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Operation of Drifting Sand Filters at Toronto

Average Reduction of 85.4% in Total Bacteria and of 94.8% in B. Coli During Year 1918—Chlorination Killed Practically all Remaining Bacteria—More Coagulant Needed in Summer Than in Winter—Water Undergoes Two Distinct Changes During Year

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PURIFICATION of the water supply for the city of Toronto is effected by means of two systems, one being a slow sand and the other a mechanical of the drifting sand type. The water is drawn from Lake Ontario to the south of Toronto Island, two intakes being situated a little over 2,000 feet from the shore, submerged in about 60 and 80 feet of water, respectively. The slow sand system has given excellent results, but when an extension was found necessary in 1914, the city decided on mechanical filtration, the reasons given being difficulties in operation caused by a combination of occasional high turbidity and the low temperature in the winter months.

The object of this paper is to give, as briefly as possible, a description of the drifting sand system* and the results of the operation and purification effected during 1918. Throughout the paper the word "gallons" are Imperial gallons. The capacity of the plant is 60 million gallons in 24 hours, but a maximum rate of 72 million gallons daily must be maintained for a period of 10 hours. The rate of filtration is somewhat higher than is usual with mechanical plants, the rate being 150 million gallons per acre per day. Before describing the plant it would be well to state the two principles involved in its operation. They are the introduction of a coagulant without sedimentation and the necessity for there being a drifting as well as a stationary body of sand in the filter. These would seem to be the two differences between modern mechanical plants of the gravity type and the drifting sand filter.

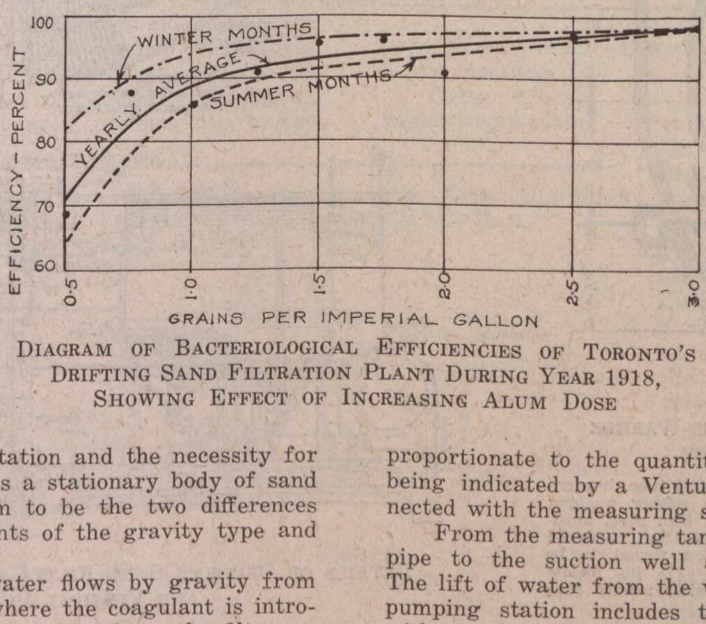

Diagram of Bacteriological Efficiencies of Toronto's Drifting Sand Filtration Plant During Year 1918, Showing Effect of Increasing Alum Dose

In the Toronto plant the water flows by gravity from the intake into a suction well, where the coagulant is introduced, the water then being pumped directly to the filters.

The coagulation plant consists of a large storage bin in which is stored alumina sulphate used for coagulation purposes. Through a number of control doors the chemical is automatically fed to two dissolving channels, the density of which is kept from 12 to 14 degrees Baume (about 15% solution). The strong solution passes into a hydrometer chamber, where it is automatically diluted to the required strength. The hydrometer is poised in the solution between two valves, one discharging alum and the other water. Any vertical movement of the hydrometer opens one valve and closes the other. Thus the hydrometer tank is supplied with strong alum solution at the top, or water at the bottom, depending whether the hydrometer is up or down. The tank is made of concrete, whilst the hydrometer is steel, thickly covered with paraffin wax, and has a displacement of 6,000 lbs. of solution. It is weighted so as to just float in solutions of alum ranging between 4% and 10%. Owing to the differences in the density of alum and water, circulation is maintained, a 10% solution of alum being approximately 5% heavier than water. The heavier liquid coming in at the top immediately starts travelling downwards and meets the lighter liquid rising upwards. At the point of discharge a perfect mixture is obtained, it being impossible to detect stratification.

A beam with knife edges above the hydrometer, which is extremely sensitive, provides for permanent adjustment and also for altering the density of the solution. Along the beam is a scale of divisions graduated in 1/10th grains, so that by moving a weight the required strength of solution may be obtained. The solution of alum next discharges into an orifice chamber. A mechanical device regulates the discharge of solution, which is proportionate to the quantity of water being pumped, this being indicated by a Venturi meter which is directly connected with the measuring slot.

From the measuring tank the alum passes through lead pipe to the suction well and is pumped to the filters. The lift of water from the well to the filters is 32 ft. The pumping station includes three electrically driven pumps with a combined capacity of 100 million gallons and a lift of 32 ft. Besides these, there are a two-million gallon auxiliary pump with 32-ft. lift, two half-million gallon backwash tank pumps with 100-ft. lift, two one-million gallon drainage pumps with 20-ft. lift and two hydraulic-pressure pumps with a capacity of 8,640 gallons a day under 700 lbs. per square inch. The discharge of the main pumps is controlled automatically by the level of the water in the filter tanks, through pilot valves, operating hydraulic valves on the discharge of the pumps. There has also been installed a steam turbo-generator set, in case the electric power should fail.

The multiple filter unit system was adopted in Toronto, and consists of ten units, each having a nominal capacity of six million gallons. Each filter is made of steel, is 14 ft. high, 50 ft. in diameter, and is divided into thirty smaller units. These units are nested together in two rings of 18

*For photographs, plans, sectional drawings and further data regarding the construction and method of operation of this plant, the reader is referred to the following issues of *The Canadian Engineer*: October 24th, 1918, pp. 359-64; September 14th, 1916, pp. 203-10; November 25th, 1915, pp. 618-20; April 8th, 1915, pp. 433-8; April 23rd, 1914, pp. 639-41.