The ratepaying engineers, we are informed, assumed a higher co-efficient of roughness for their calculations of flow, and adopted a value of $n = 0.03$ as more correct, in their opinion, to meet the conditions of the canal, particularly that section which is in the rock cut, the effect being to give somewhat lower values in flow capacity.

After having given consideration to all the conditions affecting this factor, and examined the bottom and sides of the canal, we have come to the conclusion that co-efficient $n = 0.025$ is best suited to the conditions of the canal.

The canal is assumed to be covered with two feet of ice for winter conditions. It is also assumed that the hydraulic gradient is parallel to the bed of the canal, making the depth of water uniform; in other words, the difference in level or friction head between the entrance of the canal and the forebay, *viz.*, 3.3 feet, is totally absorbed in cases of maximum flow to produce motion or induce the water to flow in the canal.

When the turbines, however, take only a percentage of the natural flow, then only a percentage of the total friction head is absorbed.

Probably one of the most critical questions to be considered, which affects mostly, in this case, the amount of energy to be obtained from the development, is the question of permissible velocities as governed by the character of the bottom and sides in both the headrace and tailrace.

We are informed that the tailrace will be paved, thus permitting of velocities as high as 8 or 10 feet per second (5.46 to 6.82 miles per hour).

The bed of the headrace, for a large proportion of its length, is of such a character as will permit only of a very low flow velocity, in order to prevent scour and danger to the walls. On this account we have looked with particular care into the question of limiting velocities for the project as designed.

Velocities.—The principal elements of a water power development are, the sectional area of the power canal, the permissible velocity of flow due to the material through which the canal is built so as to prevent all danger of scouring, the amount of water available and the net head.

For the project under execution we may say that the supply of water is practically unlimited. The section of the headrace or canal may be said to be fixed; that is, it cannot be further enlarged without great and unreasonable cost, on account of the large percentage of the side-walls already built, and it must remain the governing factor as to amount of water available to produce power, assuming an adequate enlargement of the tailrace where no work has yet been done.

The capacity of the canal is, in turn, necessarily dependent on the maximum velocity which can be permitted on the earth bottom sections of the canal, side concrete walls being provided under existing contracts.

We have given the most serious consideration to this question, and comparative studies have been made to determine the resulting flow and power, considering the nature of the material forming the bottom of the present canal, and also a concrete paved bottom.

Taking first the case of development under the present plans, we find the following reference to the nature of the material, in the report dated February 21st, 1914, of Messrs. J. A. Jamieson, R. S. Lea and G. R. Heckle, on the Montreal water supply conduit:—

The soil through which the aqueduct is being excavated, and in which the conduit is embedded for the greater part of its length, is largely composed of boulder

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MONTREAL WATER AND POWER COMPANY'S CHLORINE CELL INSTALLATION.*

By Frank Henry Pitcher, M.A.Sc.,
General Manager, Montreal Water & Power Co.

and James O. Meadows, A.M.Can.Soc.C.E.,
Chief Chemist, Montreal Water & Power Co.

THE sterilization of public water supplies with chlorine or chlorine compounds, either as an adjunct of filtration or as a sole method of purification, is now standard practice and this method is well understood, but the production of electrolytic chlorine and the application of the gas so produced to the water to be purified, is of rather recent date, and except in a general way is but little understood by the waterworks fraternity.

The electrolytic cell installation of the Montreal Water & Power Co. has been in service since the first part of the present year, a period hardly long enough from which to gather average operating results, but during the time that the plant has been in service considerable information and data has been secured that is of interest.

Historical Sketch.—The fact that the common salt can be broken down or decomposed into its elements, sodium and chlorine, by electrolysis, has been known practically since the discovery of the galvanic cell, but the commercial application of this principal was impossible until many difficulties had to be overcome to perfect an electrolyzing equipment which would efficiently and effectually separate the products and at the same time withstand the corrosive action of the chlorine gas.

Numerous types of electrolytic cells, or decomposing chambers, have been evolved and perfected to a degree, but only a few have been even a partial success commercially.

In its simplest form an electrolytic cell is a tank or chamber, composed of materials that will resist chlorine, and containing brine in which a positive and negative electrode is immersed. Upon the passage of an electric current through the cell, chlorine gas is liberated at the positive electrode, or the anode, and simultaneously metallic sodium is released at the negative electrode, or the cathode. This metallic sodium immediately combines with the water in the brine, forming caustic soda, and liberating hydrogen gas. The momentary products from the cell are, therefore, chlorine gas, a weak caustic solution, and hydrogen gas: but the chlorine gas and the caustic soda immediately combine to form sodium hypochlorite, or so-called sodium bleach.

Cells of exactly the type described have been and are now sold for laundry use, but they cannot be employed when a complete separation of the products is required. Furthermore, this type of cell can produce only a weak bleaching solution, and that inefficiently, because after the sodium hypochlorite reaches a certain strength, it is in turn decomposed by the electric current, making the process retroactive, with the damaging result that the oxygen in the sodium hypochlorite combines with the carbon of the anodes to form carbon dioxide gas.

From the foregoing it is obvious that to obtain a perfect cell for the production of chlorine gas, the chlorine and the caustic soda, which are the primary products of electrolysis, must be prevented from recombining.

*Paper read before American Waterworks Association, May, 1917.