The fact of perhaps greatest importance is that there is apparently a critical point in dosage, at which satisfactory results will be obtained, but below which it is not safe to go. With the Cleveland water it was found experimentally, for instance, that 0.6 to 1,000,000 was adequate but that 0.5 was not. Moreover it is also true that a marked excess over this point is of no value as the total efficiency has already been obtained. Continuance of the experiments indicated that 0.7 allowed the necessary factor of safety, except under extraordinary conditions, when it will be advisable to make a temporary increase.

When the chlorine is put into the water where there is chance for aeration, as at the entrance to a reservoir, there is a very rapid action, and a very rapid disappearance of smell and taste, but where the circumstances are as in Cleveland, with the actual place of intake inaccessible during a large part of the year, this ideal method cannot be used. Accordingly it is necessary to put the chemical into the pump well, where there is an interval of less than five minutes before it goes under pressure. The killing effect has been satisfactory at this time, but the taste persists for a time dependent mainly on the temperature of the water, lasting longer in cold water, ordinarily from 30 minutes to an hour, while the odor persists practically until the water is released from pressure at the tap. The amount of odor will decrease with the increase of time from the intake and at distant points will be only appreciable by keen senses, while at nearer points it may be readily smelt, for instance, at the time of the morning bath. The actual disappearance is rapid, tests showing that when samples are taken at once and after five minutes there is already a decrease of nearly 50 per cent., and when the water reaches the consumer there is present less than one part in ten million, so high a dilution that to scientific men it is hardly necessary to point out the absence of danger.

Wherever the method has been tried, it has proved successful in reducing the water-borne diseases, and this has been notably the case in Cleveland, where at the time of introduction of the process, there were all the weather and water conditions suitable for the development of a serious epidemic, which, however, failed to appear. The typhoid rate in December has been the lowest for many years, though the general water conditions have been very unfavorable. In fine, the results of chemical treatment with chlorine have been found here and elsewhere to reduce typhoid to a very large extent and to reduce the pollution of the water as indicated by the daily tests at the city laboratory, which have been carried on since 1904, while there has been absolutely no positive evidence of the slightest ill results to persons who drink the water. The objections are in the main sentimental, and at times hysterical, but all the proof lies on one side of the case.

Note.—Cost of process. Apparatus for small communities pumping 200,000 to 500,000 gallons a day may be established for less than $25. Where there is a reservoir, very large quantities may be treated at a very low cost, and the only real expense lies in the establishment of the large tanks and the power mixer advisable for large communities. The cost of the Cleveland plant was $4,143.68.

The cost of the bleach is usually from $20 to $25 a ton, and roughly one-third of this represents the available chlorine. With the weight of a gallon as eight and one-third pounds one may calculate twenty-five pounds of the powder as able to disinfect one million gallons at a strength of one part in a million. From this the daily cost may be readily computed. Tests of the bleach should be frequent to check irregularities. The dosing outfit should be so arranged as to prevent the ingress of any of the sediment and should allow of flexibility in flow in case of changes in pumpage or in the quality of the water.

PURIFICATION BY OZONE.*

By R. M. Leggett.

One of the most convincing arguments in favor of our advanced civiliation lies in the fact that governments, both national and municipal, have taken to themselves the task of guarding the public health.

A sick or dead citizen ceases to be an asset to any community, and in a great many instances becomes a liability. The trend of modern medicine is to prevent disease, to teach people how to keep well, more than to make them well when stricken.

Thus, modern conditions place responsibilities upon cities that did not exist a decade ago. The city governments to-day are responsible, to a great extent, for the health and safety of every citizen. They supply an adequate police force to protect the public in so far as it is possible to do so, they provide asylums for the insane and hospitals for the sick, but so far as public health is concerned, a great many cities lock the stable door after the horse has been stolen. This they do by compelling the citizens to drink water containing sewage pollution and disease producing bacteria. To quote Ellice Hopkins, "It is better to fence the precipice at the top, than to wait with an ambulance at the bottom."

The majority of American citizens have learned by very bitter experience that it is costly to provide for their inhabitants a polluted drinking water.

Very rapid strides have been made by sanitary engineers in the last ten years, and their labors have resulted in placing at the disposal of cities various devices having as their object the purification of water.

Water purification embraces two principal acts, first, the removal of matter in suspension; second, the destruction of matter in solution.

Suspended matter comprises:

First—The grosses particles, such as clay, sand, leaves and parts of dead fish, sewage, etc.

Second—Micro-organisms.

Third—Bacteria.

The soluble content is composed of the organic compounds due to animal and vegetable decomposition, and mineral contamination from factories, and natural conditions of soil and rock.

In all problems of water purification, we have first to deal with that which causes disease, and after that, with those contents that cause unpleasant but harmless odors, colors and tastes.

The water to be treated by ozone must usually first be passed through a rapid roughing filter. This simply acts as a strainer, removing the grosser matter in suspension. Particles of sewage, dead leaves and organic matter absorb so much ozone, that if present in the water to be treated, reduce the efficiency of the system, unless first removed in this way.

(To be continued.)

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*Paper read before Cleveland Engineering Society.