). In order to complete the oxidation the ammonia has to be converted into nitric acid. This, as is well known, is effected by the action of a micro-organism, or of a series of such, and it is thus established that a typical excretory substance can be entirely destroyed by the aid of fermentative or allied action of minute organisms without any adventitious assistance. That non-nitrogenised substances, such as starch, can, by the life action of micro-organisms, be gradually oxidised and finally converted into carbonic acid and water is, of course, a matter of common knowledge. The problem therefore resolves itself into the question of how this natural method of oxidation may be best controlled and expedited.

In all methods of sewage purification which have been previously employed, the final oxidation has been effected by the agencies that have been alluded to, although this has failed to be generally recognised. The best and most natural system hitherto tried—namely, the application of sewage to land—depends for its success entirely upon the fostering and increase of micro-organisms. But the use of crude sewage upon land leads to great difficulties, and in consequence previous chemical precipitation has been resorted to. It has not been seen that the same agencies which destroy the dissolved impurities could, if given the necessary conditions, equally deal with those in suspension. Hence came all the numerous chemical schemes, with their inevitable accompaniment, sludge. With the clear effluent it was possible to deal, although the process being dependent so much upon local conditions and climatic influences, was always uncertain, but the sludge always remained, the bete noir of all those concerned in sewage disposal. In the recognition of the fact that all processes of sewage purification must be made subservient to the requirements of the various micro-organisms, lies the whole secret of success. All sterilising or antiseptic agents must be strictly excluded; a condition of neutrality or slight alkalinity must be maintained; oxygen, anyhow in the final stages, must be freely supplied; the temperature must be kept above the freezing point of water; and the amount of food must be proportioned to the powers of the organisms.

In the process of completely oxidising effete matters, two stages may be recognised in which distinct classes of organisms play their respective parts. The actual identification of these organisms may be left for future discussion, it being sufficient for the present purpose to divide them into those that are able to break down and liquefy solid organic matter, and those that deal with it when in solution. It is not pretended that a clear line of demarcation can be established, although between the extremes of either class there are very distinct and clearly defined functional differences. The first-mentioned class may again be divided into two—viz., those that do their work in the presence of air, and those that thrive in its absence. Both of these are always present in ordinary sewage, and the predominance of one or the other is entirely in the hands of the sewage operator. If, as at Sutton, the first be employed, care is taken that oxygen shall have free access to every part of the culture medium; the beds are frequently entirely emptied to admit the air to every crevice; and the most successful work, hitherto, has been by working and resting intermittently. When, however, the anærobians are employed, air is rigidly excluded; a fermentative action of a putrefactive character is encouraged, and the process is necessarily continuous. This is the method which has been adopted with such satisfactory results at Exeter. Into the relative merits of these two systems, ærobian and anærobian, the authors do not propose to enquire; both are based upon scientific principles, both have been highly satisfactory in practice, and both remove, once and for all, the troubles of sludge disposal. The liquid organic matters are then subjected to the influence of micro-organisms which effect final oxidation, and this part of the process is the same whether the original breaking down of the solids be effected by ærobic or anærobic means. Whether both processes can be successfully carried out in one operation remains to be shown; it is, however, probable that difficulties may be found, owing to the somewhat different conditions obtaining. As far as the results of working on these principles are concerned, the authors can confidently state, of their own practical knowledge, that firstly, no previous chemical treatment is required; secondly, no sludge is produced, thereby removing the chief difficulty hitherto met with; and thirdly, the quality of the final effluent can be controlled, admitting as it does, of being brought to any required degree of purity.

(To be Continued.)

* Paper read before the British Sanitary Congress.