Volume 24 Toronto, June 19, 1913

Contents of this issue on page 883

The Canadian Engineer

An Engineering Weekly

METHODS OF RAPID SAND FILTRATION

GENERAL DESCRIPTION OF SYSTEM — COAGULATING CHEMICALS FOR CLARIFYING RAW WATER—OPERATING DEVICES—COST OF CONSTRUCTION AND MAINTENANCE*

By GEORGE A. JOHNSON, M. Am. Soc. C.E.

RAPID sand filtration first attracted attention as a method for purifying public water supplies in 1885, when a rapid filter plant was built to treat the supply of Somerville, N.J. Since that time this method has come into use in more than 350 cities in different parts of the world and supplies a total daily demand of considerably over 700,000,000 gallons. The largest plant of this type is installed at Cincinnati, Ohio, and has a daily capacity of 112,000,000 gallons. Others are located at Columbus, Ohio, capacity 30,000,000 gallons daily; Hackensack, N.J., capacity 24,000,000 gallons; Harrisburg, Pa., capacity 20,000,000 gallons; Little Falls, N.J., capacity 32,000,000 gallons; Louisville, Ky., capacity 36,000,000 gallons; Toledo, Ohio, capacity 39,000,000 gallons; and New Orleans, La., capacity 40,000,000 gallons. Among the larger rapid filter plants under construction in 1911, were those at Minneapolis, Minn., daily capacity 39,000,000 gallons, and at Grand Rapids, Mich., daily capacity 16,000,000 gallons.

Of the three score rapid filter plants in foreign countries the largest is that at Alexandria, Egypt, capacity 12,000,000 gallons daily. Similar works of even greater capacity are under construction at Kyoto, Japan, and at Cairo, Egypt.

The essential differences between rapid sand filters and slow sand filters are as follows: In the rapid sand filters, the filter units are much smaller; the sand grains comprising the filter bed are much coarser; a coagulant is always used in preparing the raw water for final filtration; the rate of filtration is in round numbers forty times that ordinarily used in slow sand filters; and the whole filter bed, when dirty, is cleaned in the tank itself by forcing water upward through the sand instead of scraping off the surface layers as in slow sand filters.

Up to 1902 rapid sand filters were of more or less uniform design. They were contained in wooden or steel tanks of comparatively small diameter, and the more economical concrete construction had not as yet been attempted. At the commencement of the classic investigations into this process of water purification, conducted at Louisville, Ky., under George W. Fuller, in 1895-1898, even the process itself had not proved its usefulness in the purification of large volumes of water. Provisions for adequate preparatory treatment of the raw water were rarely made, and the whole subject of the suitable design and operation of such works was but little understood.

The need of adjusting the design of rapid filter plants to meet local requirements began to be fully realized when the plant at Little Falls, N.J., was built in 1902 for the East Jersey Water Company. In this plant suitable provision was made for the accurate application of the coagulating chemical (sulphate of aluminum) to the raw water. A basin of adequate size was provided in which coagulation and sedimentation of the raw water could take place. The filter tanks themselves were built of concrete, for the first time, and were rectangular in plan. Improved facilities were installed for agitating the sand layer with compressed air during washing. Neat operating tables, from which all valves could be operated and motors started and stopped by hydraulic power, took the place of the less neat and convenient wheel stands. With the Little Falls plant the modern ideas of proper design for rapid filter plants began to be realized, and its construction marked a most important epoch in municipal water filtration.

Nearly all rapid filter plants are now built of concrete, although wooden and steel tanks are still used for small installations. The filter tanks are ordinarily built monolithic, and embedded in the floor of the tanks is the underdraining system, composed of perforated pipes or strainer cups, designed to permit the filtered water to pass out without allowing sand to escape and to permit an even distribution of water throughout the sand layer when the filter is being washed. Over the strainer system a shallow layer of coarse sand or gravel is placed, and on this rests the sand layer which forms the filter proper.

When the raw water has been sufficiently clarified by coagulation and sedimentation it is passed on to the surface of the filter, over which water ordinarily stands to a depth of several feet, and allowed to pass downward through the bed at a rate of 100,000,000 to 120,000,000 gallons an acre daily, such rates being automatically controlled by special devices. This corresponds to a rate of 2,310 to 2,760 gallons a day on 1 square foot of filtering surface.

The water applied to the filter always contains a considerable amount of coagulated matter, such as mud, vegetable stain, and bacteria, which is retained at or near the surface of the bed. As operation is continued the frictional resistance in the sand layer increases to a point where it is necessary to close the filter for washing. At such times the water standing over the bed is drained down to the level of the overflow gutters, which are located a foot or more above the sand layer, and filtered water is then forced upward through

*Extracted from United States Geological Survey Report, 1913, "The Purification of Public Water Supplies."