DISCUSSION.

Dr. S. Rideal said he was glad to be present at the reading of Mr. Digby's Paper, although he was interested in the chemical rather than in the physical side of hypochlorite manufacture. The hypochlorite problem was a very difficult one ; the commercial problem to be solved was how to make a stable solution in which the proportion of undecomposed salt present was low. A satisfactory result had not yet been arrived at, but Mr. Digby had certainly advanced a step towards the desired end, and he hoped that he would continue his work.

Mr. C. W. V. Biggs (*communicated*) : It is to be regretted that time would not permit of a fuller discussion of Mr. Digby's excellent Paper upon hypochlorite production, as we have considerable evidence to show the disinfectant and sterilising value of a fairly strong solution of this oxide of chlorine. The various practical uses to which it can be put in connection with sewage effluent and polluted streams are evident, and its general use appears to be a question of economical production upon which the views of the leading chemists, electricians, and metallurgists would have been of the utmost value.

Mr. Digby has, in his Paper, dwelt principally upon the problem of establishing something like a fixed relation between (a) power consumption, (b) quantity of material, and (c) the product, a stable solution. We know, from Sir Henry Roscoe's report on the Hermite process, and from more recent examples, that a solution, to be of sterilising value, must be of fairly high strength, some 2 or 3 grammes of free chlorine per litre, and from Professor Kanthack's observations at Maidenhead that better results are to be expected the stronger the solution employed. We also know that, to be

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stable, *i.e.*, of practical use, the solution must be of a certain strength, probably 2 grammes per litre and over. We are, therefore, faced with the proposition—which I should like to ask the author to elucidate further—whether a stable solution of hypochlorite can be produced at such a rate as to render the liquid cheaper than deodorisers and sterilisers now in use, or at a rate consistent with its higher efficiency as a steriliser?

In manufacturing this solution, the limit of practical working appears to be reached when the additional conversion of NaCl into NaClO is very slightly greater than the deterioration simultaneously taking place in the liquid already charged with NaClO in the tank. Could the author inform us if the use of a smaller tank, in which less bulk of liquid is under conversion, would obviate this in any way? And at what point, in grammes, can the solution safely be stored, with certainty that it will not decline in strength below the useful value?

Mr. Digby has taken the leading question to be decided on—the economical production of a stable solution—and gathered considerable evidence from which to deduce how far the process should be carried to obtain a satisfactory sterilising fluid. He has also touched on the question of foreign salts in the liquid, a question which opens up the whole series of difficulties in the manufacture arising from the combination of most metals with the elements in the solution. It is probable that, with his experience in the matter, he will be able to point out the line of development which these processes should take, and to tell us if it is possible to formulate any direct equation such as x units of electricity + y lbs. NaCl + z H₂O = π gallons of solution of a strength ρ grammes per litre in τ time.

Mr. H. C. H. Shenton (*communicated*): I am sorry that time did not permit of the discussion of Mr. Digby's Paper, which I take to be the first presented to any society since Sir Henry Roscoe read his Paper before the Society of Chemical Industry in 1895.

From the point of view of the civil engineer connected with works of sewage disposal, I think the Paper possesses a particular interest as regards the use of hypochlorites for sewage effluent sterilisation. Not being a chemist I am disappointed that the Paper is so entirely chemical in its nature. The importance of being able to sterilise effluent from sewage disposal works is, in some cases at any rate, obvious, though in most cases natural processes may be relied on to do this. With proper care there is no great difficulty nowadays in purifying sewage, chemically speaking; but I believe there is, at any rate, considerable doubt or difference of opinion among scientists as to whether disease germs may not be given off with the best effluent under certain conditions; and if it were possible at a cheap rate to sterilise such effluents before discharging them into rivers, like the Thames, which are used for water supply, there is very little doubt that a commercial opening would exist for the agent that would produce this effect.

I am unable to speak as to the use of hypochlorites for sewage sterilisation from personal knowledge, but I notice that Professor Roscoe came to the conclusion that for sewage purification purposes he did not consider the process adopted in his experiments suitable. This was a good many years ago, and the strength of the solution used by Professor Roscoe might account for the result.

In 1898 Professor Kanthack reported that a satisfactory sterilisation of sewage effluent was effected by a 2 gramme solution, after a contact with sewage of $3\frac{1}{2}$ minutes.

In 1904 Dr. Rideal reported that $18\frac{1}{2}$ gallons of oxychloride to 1,000 gallons of raw sewage was sufficient to destroy practically all the organisms

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in the sewage. This had reference to experiments carried out at the Guildford Sewage Disposal Works. The question I wish to ask is whether a hypochlorite solution would effectually destroy all disease germs and spores that might exist in the purified effluent coming from, say, a continuously aerating filter at a smallpox hospital—assuming, of course, that such germs do exist in such an effluent.

The question of deterioration of the hypochlorite solution is of interest in regard to the sterilisation of sewage effluents, seeing that the flow of effluent is apt to be very irregular—especially in times of rain; and if it were necessary to increase the quantity of hypochlorite solution suddenly in treating an increased bulk of effluent, how would this demand best be met? Would it be necessary to increase the plant capacity, or would it be possible to keep a supply of hypochlorite solution ready, in case of sudden demands? Would the hypochlorite solution thus stored be apt to deteriorate to any great extent, practically speaking?

Another question that I should like to ask the author is whether there would be any difference as far as the sterilising of effluents is concerned due to stable or unstable conditions of the hypochlorite?

Another point (which is at any rate of academic interest) is suggested by the author. His Paper shows, practically speaking, that with a solution containing 6 grammes of available chlorine per litre, only 10 per cent. of the chlorine present as sodium chloride is doing useful work, *i.e.*, assisting in the preparation of the hypochlorite. Now while 10 grammes of chlorine will sterilise the effluent leaving the said effluent inappreciably affected, the addition of nine times this quantity of chlorine in the effluent might be a more serious matter.

In conclusion, I must apologise for the practical nature of my remarks, which are due to the fact of being daily called upon to find practical means to purify sewage.

Mr. W. Pollard Digby (*communicated reply*): In reply to Mr. Biggs' remarks as to the production of stable hypochlorite solutions, I must refer him to the literature issued by the hypochlorite-making companies who are at work in this country, and to Dr. Alexander's recent reports to the Poplar Borough Council.

In view of the advantages which hypochlorite solutions offer, in that they are rapid in their action and non-poisonous in their effects, I believe that there is a very fair field for deodorisation and sterilisation generally. The use of a tank in which the ratio of tank contents to the hourly output is small, would give a wider range of efficient working than that recorded in my table. Mr. Biggs' suggestion that I should formulate a simple equation for the manufacture of hypochlorite solutions asks for that which cannot easily be given, because of the fact that the characteristic curve with any given current density varies with the specific gravity of the solution and the temperatures reached during working.

Replying to Mr. Shenton, I welcome his pronouncement in favour of the sterilisation of chemically pure effluents before their discharge into rivers. Since Sir Henry Roscoe read his Paper, progress in regard to hypochlorite production has been very great. Moreover, the keynote of those experiments was the treatment of crude sewage containing large quantities of solid organic matter. To attempt to deal with such is only to court failure, so that, so far as sewage treatment goes, sterilisation of a filtered effluent is all that hypochlorite solutions should be called upon to perform. Such a special case as that of the drainage for a smallpox hospital falls in a different category from that of the sewage for the town, and for this purpose I believe that hypo-

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chlorite solutions will be found superior to any known germicide. From my own experience with a sewage-treatment plant some six or seven years ago, I believe that the electrolyzers and tanks should be designed for the purpose of producing enough of the hypochlorite solution in 8 hours to deal with the average daily flow of sewage effluent. The storage capacity should be equal to 8 hours' normal demand. In the case of heavy rain storms, it would be necessary to run the electrolyzers for a longer period. In any small town after a couple of hours of heavy rain the sewage which has to be dealt with contains little organic matter, and can be sterilised with smaller quantities of chlorine.

The question as to whether there is any difference in the sterilising properties of stable and unstable solutions is hard to answer. I have never worked with any solution which lost by depreciation less than 1 per cent. of its available chlorine in four hours. As to what is the precise constituent of the electrolytically-produced hypochlorite, it is very difficult to say. Dr. Rideal has, however, pointed out in regard to his Guildford experiments, that in contact with organic matter 60 per cent. of the available chlorine was taken up immediately, while about 40 per cent. remained and declined more gradually, this pointing to the fact that the available chlorine existed in two forms, one which readily attacked organic matter and then reverted to inert sodium chloride, and the other which did not change its character so quickly.

In regard to these tests, we are only able to use arsenious acid which gives us the proportion of available chlorine present, but does not tell how much oxygen is combined with the available chlorine.

Mr. Shenton's last question is of both chemical and commercial importance, as the presence of large quantities of sodium chloride which has not been converted into hypochlorite of soda, and has, therefore, done no useful sterilising work, involves both a waste of salt, which is extremely unscientific, and adds to an effluent a large quantity of salt which the analytical chemist would regard as undesirable.

I hope to be able at a later date to place before the Society some accounts of a method designed to reduce this large proportion of unelectrolysed sodium chloride.