THE DISINFECTION OF SEWAGE AND SEWAGE FILTER EFFLUENTS.*

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Review by T. Aird Murray, C.E.

Previous chapter in last week's issue dealt with evidence of pathogenic germs in sewage and sewage effluents from various methods of treatment. The necessity for disinfection and classification of methods of disinfection.

Chapter II.—Experimental Investigations.

Early in 1906 an arrangement between the Massachusetts Institute of Technology and United States Geological Survey, made it possible to go thoroughly into the question of disinfection of sewage by the use of chemicals. The experimental work was carried out at Boston, Red Bank, N.J., and at Baltimore.

The method employed by the author in expressing results is very satisfactory. General averages are very apt to be misleading. It is commonly said that "a chain is just as strong as its weakest link." In presenting averages which cover long periods it is quite possible that the weak links in the chain may be overlooked. To obtain an intelligent knowledge of the real value of disinfection, extreme deviations from the average should receive consideration. The routine work is reported in the form of weekly averages, and individual variations from the average bacterial removal are also given.

Such a system is highly commendable, and it would be well if it were more generally used in expressing results in water filtration. We know of cases where annual average bacterial removals are given which appear highly satisfactory, but which take no note of periodical breakdowns, the few days of low efficiency figures being swallowed up in the greater number of higher efficiency figures, producing generally what appear as most satisfactory results, yet taking no cognizance of periods when highly infected water was being produced. The real information required is what was actually accomplished, when the plant was working at its lowest efficiency; this information may then be compared with general efficiency.

The preliminary experiments were made in order to be able to define practical working limits with reference to efficiency and cost. It is shown that complete sterilization is practically an impossibility. It is for this reason that the term "disinfection" is used rather than the term "sterilization." The well known fact is pointed out, that it is easy to kill the first 95 per cent. of the bacteria, and very difficult to destroy the remaining "resistant minority" as Whipple terms it. This applies to all methods of disinfection. The author states a concrete example as follows: "It might happen that the pathogenicity of an effluent could be reduced 96 per cent. by the expenditure of a certain sum of money, 97 per cent. by the expenditure of twice that sum, and 99 per cent. by the expenditure of five times that sum. The first reduction might represent a feasible plan, and the last a prohibitively expensive one."

The Boston experiments were carried out more particularly with reference to disinfecting effluents from percolating filters. Two filters were used each of an area of 50 square feet by 8 feet deep. The combined filter capacity being equal to about 30 cubic yards of rough stone varying from once inch to two inches in diameter. The rate of flow was 5,000 gallons of sewage per twenty-four hours or one hundred and sixty-six gallons of sewage per cubic yard of filter. The effluents from the filters passed into a Dörtmund tank of a capacity equal to a flow of 200 gallons per hour. The chlorine solution was fed from an orifice box direct into the effluent flowing into the Dörtmund tank.

Results of experiments are given with various degrees of strength of available chlorine, over a period from November 12th, 1907 to June 27th, 1908. Thus results under fluctuating conditions of temperature are obtained.

During the first five weeks about six parts per million of available chlorine was used, and during the remainder of the period from two to four parts. The remarkable feature of the tests lies in the fact that the reduction in the amount of disinfectant used did not materially effect the results. The results also show that variation in temperature has no appreciable effect on disinfection.

The average reduction in B. coli throughout the whole period was 99.19 per cent. From November 12 to December 12, during which period 6.3 parts per 1,000,000 of available chlorine was being used, the reduction of B. coli averaged 99.99 per cent. January 27 to March 28, during which period 3.2 parts per 1,000,000 of available chlorine was being used, the reduction of B. coli averaged 98.5 per cent. From April 27 to June 27 when slightly over two parts per 1,000,000 of available chlorine was being used, the reduction of B. coli averaged 99.07 per cent.

A consideration of the B. coli removal from November to December of 99.99 per cent., with 6.3 parts of chlorine used, compared with the removal 98.5 per cent. from January to March with 3.2 parts of chlorine, is illustrative of the excessive increase of chlorine required to obtain only slightly improved results.

An interesting feature in the above results with reference to temperature having little or no effect on chlorine processes, lies in the fact which has been clearly demonstrated that concentrations of sulphate of copper must be doubled during winter months in order to maintain efficiency.

The reliability of the above tests, however, depends upon its weakest or poorest results. Phelps presents a table which shows that with individual tests over half the number resulted in removals of from 98 per cent. to 100 per cent., while only 15 per cent. of the total number of tests resulted in less than 94 per cent. removals. The weakest links in the whole chain showing 2 per cent. of the tests with results not greater than 75 per cent. removal and not less than 65 per cent. removal.

Experiments were also carried out at Boston in order to determine the length of time necessary for contact of the disinfectant with the sewage. Samples were taken of the percolating filter effluents after the disinfectant had been added, these being allowed to stand ten minutes, fifteen minutes, one hour, and two hours. The experiments covered a period from August 6th to August 23rd with available chlorine added in parts of 5 per million. The percentage of bacteria remaining after the above periods of contact were as follows: In ten minutes 5 per cent., in fifteen minutes 0.17 per cent., in sixty minutes 0.10 per cent., in one hundred and twenty minutes 0.07 per cent.

The above points to a contact of about an hour, as being the period producing a practical efficiency. Little is gained by extending the period to two hours.

It should be noted that the above results include any sediment, so that no allowance is necessary for bacteria which may have been removed by precipitation.

Phelps concludes that "these results demonstrate the entire feasibility of satisfactorily disinfecting trickling filter effluents with chloride of lime, and they indicate that about 3.5 parts per million of available chlorine and a contact

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