CHEMISTRY AND SEWAGE PURIFICATION.

In this issue we publish a paper read before the British Society of Engineers upon the above subject. Dr. Sommerville, the author, is lecturer in King's College, and is an authority upon whom we may depend for any chemical explanations of the various processes which sewage undergoes in its transformation from the organic to the inorganic.

It is interesting to note that his conclusions are in general agreement with those of the German chemists. He holds and agrees with Dr. Dunbar, of Hamburg, that the fermentation processes which occur in sewage are mainly due to enzymes. Some of Dr. Sommerville's practical conclusions will be read with interest by engineers, especially those dealing with so-called anaerobic action or septic treatment. He considers that "aerobic action has the best of it all the way round." "It was possible to construct a septic tank installation on a small scale where all might go well for a number of years, but large installations without exception failed."

We cannot agree with the author's remark, that "sewage purification was from first to last a matter of biological chemistry committed to the **tender mercies of the engineer."** After all, the engineer has been the pioneer in this particular work, and although his attempts may have rested upon empirical bases, the bacteriologist has simply come along and explained and defined results. Sewage disposal and especially the question of removal of solids is largely a question of mechanics and hydraulics. The flow of liquid, its distribution by sprinklers or other mechanical methods ae entirely engineering questions. We are content that the chemist and bacteriologist take their part in the problem, and are sure that much is to be learned by the engineer from their collaboration; but, we are not content that the chemist shall claim that the whole question is entirely one of chemistry.

CHEMISTRY AND BACTERIOLOGY OF SEWAGE PURIFICATION.

At a meeting of the Society of Engineers held on Friday at Caxton Hall, Dr. David Sommerville, of King's College, lectured on the above subject.

Dr. Sommerville prefaced his paper by saying that in no field of applied science is the need of research more pressing than in that of the purification of sewage. Sewage purification was from first to last a matter of biological chemistry committed to the tender mercies of the engineer. In this work chemistry and bacteriology could not be separated. The intention of the paper was to refer engineers to some fundamental principles connected with the purification of sewage. The author showed that bacterial action was effected through enzymes. The cell consists of colloids and crystalloids in common solution in water, and all cellular reactions are reactions in solution, and based on laws governing their velocities and the conditions of equilibrium. The living cell was an energy transformer, and in all its activities conforms to the requirements of the doctrines of the conservation of matter and of energy.

Enzymes were catalysts, and under their influence it could be shown that for a single substance α undergoing conversion into two substances β and γ, the common type of action of enzymes,

$$\frac{dx}{dt} = k_1 (\alpha - x) - k_2 (\beta + x) (\gamma + x)$$

where α is the molecular concentration of the single substance, β and γ molecular concentrations of the two into which it is converted, and x the change in concentration in time t. Enzymes, unlike inorganic catalysts, were rendered inactive by rise of temperature. Enzymes were colloids, and as such subject to the laws governing the phenomena known as "absorption." Enzymes were capable of reversible action, and consequently effected syntheses as well as dissociations. Sewage was composed of a watery mixture of proteins, carbo hydrates, fats, and various inorganic matters. The organic matters existed in solution and in particulate form. Colloidal solutions were constantly encountered. Sewage was charged with bacteria and enzymes and when of domestic type contained, in addition to air, water, and soil organisms, dominant types indigenous to the human intestine.

Where population was sparse the disposal of human excreta was a matter of little difficulty, for the soil received them and dealt with them effectively. In point of efficiency, no artificial method could compare with this natural one, and all that was required was to commit the materials to earth at a safe distance from the dwelling and from watercourses. Sewage carried the organisms and enzymes of its own putrefaction. The chemical reactions of the putrefactive stage were closely analogous to those which effected the digestion of food-stuffs in animals. Protein dissociation occurred in two secondary—amino acids. Dr. Sommerville referred to the constitutional structure of a few of the more commonly occurring amino acids, and said the hydrolysis of carbohydrates and fats was simple when compared with that of proteins. Most species of bacteria in sewage and soil were capable of forming ammonia from organic matter. Free nitrogen was liberated by some sewage bacteria and atmospheric nitrogen fixed by others. Certain bacteria reduced nitrates to nitrites and ammonia; others reduced nitrates and nitrites to NO and N_2O. Where unlimited oxygen was supplied nitrification predominated, but where oxygen was limited denitrification appeared. In certain cases it might be advantageous to transform as much as possible of the nitrates and ammonia into free nitrogen. The presence of humus in soil added to its nitrifying power, and beds performing nitrification poorly might have their activity increased by the addition of humus from other beds working normally. Experiments carried out at Kingston-on-Thames in 1907 of seeding nitrifying beds doing poor work with humus from other beds working normally, showed that the purification was in all cases increased. From these results it would appear that there are conditions in which increased nitrification went hard with land with increased ammonia formation, and one must be careful not to dogmatize or draw a priori conclusions as to what might or might not take place in the as yet unknown complexities of the sewage bed. Inasmuch as it required weeks or months to transform dead proteins in the soil into nitric acid it was useless to conclude that in a filter bed of whatever type wherein the opportunities of nitrification were often no better than, if as good as, that in the soil, masses of particulate nitrogenous matter were dissociated and completely oxidised in a few hours. In the nature of things this could not be. It was true that the effluent for such a bed was in physical characters very different from the sewage that entered the bed, but it was not true even in the case of the most efficient bed that the matters with which the effluent had parted had been fully or even partially oxidised. It was possible in five minutes to transform the foulest sewage into a passable effluent by two or three filtrations through animal charcoal, but the charcoal at the end of a month would still contain undissociated proteins, which at the end of the second month would not have reached the stage of nitrification. In phasic enzymic action, where it was desired to maintain activity continuously, it was import-