

tubes and the dielectric. The space in each case is about 1/16 inch, through which the air is passed.

The ozonizers are enclosed in steel tanks which have a circular dam in the middle, which forms two compartments. One compartment is the receiving end, where air under pressure from an air compressor is taken in and passed through the ozonizer. Part of its oxygen is converted into ozone and the air then passes along, as required, to the sterilizing towers.

After the air is compressed, it is passed through a cooler, thus preventing any heating of the ozonizer due to the discharge. It must be explained that only a small percentage of the energy applied to the ozonizer is utilized in the production of ozone. The greater part is lost.

Just as ozonizers are various in their form, so are, to no less extent, the means for applying the ozonized air to the water. The problem is evidently to produce a thorough mixture and in the methods in successful use there are two fundamentally different ways of doing this. In one the water is finely subdivided and passed through the ozonized air and in the other, on the contrary, the air is subdivided and passes through the water. The Ann Arbor plant belongs to the second class.

The ozonized air is conveyed to the sterilizing towers, which are built in batteries of a size to meet the capacity demanded. These towers are built on steps, with a fall of 3½ feet between each step. The water is taken in at the top of No. 1 tower, at the bottom of which are arranged suitable spray nozzles for the introduction of the ozonized air. Each tower contains four baffle plates that compel the water to travel 57 feet in each 13 feet of tower. This prolongs the contact of the water and ozone and enhances the efficiency of the system. The water leaves the bottom of No. 1 tower and enters the top of No. 2 tower, 3½ feet lower, where the same operation is repeated, and so on to No. 3 and No. 4 tower.

The chief advantages of the ozone system over any other known system of water purification lie in economy of operation, constancy of action, and freedom from costly repairs and renewals.

Nothing is added to the water to cause it to have an unpleasant taste.

No deleterious by-products are formed and odors and tastes due to organic matter are destroyed. Filtration by any means is only a greater or less reduction in the bacteria contained in the raw water. This percentage may be as high as 99 per cent. when everything is working right, but the remaining 1 per cent. in a highly polluted water may represent a grave danger. Filtration exerts no selective action. It removes the same percentage of pathogenic organism as it does of the harmless ones.

Ozone, on the contrary, has a selective action, killing all the pathogenic germs and practically all of the others. This is due to the low power of resistance to oxidation of the pathogenic germs and is confirmed by the statistics of various places where ozonization has been introduced. Paderborn, Germany, had a typhoid rate of about 1,500 per 1,000,000 population. Filtration reduced this rate to 290, and ozonization still further reduced it to zero. This plant was built in 1897 and has been in continuous operation since that time. Similar results have also been recorded in Paris, Dinard, Chartres, Nice, Weisbaden and other European cities.

In conclusion, it may be stated that any municipality using surface water may render this water safe by ozonization properly applied as outlined above.

THE ELECTRIC PURIFICATION OF WATER.*

By D. D. Vincent.

The pollution of the sources from which our great cities draw their water, and the sickness and loss resulting from the use of impure water, has drawn the attention of scientists and engineers to the various methods proposed for the purification of such water as is available.

Your attention is invited to the electrical purification of water, as practised by the Electra Pure Water Co., of this city, with which I am associated, as this method produces an ideal table water, free from organic matter, but not devoid of the necessary mineral salts.

Water purified by this process is taken from the city mains under pressure and passed between aluminum plates which are connected to a suitable source of electrical supply. It is then filtered through crushed quartz while still under pressure. We do not know to-day all of the changes which take place in the presence of the current. We do know, however, that a small percentage of the water is decomposed and that the organic matter in the water is oxidized and coagulated by the oxygen which is released and that the hydrogen combines with minerals in solution forming flakes of solid matter which can be removed with the organic matter by filtration. Repeated tests have shown that colon bacilli will not survive in this water any longer than in distilled water.

Exact work is being undertaken to establish the best practice in using this method of purification, both as to the form of apparatus used and the most economical current density and we are convinced that the cost of purification can be reduced to such a low figure as to give this method of purification a very wide application.

*Paper read before Cleveland Engineering Society.

DISCUSSION ON FOREGOING PAPERS.

Langdon Pearse* :—

The previous speakers have given a general review of the field of water purification. Mr. Pratt has shown you what the processes of filtration are, and the cost.

Mr. Leggett's paper covers the ozone plant as erected at Ann Arbor. The ozone process, as a means of sterilization, is not yet on a commercial basis in this country, in that a plant cannot be operated continuously to give uniform results, nor is it economical. This was conclusively shown by careful independent tests, made at Jerome Park reservoir, for the city of New York several years ago. Sterilization by hypochlorite of lime is much cheaper and more dependable. Ozone treatment was considered for the city of Montreal, but Messrs. Hering and Fuller in their report distinctly state that it is not yet on a basis to merit recommendation.

The paper by Mr. Vincent describes a process for the purification of water, based on making electrolytically aluminum hydrate. Instead of adding sulphate of aluminum the hydrate is made by passing an electric current between two plates. This simply coagulates the water, and a filter is essential both to remove the turbidity and the bacteria. There is no virtue in the electric current. It is cheaper to buy the sulphate of aluminum and apply it in the usual way. In the Louisville report, in 1896, Mr. George W. Fuller ex-

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