ON "SOME RECENT RESULTS OBTAINED IN THE PRACTICAL TREATMENT OF SEWAGE."

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ALTHOUGH it is not difficult to obtain reports, substantiated by more or less elaborate chemical analyses, on the efficiency of patent processes for the treatment of town-sewage, yet the value of such testimonials is generally but slight, inasmuch as the experiments upon which they are based have usually been made under circumstances of such an exceptional character that similar results are rarely if ever realized in actual practice.

Having recently had occasion to inspect a number of the largest sewage works in the country, in connection with a proposed scheme for the disposal of the sewage of one of our most important towns, it appears to me that the results of this inquiry into the daily practical working of the more important processes now in operation, may not be without interest to those directly or indirectly concerned with the disposal of town-sewage.

The sewage works examined were six in number, and were representative of all the principal methods of treatment now in vogue. For various reasons it will be preferable to refer to the several towns by distinctive letters instead of by their names. In the case of three of the towns the method of treatment was by precipitation only, whilst in the other three the latter was supplemented by application to land.

TREATMENT BY PRECIPITATION ONLY.

Town A.—In the case of this town 9-10,000,000 gallons are treated daily, and the only precipitant used is lime, which is added in the proportion of one ton to 1,000,000 gallons of sewage. The lime is made into a thin cream, which then mixes with the sewage in the pump-well and becomes thoroughly incorporated with it in the process of pumping. The mixture then flows into a series of twelve depositing tanks, of a total area of 71,270 square feet, or 1·75 acre, and of an average depth of six feet, the cubical contents being 2,500,000 gallons. The sewage has thus to pass a distance of 1,200 feet through the tanks, and this passage occupies about two hours. The tanks are divided from each other by walls, over which the sewage flows. As indicating the distribution of the precipitate it should be mentioned that the first four tanks are cleaned out consecutively about every fourth day, the fifth and sixth about every seventh day, while the remaining six scarcely ever require cleaning.

From the analyses given, p. 218, through the proportion of chlorine it appears that the samples of effluent collected were all derived from somewhat weaker sewage than that represented by the sample of raw sewage. The suspended matter in the effluent sewage, however, may be taken at about 2-3 parts per 100,000, and of this about one-half was organic in nature.

Towns B and C.—These two may be considered together, inasmuch as the method known as "intermittent treatment" with lime alone is practically the same in both. At town C, the daily quantity of sewage dealt with is 10,000,000 gallons. The sewage receives 15 cwt. of lime per 1,000,000 gallons, the lime being, as usual, added in the form of cream. The precipitation takes place in a system of no less than thirty tanks, the important distinguishing feature being that a period of perfect rest is given to the sewage in each tank. Each tank has a capacity of 50,000 gallons, the total tank capacity being 1,500,000 gallons. The method of working consists in filling four tanks simultaneously, this occupies upwards of sixteen minutes after about twenty minutes' complete rest, the liquid is run off through a floating exit-pipe, from which it passes over a weir in a thin layer, and then downward through a filter which is constructed of lumps of coke, to a depth of about two feet, after which it passes upwards through a similar layer of coke The coke in these filters is changed about every three months. The process of drawing off the clarified liquid from a tank takes about two hours. but it is considered advisable to allow even longer.

The analyses given, p. 218, show that this complicated system of intermittent precipitation yielded results very similar, but by no means superior, to those obtained by the simpler method of continuous precipitation adopted in the case of town A. Moreover, the process of filtration through coke, as carried out at these works, appears to deteriorate, rather than improve, the character of the effluent.

TREATMENT BY PRECIPITATION AND SUBSEQUENT APPLICATION TO LAND.

In the case of the three other towns visited this compound method of treatment was in operation, but in order to be able to compare the efficiency of the methods of chemical treatment with those adopted in the three towns referred to above, the effluent from the precipitation-tanks, as well as that from the land, was in each case submitted to separate chemical examination.

Town D.—Here the sewage of 50,000 inhabitants, amounting to 2,000,000 gallons daily, is treated with 13 cwt. of quick or one ton of slaked lime and 18 cwt. of sulphate of alumina. The sewage first receives the requisite amount of sulphate of alumina, after which the lime is added, a thorough mixture being effected in a special tank of small dimensions. The treated sewage then flows into eight tanks arranged in parallel series, each tank being 5 ft. 6 in. in depth, and having a capacity of 120,000 gallons, is not subdivided by any partitions. Thus, although a given volume o sewage only passes through a single tank, still the

total tank-capacity is so large in proportion to the volume of the sewage, that the rate of passage through the tank is extremely slow.

On referring to the analysis it will be seen that this extremely simple arrangement also yields an effluent containing as little suspended matter as that from any of the more complicated systems of tanks already referred to. Two out of the eight tanks are daily completely emptied, and yield 74 tons of wet sludge. It is worthy of notice that at these works a ready sale for the pressed sludge is obtained at the rate of about 1s. a load, and in point of fact, at the time of my visit there was little or no sludge on the premises.

The effluent from this process of chemical treatment then passes on to a plot of land eight acres in extent, and laid out in intermittent filters, underdrained at a depth of 4 to 6 feet. This land yields seven crops of rye-grass annually, and realizes from £2 to £3 a week.

The chemical examination of the effluent from this land shows that, whilst the proportion of suspended matter is diminished, the dissolved organic matter has undergone very considerable reduction. It is evident, however, that the area of land is insufficient to completely deal with the quantity of sewage applied to it, inasmuch as the effluent is quite free from nitrates.

This town affords a very striking and interesting example of sewage-treatment, both by chemicals and filtration, the method of precipitation being remarkably simple and compact, whilst the area for filtration purposes is exceptionally small.

Town E.—In the case of this town, the principal purification relied upon is the application to land, towards which the chemical treatment is merely a preliminary operation.

The sewage, about a third of a mile before reaching the works, receives an addition of lime to the extent of about 16 cwt. per 1,000,000 gallons. On reaching the works the treated sewage divides nto three large tanks arranged in parallel series, and in passing through which precipitation takes place.

Reference to the analytical table will show that the effluent from this single-tank precipitation contained only a small proportion of suspended matter, whilst the organic matter in solution was scarcely reduced at all. The effluent from the tanks is then distributed over the land by way of irrigation, each acre receiving on an average the sewage of 400–500 persons. The soil is extremely well suited for the purpose, being gravelly throughout, and is drained to a minimum depth of 4ft. 6in. The farm is made to yield a very varied produce; thus—milk is a large and increasing item, a considerable portion of the area is devoted to mangolds, swedes, and Kohl rabi, another large fraction to market garden produce, another to Italian rye-grass, another to cereals, besides a large part laid down as pasture.

A sample of the effluent from the land was collected, and found to be almost free from suspended matter, whilst the organic matter in solution was also very largely reduced. As evidence of the liberal allowance of land given to the purification of the sewage, a very large proportion of nitrates was found in the effluent, which in this respect presented a marked contrast to the conditions existing in the case of town D, where the sewage of about 6,000 persons is applied per acre.

Town F.—In the case of this town the allowance of land for purification is even greater than in that of town E, inasmuch as only the sewage of about 300–400 persons is applied per acre.

The method of chemical treatment is varied, sometimes lime and sulphate of alumina being used, whilst at other times, especially in summer, lime and refuse carbon are employed. The lime is added first (about 16 cwt. per 1,000,000 gallons), and then the sulphate of alumina (about 5–10 cwt. per 1,000,000 gallons); the carbon is employed in about the same proportion as the lime.

After thorough mixture taking place during the process of pumping, the treated sewage passes into six tanks arranged in two parallel sets of three. In these tanks a period of perfect rest is given, which varies in duration according to the quantity of sewage coming down. The clarified liquid is drawn off by means of floating arms, and then passes on to the land. The mode of application consists in causing the sewage to flow twice over the surface of the land, as the attempt to filter it by under-draining proved very unsuccessful, in consequence of the heavy nature of the soil.

The principal produce of the farm is Italian rye-grass, which is cut five times annually; there are also smaller plots under oziers, mangel-wurzel, and market gardens.

Two complete series of samples, taken on two different days, were submitted to analysis. On the first occasion lime and sulphate of alumina, with a quarter-of-an-hour's rest in the tanks, were employed, whilst on the second day lime and carbon were used with half-an-hour's rest in the tanks. The results obtained were essentially similar on both occasions; in neither case was the removal of suspended matter, by precipitation, very satisfactory, whilst a marked reduction in the proportion of dissolved organic matter was effected. In both cases the effluent from the land was almost quite free from suspended matter, and the dissolved organic matter was very greatly reduced.

General Conclusions.

The six examples described above may be taken as fairly typical of the average performance of some of the best managed sewage works in the country.

The results show that if the only object of the treatment is the production of a fairly clear effluent, this can be satisfactorily attained by a number of processes of chemical precipitation.

As regards the chemicals employed, there would

appear to be distinct evidence in favour of the use of sulphate of alumina along with lime, as by this means the dissolved organic matter is generally more reduced than if lime alone be employed. In no case, however, can any very great reduction in the proportion of dissolved organic matter be secured.

As regards the execution of these precipitation processes, the method of subsidence under complete rest, at any rate as at present carried out, appears to have little to recommend it; for although unquestionably correct in theory, it is difficult in practice to afford rest of sufficient duration for the advantages to come into play; whilst the far greater complexity both of construction and management which this method entails are very much against it. In none of the three towns, in which this method was in operation, was the effluent remarkable for its freedom from suspended matter.

In practice the greatest success is to be anticipated by employing the maximum capacity in a single tank of moderate depth without partitions. In short, let the whole of the available money be devoted to the acquisition of the largest system of tanks, of the simplest construction and requiring the least attention.

In cases where not only a clear effluent, but also one as free as possible from dissolved organic matter is required, we must resort now, as heretofore, to the application of the sewage to the land. In such cases, however, the sewage should invariably be submitted to a preliminary process of precipitation.

As regards the amount of sewage which can be safely applied to a given area of land, this must depend mainly upon the nature of the soil; but in all cases the guarantee of active oxidation should be demanded in the shape of a marked proportion of nitrates in the effluent.

RESULTS OF ANALYSIS EXPRESSED IN PARTS PER 100,000.

	Description.	Matters in Solution.							Matters in Suspension.		
		Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total Combined Nitrogen.	Chlorine.	Mineral.	Organic.	Total.
	Chemical Treatment only:										
Town A	Raw Sewage	96·48	4·066	·987	2·30	0	2·881	16·5	17·12	29·40	46·52
,,	Effluent (*a*)	64·08	·980	·333	1·20	0	1·321	11·2	·56	·56	1·12
,,	,, (*b*)	75·36	1·342	·503	1·30	0	1·574	15·1	1·58	·46	2·04
,,	,, (*c*)	88·76	2·000	·444	1·80	0	1·926	13·6	1·88	1·56	3·44
,,	Limed Sewage from tank after subsidence in Laboratory	95·50	3·887	1·081	1·30	0	2·152	11 6	0	0	0
Town B	Effluent	178·78	10·847	2·416	·80	0	3·075	7·9	2·34	1·28	3·62
Town C	Raw Sewage	51·00	1·280	·181	1·30	0	1·252	10·6	23·56	15·16	38·72
,,	Effluent from Settling-tank	45·12	1·629	·311	·52	0	·739	8·2	1·62	·46	2·08
,,	,, after passing over Weir	44·56	1·594	·305	·50	0	·717	8·4	1·64	1·86	3·50
,,	,, after filtration through Coke	39·72	1·059	·273	·50	0	·685	7·2	3·60	2·98	6·58
	Chemical Treatment combined with Application to Land:										
Town D	Raw Sewage	75·00	3·253	·501	4·20	0	3·960	9·4	11·88	22·92	34·80
,,	Effluent from tanks	75·00	2·208	·360	3·80	0	3·489	8·7	·98	·68	1·66
,,	,, land	60·40	·959	·159	1·30	0	1·230	6·2	·96	·78	1·74
Town E	Raw Sewage	104·20	4·134	·700	3·70	0	3·747	21·0	23·20	28·64	51·84
,,	Effluent from tanks	113 32	3·655	·705	2·50	0	2·764	23·8	2·08	1·52	3·60
,,	,, land	80·40	·605	·118	·09	1·548	1·740	11·2	·26	·18	·44
Town F	Raw Sewage, first day	98·60	4·204	·623	3·00	0	3·094	8·3	10·24	11·76	22·00
,,	Effluent from tanks (treatment with Lime and Sulphate of Alumina; ½ hour's rest)	85·36	2·145	·358	2·30	0	2·252	7·2	1·88	2·12	4·00
,,	Effluent from land	85·28	·906	·180	·05	·820	1·041	7·0	·22	·36	·58
,,	Raw Sewage, second day	82·20	3·371	·563	4·30	0	4·104	7·1	6·56	9·52	16·08
,,	Effluent from tanks (treatment with Lime and Carbon; ½ hour's rest)	73·28	1·617	·204	2·50	0	2·263	7·5	2·52	2·48	5·00
,,	Effluent from land	77·00	·937	·275	·005	·611	·890	6·9	·40	·14	·54

THE INCUBATION OF DIPHTHERIA.—From a painful case described by Mr. Charles Roberts, *Lancet*, Vol. II. 738, in which a surgeon repeatedly sucked the tracheotomy tube of his own child dying from diphtheria, and contracted in consequence a fatal attack of the same malady, it would seem that the period of incubation under such conditions is thirty hours, but the diphtheritic deposit itself was not visible until twenty-four hours later. In connection with this and similar cases it is obvious that a tracheotomy tube could be cleared without danger by a very simple apparatus, say, for example, a glass tube fitting in the aperture by means of a thin piece of rubber tubing stretched over the end so as to make a tight joint, then the glass tube being attached to a short length of caoutchouc leading to a flask like a common chemical wash bottle, with the long tube dipping under a disinfectant solution. Under these circumstances powerful suction could be applied so as to cause a partial vacuum in the flask, and infection could not occur.