although they have not shown themselves equal in this respect to slow sand filters."

Again he says; "The main point is that disease germs shall not be present in our drinking-water. If they cannot be kept out, we must take them out afterwards; it does not matter much how this is done, so long as the work is thorough."

Hazen at the time when he published the above work, evidently did not contemplate any method apart from filtration for the removal of bacteria, and was content to compare the average results of slow sand and rapid filtration, without reference to disinfection. In our issue of last week we published a paper read by E. Bernard Phelps, on the disinfection of sewage and water, in which he stated with reference to water supplies; "The two great fields which are open to water disinfection are the treatment of a very slightly or only occasionally polluted supply by disinfection alone, and the treatment of a more seriously polluted supply by the present methods at highly increased rates and by subsequent disinfection. In the latter case disinfection will be found a valuable adjunct to overload mechanical filters. The limiting rates of operation on slow sand filters are determined largely by the organic content of the water, and by consequent economy in the expensive cleaning processes. The limiting rates in mechanical filters, on the contrary, are practically determined by the necessity for obtaining bacterial purification. Therefore, it is especially with reference to this latter type that disinfection will be found important."

At once, it will be apparent that the conclusions of Hazen in 1908, are very different from those of Phelps in 1910.

The conclusions of Phelps based upon absolute data and evidence, which was not in existence in 1908, require that the water purification engineer and chemist face new conditions with re-consideration.

The temptation to install mechanical filters has always existed in the fact that water can be filtered at rates from fifty to one hundred times the rates possible in slow sand filters. Efficiency at these rapid rates requires the use of a coagulant. Further, such rapid filters can be easily housed and protected from weather conditions.

The temptation on the other hand to install slow sand filters has always existed in the fact of a somewhat higher bacterial removal, and that, generally, no coagulant is required.

Otherwise mechanical filters have been considered more suited to very turbid waters and slow sand filters to less turbid waters.

It is, generally, conceded, that in some phase or another every water requires some variation in treatment; but the fact remains, that most waters can be successfully depleted of color, odor, and suspended matter by rapid filtration; that is, a water can be easily, economically and within small space made acceptable to the palate and eye. It is further apparent that an easy and economical method is at hand of destroying disease germs.

The retarding influence on the adoption of methods of disinfecting water will certainly be found in popular prejudice to the addition of chemicals to drinking water. No matter how infinitesimal the amount of chemical used, people will at first imagine harmful results and believe that they taste it. This objection was at first raised to the use of a coagulant, such as sulphate of alumina, and only time and practical evidence of no ill effects can be relied upon as an argument against prejudice.

EIGHT EXAMPLES OF HYPOCHLORITE STERILIZATION OF WATER.*

Nashville.—The water supply of Nashville is derived from the Cumberland River, the water being of a turbid character and of an unsatisfactory bacterial quality. The water is stored in a reservoir holding three and a-half days' supply, and is treated with sulphate of alumina as a coagulant, but since August, 1909, hypochlorite of lime has been added in order to improve the bacterial quality of the water. The reservoir is divided into two basins of equal capacity. The coagulant is added to the water as it enters the first basin, and the hypochlorite of lime is added as the water passes over a wier into the second basin. An allowance of 0.1 grain of hypochlorite of lime per gallon is the amount which is generally used. Dr. William Litterer, reporting upon a number of examinations made in January, 1910, states that the intake sample showed a bacterial content at room temperature of 6,800, and at incubator temperature 6,100 per cubic centimetre. Of twenty-five samples for b. coli 92 per cent. were positive. A sample from the reservoir after treatment showed the bacterial content at room temperature to be 110, and at incubator temperature to be 80; no coli were present in twenty-five samples taken. The percentage of bacterial removal as judged by a sample taken from a hydrant was 98.4 per cent.

In this case the hypochlorite of lime contained about 36 per cent. of chlorine. It is mixed in a tank holding about 1,000 gallons by means of a vertical shaft and wooden agitating blades. The bottom of the tank is cone-shape, and from it a 1½-in. pipe is connected to a small pump. The liquid is drawn from the botom of the tank and is returned into it over the top, so as to stir thoroughly the hypochlorite of lime. The pump is worked by a 2 horse-power motor.

The expense of installing this plant was about $400, and the working expenses are about $6 a day. The cost of the hypochlorite of lime is $1.5 per 100 lbs.; the cost per 1,000,000 gallons of water treated is $1.05 for the hypochlorite treatment. The water consumption from the year 1909 was about 14,000,000 gallone per diem.

Minneapolis.—A 20,000,000-gallon hypochlorite water sterilizing plant has been installed at the city of Minneapolis. Sterilizaiton was first adopted on February 25th, 1910, in order to deal with a severe outbreak of typhoid. The successful results have caused the city to continue the use of the method for the present.

The water supply is derived from the Mississippi River, whence it is pumped to a reservoir of 97,000,000 gallons' capacity. The river, during recent years, has been badly polluted with the sewage, owing to the growth of the cities upon its banks. There had been previous outbreaks of typhoid fever, and it had been proposed to obtain a supply from a lake 18 miles distant. But, upon the advice of Mr. Rudolph Hering it was decided to continue the use of the Mississippi River water, but to treat it by mechanical filtration in conjunction with sterilization by hypochlorite.

In February, the typhoid death rate was four times the normal for the year; thus, in January, 1909, there was one death from typhoid against eleven deaths in 1910. In February, 1909, there was one death from typhoid against thirty-one in 1910. In face of this state of affairs the city

*From the Surveyor and Municipal and County Engineer.