6. Miquel: Etude générale sur les bactéries de l'atmosphère. *Annuaire de Montsourris*, 1881, p. 40.
- Naegeli: Die niederen Pilze, 1877.
7. Wernich: Die Luft als Trägerin entwicklungsfähiger Keime. *Virchow's Archiv*, Band lxix., page 424.
8. Rozsahegyi: Ueber die Luftbewegung in den Münchener Sielen. *Zeitschrift für Biologie*, Band xxv., 1881, p. 23.
9. *Annales de l'Institut Pasteur*. 1892, p. 755.
10. *Ibidem*. p. 721.
11. *Annali dell'Istituto d'Igiene di Roma*. 1893, p. 477.
12. *Soc. Médic. des Hôpitaux*. 6th March, 1891.
13. Zur Lehre von der Aetiologie der Complicationen in abdominal Typhus. *Jahrbücher der Hamburgischen Staats Krankenanstalten*. 1890.
14. *Fortschritte der Medicin* n. 18. 1889.
15. *Soc. Médic. des Hôpitaux*. 13th November, 1891.
16. *Annales de l'Institut Pasteur*. 1893, p. 141.

THE HERMITE PROCESS FOR SANITATION OF TOWNS.

BY EDWARD J. PATERSON, M.I.E.E.

THE readers of this Journal are probably cognizant that a process under the above name, and which claims to be a distinct and novel departure in the improved sanitation of towns, has been the subject of important demonstrations in France and in England, and has been definitely adopted and installed by the Corporation of Ipswich, and also by the War Office at the Victoria Hospital, Netley.

The process claims to obtain by the electrolysis of sea water or similar saline solutions, a disinfectant and deodorizer far more efficient and less costly than any other known substance, in fact, at so low a cost that it may be applied to the cleansing and disinfecting of the sewers of a town, and results in a great improvement of the effluent sewage at a cost which is covered by a nominal charge on the rates.

The contention of the inventors is, that in any town however perfect the system of sewerage, the existence of large volumes of putrescent matter flowing through the sewers and giving forth to the atmosphere, and into the houses where the drains

are defectively trapped, gases which mix with the air breathed by the inhabitants, is a source of danger to the health of the town. Also that the attempts made to minimise the evil by ventilating shafts are futile and costly; and that no treatment of sewage can be satisfactory but one that prevents putrefactive changes till the sewage is outside the bounds of the town, and that the only way to effect this is to mix the sewage with an efficient antiseptic as soon after its production as possible.

The writer is aware that experts, whose opinion demands respect, have denied that there is any evidence of pathogenic germs existing in the sewer air, and, therefore, contend that sewer gases cannot be directly productive of typhoid and other diseases, notwithstanding the general opinion of the medical faculty to the contrary. In the number of this Journal for April, 1895, Dr. Louis Parkes has very ably reviewed this question from both sides, and says that though it is "difficult to understand how specifically infected sewage plays any part at all in the dissemination of typhoid fever, yet that it does so is, perhaps, one of the best recognised facts in the science of preventive medicine." The burden of the proof to the contrary rests with the Bacteriologists, and in the meantime the almost universal belief in the toxic qualities of putrescent sewage, and the gases arising from it, may be considered as not having been effectively or even seriously controverted.

The apparatus used in the Hermite process for electrolysing sea water, is one specially designed and perfected at great cost and after lengthened trials. It consists of a galvanised-iron tank in which are platinum and zinc electrodes of very considerable superficial area. The platinum electrodes are constructed of platinum wire gauze; the zinc electrodes are discs of pure zinc, a series of which are threaded upon two spindles, with room between them for the platinum electrodes to be inserted. The zinc electrodes, being attached to a spindle, revolve, and have scrapers acting on them for the purpose of removing the deposit of magnesium oxide which coats their surface during the electrolysis. The normal size of these electrolysers is such that a current of 1,000 or 1,200 amperes may be employed, and the electromotive force, which of course varies slightly according to the density of the solution, may be taken approximately at 6 volts. On filling the tank with sea water, and passing the current through the electrolyser, the electrolysis of the sea water is brought about.

The chemical changes which take place are a little obscure, and any explanation that has been given, limiting them to the production of hypochlorites of a similar nature to those contained in bleaching powder, (with the substitution of magnesia

for lime as a base) are not sufficient to account for the remarkable disinfecting power of the sea water after electrolysis. The results of the electrolysis are of a complex nature and seem to point to the production of two or more distinct antiseptic products, one of which (the hypochlorite) is tolerably stable, and the others exceedingly unstable, but at the same time of high antiseptic power. Dr. Rideal, in his work on disinfectants, has referred to the antiseptic properties of peroxide of hydrogen and also of the periodates and hints at the probability of their existence in the hermite solution (pp. 76 and 84); and it is probable that here we have a clue to the chemical changes which account for the remarkable properties of electrolysed sea water prepared by the Hermite process, as all the conditions necessary for the production of these substances appear to be present. Anyway, it is a fact, that hermitine (as the Hermite Solution is called) loses much of its antiseptic properties if allowed to get stale, and it is very unfortunate that some of the tests on the antiseptic value of hermitine have been made by eminent chemists with stale solution, and that where this has been done its value has been much underrated.

For purposes of comparison, the chemical tests made of the hermitine have ignored these unstable products, and simply dealt with the amount of available chlorine per litre, as shewn by the arsenious acid test. As the production of hypochlorites may be presumed to be always accompanied by that of the more unstable products, this test may be considered, perhaps, as being adequate to the purpose in view—at all events with freshly prepared samples.

The sea water is electrolysed till it shows with the arsenious acid test, from half a gramme to one gramme per litre of chlorine. It is generally admitted by the experts who have reported on the process, that if sufficient hermitine be added to the sewage of the town to give one gramme of chlorine per head of population per 24 hours, effective deodorization and arrest of fermentation for two days is secured; and that an increase of the amount to 2, 3, 4, 5, or 6 grammes per head results in the complete destruction of micro-organisms, the pathogenic ones succumbing to 2 or 3 grammes per head, and the more resistant spore breeding organisms to stronger doses. Samples of sewage, treated with 2 or 3 grammes per head, have been found to keep free from smell and fermentation for 14 days, that is, until in the ordinary course of things, the sewage would have been far out at sea.

The properties of hermitine have been investigated by various eminent experts, and (except where as stated above a stale solution has been employed and its antiseptic value underrated)

their reports are eminently satisfactory. These reports comprise those of Dr. Ruffer and Sir Henry Roscoe for the British Institute of Preventive Medicine; Dr. Piton of the Naval School at Brest; Dr. I. de Christmas of Paris; a Commission specially appointed by the "Lancet;" one by Mr. Napier, the County Analyst of Ipswich, and a suggestive one by Dr. Jenkins, the Medical Officer of health for Lytham.

In some of the trials made with Hermite Solution, it was applied to fresh fœcal matter direct from the water-closet and not to liquid sewage. Mons. Hermite's aims were directed to the complete sterilisation of fœcal matter by using hermitine to replace the ordinary flush for the closet, he having in his mind the sanitary needs rather of continental and tropical towns than of towns in the United Kingdom. It is probably somewhat unfortunate that the first demonstration of the process in England, viz., that at Worthing early in 1894, was carried out on these lines, as it gave opponents occasion to remark with some show of truth that whatever the effect on the sewage might be, the introduction of the process on this system would require such a network of supply pipes, and necessitate such alterations to the sanitary arrangements of every house, that the cost and inconvenience would set the public against it.

The Hermite system has been too much considered as exclusively a system for conveying this antiseptic into the houses for flushing the closets with it, which is hardly a fair statement of the case. It is essentially a system for treating the sewage in the sewers as high up as it is found economical or advantageous to go; and it must be allowed that Dr. Ruffer has very properly pointed out that every town must be treated on its own merits. Where the sanitary arrangements of the houses are good, so far as modern science goes, and where the death-rate is comparatively low, financial prudence may dictate confining the application of the system to the main sewers and the branch sewers. On the other hand, where (as is the case with a large number of towns in tropical climates) the death-rate is extremely high and sanitary arrangements are very defective, and it is found that the authorities are justified in imposing upon the inhabitants a considerable outlay in order to bring the health of the town up to modern views of sanitation, then a complete system of carrying the solution into the houses should be insisted upon. Between these two there are various modifications. There is the consideration whether, in towns which limit the application of the system to the main and branch sewers, an exception should not be made in dealing with any insanitary areas or in dealing with hospitals; also, whether it is not wise to provide stand-pipes in different parts

of the town, where the disinfectant supply can be obtained freely by all inhabitants requiring it, and the use of it made compulsory in visitations of epidemic. Numerous other modifications of the application of the system will suggest themselves to meet special cases.

In order more fully to set forth the method of working, and the results obtainable by the Hermite system, it may be interesting to give a few particulars of the work carried out at Ipswich, at Lytham, and at the Victoria Hospital, Netley.

Ipswich.—The Sewerage Committee of Ipswich being favourably impressed by what they saw of the system at Worthing, determined in the autumn of 1894, to put down a temporary installation to test the result of the process on a limited section of their sewerage system. After three months' run the County Analyst reported on it in very favourable terms. The Sewerage Committee followed up this report by urging strongly on the Town Council the permanent adoption of the process, at all events, on a scale sufficient to deodorize the main sewer and improve the outfall, both of which were sources of great annoyance from bad smells. The Borough Surveyor stated that nearly a thousand pounds had already been spent on ventilating shafts, and another thousand would certainly be required before the smells could be effectively dealt with. The adoption of the process would save this further outlay. It was unanimously resolved by the Council to put down an installation sufficient, at all events, to supply hermitine to the main sewer at the rate of one gramme chlorine per 24 hours per head of population. The outlay necessary for this was calculated at from £2,000 to £2,500, and the annual cost about £300 to £350, or say 1½d. per head of population per annum. The approval of the Local Government Board having been obtained and the site selected, the installation was erected and set to work in May, 1895, and has been at work daily ever since.

The plant consists of a compound engine giving about 30-brake h.p., a 4-pole dynamo giving a current of 600 amperes and 28 volts, 4 electrolyzers placed in series and so arranged that the supply of sea water flows from one to the other, the electrolysis being completed at the discharge outlet of the lower one, a pump to draw the sea water from the docks three quarters of a mile away, and another centrifugal pump to force the electrolysed fluid through 600 yards of galvanized iron pipes to the point where it is discharged into the main sewer. The process is continuous, viz., the hermitine as fast as it is produced is delivered into the sewer and disinfects the sewage during its course through the town to the outfall works, two miles down the river Orwell, a point well known to steamboat

passengers up the Orwell by the bad smells. The amount of sea water drawn from the docks in the 24 hours approximates 26,000 gallons, or 1,100 gallons per hour, and the chlorine production is 2,400 grammes per hour, or say, $2\frac{1}{4}$ grammes per gallon or $\frac{1}{2}$ gramme per litre. This is produced by an electrical expenditure of 600 amperes and 5 to 6 volts for each of the 4 electrolyzers, so the yield in chlorine is 1 gramme per ampere hour. In fact it is somewhat above this, as the report of the County Analyst submitted after three months' run shows, his tests being taken daily for 30 consecutive days.

The effect of turning into the main sewer 26,000 gallons per diem of Hermitine of the above strength is very satisfactory. It must be borne in mind the amount is very small and did not pretend to be effective for sterilisation or other than effective deodorisation. The sewer throughout its length is free from smell, and samples taken at any point keep sweet for three or four days in the laboratory. The sewer is much cleaner, the slimy matter being broken up and washed away, and the effluent greatly improved. This last is attested by captains of steamers coming up the Orwell who assert that in no previous year has the condition of the Orwell near the outfall works been so satisfactory. And what is more significant is that the effects improve from week to week, showing that much of the hermitine has been absorbed by the mud deposits in the sewer, and as these get cleansed by its action, and the disinfectant exerts its full power on the daily flow of sewage, the effluent improves more and more. The result all round is considered very satisfactory by the Town Council, and it is contemplated to increase the plant and extend the distributing pipes so as to supply the solution to the higher parts of the branch sewers, and to allow of stand-pipes being erected at different parts of the town at which the disinfectant can be drawn off for flushing down any insanitary areas. This last is a very important feature of the system, for the cost of production does not exceed one penny per hundred gallons, so that it can be lavishly employed, and would no doubt be freely used for the disinfection of insanitary areas if provided free of charge.

In his paper read before the British Association in September last, Mr. Napier says:—

“I noticed in some of my early morning inspections, when the flow of sewage was at its minimum, that the deposit in the sewer was bleached nearly white by the action of the electrolysed solution. This process has not been going long enough to allow me to obtain any statistics as to the health of the Borough or the death-rate, compared with previous years and with other towns; but this I know that where the sewage has

been treated no complaints have been received as to offensive smells. I am confident that any town that adopts this process, which will erect plant to produce enough of the electrolysed solution, will be spending money in the right direction, and in time will feel the benefit by increased health of the inhabitants and by having a lower death-rate. This is what I have suggested Ipswich should do, so that in a year or two, when we are able to make comparisons, we will find a reduction in the death-rate. Such a result will make the process cheap at any price."

Lytham.—The trial of the process at Lytham for four months last summer, presents several points of interest, which are dealt with in a very suggestive report, submitted to the Urban District Council by Dr. Jenkins, the Medical Officer of Health. Lytham has a population of 5,000, and the sewage has up to now been turned into the Liggard brook at two or three separate points, the highest of which is half-a-mile from where the brook runs into the Ribble. At the bridge on the Preston road are a pair of automatic tide gates, so that at high tide the sea water flows up to that point, the sewage delivered into the upper reaches of the brook being dammed back by these gates. At this point consequently there is always a great accumulation of sewage matter partly brought down from above the bridge and partly washed back from below by the incoming tide, and the smell arising from this is observable far and wide. When the tide is out all the upper part of the brook is bordered by evil smelling mud banks perfectly black. An analysis of this mud shows the greater part to be clay brought down the brook from higher up the stream and the clay and sewage accumulate to the depth of from one to two feet. Altogether it is a most dangerous and unsavoury condition of things to exist so near a town. Owing to the sewers of the town being in sections independent of one another it was found impracticable to deal with more than one of these sections. The plant was put down near the pier, a tank of sea water being there available. Each day some 10,000 to 12,000 gallons of hermitine were run into this section and three months run resulted in effecting a total disappearance of the bad smell at the bridge and a most decided improvement in the condition of the brook, and this result was attained in spite of a large amount of untreated sewage being sent into the brook all the time. Dr. Jenkins in his report states: "The probable conclusion would be that if the surface layer (which had been bleached to a grey colour) were constantly removed as soon as formed, the collection (of mud) would be rapidly disposed of." The running of the plant was stopped in September pending

the consideration of alterations to the outfall. Since the supply of hermitine has been stopped the brook has returned to its original condition both as regards the blackness of the deposits and the offensive foulness of the stream.

Dr. Jenkins made some interesting bacteriological investigations to determine the comparative microbicidal value of hermitine and other disinfectants, and gives hermitine the preference by a long way as regards both cost and efficacy. His report concludes with a strong recommendation to the Council to put down the installation permanently. It remains to be seen if they will do so.

The Victoria Hospital, Netley.—This military hospital, situated on the shores of Southampton Waters, contains when the wards are full a population of some 1,500, staff and patients included. It consists of a large main building about 400 yards from the water and a considerable number of detached buildings in the rear. The plant is erected in a building close to the shore, and is capable of producing about 600 gallons per hour of hermitine. The solution is pumped from there into a tank at the top of the main building and thence distributed by pipes into all parts of the same and also into all the previously mentioned buildings in the rear. The supply pipes are connected with the closets and other sanitary arrangements, in fact hermitine is "laid on" through the whole buildings the same as the water supply. The capabilities of the plant are determined by the needs of a hospital which may at times be crowded with patients affected with infectious disease, and therefore the daily output is far greater than would be provided for a town. If worked the whole twenty-four hours an allowance per head of sixteen grammes of chlorine could be obtained, but it is expected that eight hours run per day will more than suffice for ordinary requirements. In this case then the plant is based on the *highest* scale of possible requirements just as that at Ipswich is based on the *lowest*. The installation has been recently started, therefore no data as to its efficiency are available.

All the above and similar cases involve the erection of a power station and a low tension dynamo. But it does not follow that hermitine cannot be produced except under these conditions. A useful modification of the electrolyser has been introduced, consisting of a battery of small electrolyzers connected in series and workable with a direct current of 50 or 100 volts. The efficiency of these is far less than the ordinary type, and they are not recommended for large installations, but for isolated cases provided with direct current electric light plant

such as steam ships, and many hospitals and factories, this modification is of great importance.

Such an apparatus was fitted on board a French troopship bound for Madagascar some six months since, and has given great satisfaction. Another is working in a Catholic school in Marseilles with excellent results, and there is a wide field for this type of electrolyser wherever electric light is installed on the direct current system.

The application of the Hermite system in towns provided with electric light and power stations deserves consideration as giving a "day load" for these stations. Even where the alternating system is employed, the same motive power, buildings and staff can be made use of, and the Hermite process consequently worked economically. As the steam power is not available during the whole of the 24 hours a somewhat larger plant has to be put down, but the saving in staff and expenses and stoker's wages, more than compensate for the extra cost of this.

Reference has been made hitherto to the use of the process for the sanitation of sea coast towns, but it must not be supposed that the cost of manufacturing artificial sea water would be so great as to make the system inapplicable to the sanitation of inland towns.

Moreover, many so-called inland towns are not so far distant from the sea coast as to render it economically impracticable to have sea water conveyed to them by pipes from the nearest point on the coast. Such a scheme is in contemplation for London, and a paper on the subject is to be read by Mr. Grierson before the Society of Arts. Mr. Grierson proposes to bring a supply of sea water from the South coast near Lancing, for the purpose of supplementing the fresh water supply of the Metropolis, the sea water to be used for street watering, baths, etc.

It is probable that if this scheme is carried out, the consumption of it for sanitation by the Hermite process will be equal to all other demands on it put together. And if such a scheme is feasible for London, it is equally so for Birmingham, Manchester and other inland towns.