As shown by the analyses, the hardness of the Elmhurst water supply is 102 p.p.m., total hardness, and the lime necessary to overcome this is 496 lbs. per 1,000,000 gal. of sewage. Analysis of the effluent shows that the hardness is reduced 50%.

In treating the sewage of the Borough of Manhattan only 180 lbs. of lime per 1,000,000 gal. would be required to overcome hardness, since the total hardness of Croton water is only 40 p.p.m. This would indicate that only 941 lbs. of lime would have to be used per 1,000,000 gal. in the electro-chemical treatment of sewage in Manhattan.

Power Used.—The electric power supplied to this plant is alternating current, 2-phase, 220 volts, 60 cycle. The current used for electrolysis on a flow of 25,000 of sewage daily is 18 to 20 amperes, with a pressure of 7½ volts, or a power consumption of 135 to 150 watts, which is about 1/5 h.p. The carbon electrodes take about 9/10 of the current, the balance going to the iron electrodes; hence out of 20 amperes 18 go to the carbon and the remaining 2 amperes are seriesed 8 times on the iron plates, giving an efficiency of 16 amperes on the iron. Estimating the power required per million gallons from the above figures, and remembering that with the increase of plate area in larger machines, the voltage required to put through a given amperage is proportionately reduced, about 6 kw. should be sufficient to effect the high degree of purification obtained in these tests.

Where an electrolytic machine designed to treat 1,000,000 gallons is installed, and a similar reserve unit is added, the utilization of both machines simultaneously for the million-gallon flow should cut the voltage required in half, since the plate area is doubled and the amperage remains the same. This would also halve the cost of power, which is the product of the voltage by the amperage.

Improved Electro-Chemical Machine for Sewage Treatment.—The electrolytic machine tested here was designed primarily for water purification. An improved type for sewage purification is now being built. It is designed to be installed horizontally, with the electrodes in a vertical plane and set longitudinally to secure the advantage of having the grit drop to a bottom trough. This also minimizes wear on the electrodes due to the grinding of grit by the rotating paddles, which in the new arrangement will, of course, turn in a vertical plane. In the vertical machine tested at Elmhurst this wear, however, has been hardly appreciable, notwithstanding the surface of the electrodes underneath the paddles are more subjected to it. The large machines are about 20 ft. long and 3 ft. square. As is usual with most mechanical and electrical devices, higher efficiency may reasonably be expected with increasing size.

Effects produced.—The effluent from the electrolytic machine shows immediate coagulation and when taken in a glass and held to the light the flocculent precipitate is seen to increase rapidly in bulk and starts to settle immediately. The liquid between the coagulated particles at once appears clear. Grease is rapidly saponified by the lime under the hastening action of the electric current and precipitates out as lime soap. This effect can be illustrated by the simple experiment of adding lime to a soap solution and holding two carbon electrodes in it for a moment.

Grease is one of the most disturbing elements in the purification of sewage by biological processes, on account of its tendency to clog bacterial filters and dosing devices, and the difficulty with which it is decomposed and mineralized by bacteria. Electrolytic treatment is well suited to handle sewage of this character.

Nitrogenous organic matter in the sewage becomes highly oxidized in this process, and this, together with the dissolved oxygen produced, yields an effluent of very high stability and as it leaves the small sedimentation tank after about ½ hour's retention, it is clear, colorless and without odor. The removal of bacteria is close to 100%. Disease-producing germs and allied species, outside of the body, are destroyed more readily than the ordinary bacteria of decomposition and hence if a few bacteria survive electrolytic treatment, they will not be pathogenic germs. This is borne out by observations on cultures made to identify this class of bacteria.

Storage of the Effluent for Observation.—From the small settling tank the clear effluent was run into the large concrete sedimentation tank, over which the electrolytic apparatus was erected. This tank has a capacity of about 67,000 gallons and is one of the four regular sedimentation tanks built with the Elmhurst plant. Chemical and bacterial observations made from time to time on the liquid stored in this tank showed some very interesting results. The bacterial content remained very low and the fixation of nitrogen, as shown by the increase in the nitrites and nitrates on standing, is remarkable, notwithstanding the fact that the tank is open to contamination from the air and by birds which nested in the rafters of the roof. This tank was kept full for 66 days. When emptied, a light deposit, about ¼ inch thick, was found at the bottom. This was light colored and inoffensive and was composed largely of calcium carbonate. The clear appearance of the water in this tank made interesting contrast to the dark septic sewage in the adjacent tank, with its deposited sludge continually forced to the surface in large masses by the rising gases of decomposition.

Sludge.—The flocculent precipitate in the machine effluent after sedimentation in the small tank was drawn from the bottom of this tank through 2-inch outlet pipes and forced into a filter press under about 25 pounds pressure by means of a small water-feed pump. At this pressure about 20 pounds of liquid sludge, containing about 95% moisture, could be dehydrated per hour, per square foot of filter area, based on the operation of a large press. The percentage of moisture remaining was from 55 to 60%. The filtrate from the sludge is quite odorless, colorless and has sufficient available oxygen to remain nonputrescible. The sludge has no odor, except possibly a very slight suggestion of ammonia.

The extraction of this readily settling sludge from the electrolytic machine effluent, by a process other than sedimentation in tanks, is now being considered, but on account of the short period of sedimentation required the elimination of a small tank area would be important only under exceptional conditions.

Cost.—Without including pumpage, the necessity of which would have to be determined at each point of treatment, according to topography, the cost of electricity for electrolysis at the rate of six kilowatts per million gallons at a cost of 3c. per kilowatt hour is 6 x 24 x .03 = $4.32

Lime 941 lbs. x .003 = $2.83

$7.15

Disastrous fires at the docks along the Seattle waterfront have led to an ordinance providing that all docks constructed hereafter shall be provided with fire walls spaced not further apart than 500 ft. on centres and fire stops not more than 100 ft. apart. These provisions are not required in structures fully equipped with automatic sprinklers.