

Since the installation of the first municipal rapid sand filtration plant at Somerville, N.J., in 1885, upwards of 450 municipal filter plants of this type have been built or are now under construction in the United States. Those operating have a daily capacity totalling 1,745,000,000 gallons and approximately 12,000,000 people are being supplied with water so filtered.

Between 1890 and 1900 there was much scientific investigation into the merits of the new process. These studies were in no small measure responsible for the wonderful growth of rapid sand filtration during the past 15 years, as the theory of the process was thoroughly worked out and the idea placed upon solid footing.

The type of construction changed abruptly about 1900, rectangular concrete tanks frequently replacing the circular wooden or steel tanks formerly used. The new type necessitated the use of compressed air to agitate the sand layer while washing the filter and later the application of wash water at high velocities. These methods became general, supplanting the mechanical stirrers and wash water at low velocity used in the old type of rapid sand filters, and from which they had derived the name of mechanical filter.

Among the 450 plants mentioned above, the largest are situated at Little Falls, N.J.; New Orleans, La.; Cincinnati, Ohio; Louisville, Ky., and Columbus, Ohio, the respective daily capacities being 32, 44, 112, 36 and 30 million gallons daily. Mr. Johnson's paper describes the experiences of these five plants.

Relative Cost of Slow Sand and Rapid Sand Filtration.—Construction.—In discussing the cost of building water filtration works of the slow sand and rapid sand types, respectively, Mr. Johnson gives consideration only to those items referring to the filter plant proper. Cost of land, pumping machinery, outside connecting piping, intakes, etc., in fact everything outside the filtration plant proper, is not considered. The following is a summary of this portion of his paper:

For slow sand filter costs the items will include the necessary filter buildings and filters with all appurtenances, all inside piping, sand handling apparatus, preliminary sedimentation basins, preliminary filters and appurtenances and clear water reservoirs.

For rapid sand filter costs the items will include the filter buildings and filters with all appurtenances, all inside piping, filter washing apparatus, coagulating and clear water basins. Thus a fairly good idea may be had of the relative cost of building purification plants of the two types.

It is true that, on account of the much greater area required, the cost for land is far greater in the case of slow sand filtration systems than for rapid sand systems. Roughly, other things being equal, land will cost twenty times as much for a slow sand filter installation as for a rapid sand plant. Furthermore, in large projects, it is often difficult conveniently to locate a site for slow sand filters, while for a rapid sand filter plant it is a relatively easy matter as a rule. If it is necessary to go a long distance in locating an extensive and suitable area of land for a slow sand filter site there is incurred a large expense for a conduit to bring the filtered water to the city. This is very rarely necessary in the case of rapid sand filter projects. So that, in studying the comparative figures which follow, it must distinctly be borne in mind that the costs given for slow sand filter installations are really low, since the important considerations just mentioned are not charged against them.

Cost of construction of slow sand and rapid sand water filtration plants.

| City. | Kind of sand filters. | Present daily filtering capacity. | Approximate cost per million gallons daily capacity. |
|-------------------------|-----------------------|-----------------------------------|--|
| Albany, N.Y. | Slow | 20,000,000 | \$20,000 (a) |
| Pittsburgh, Pa. | Slow | 200,000,000 | 26,000 (a) |
| Philadelphia, Pa.: | | | |
| Torresdale | Slow | 250,000,000 | 37,700 (a) |
| Upper Roxborough .. | Slow | 28,000,000 | 29,800 |
| Lower Roxborough .. | Slow | 17,000,000 | 26,300 (a) |
| Belmont | Slow | 60,000,000 | 45,200 (a) |
| Washington, D.C. | Slow | 100,000,000 | 30,000 (b) |
| Cincinnati, Ohio | Rapid | 112,000,000 | 11,400 (c) |
| Columbus, Ohio | Rapid | 30,000,000 | 13,000 (d) |
| Dallas, Texas | Rapid | 15,000,000 | 13,000 |
| Harrisburg, Pa. | Rapid | 16,000,000 | 10,300 |
| Little Falls, N.J. | Rapid | 32,000,000 | 15,000 |
| Lorain, Ohio | Rapid | 6,000,000 | 14,000 |
| New Milford, N.J. | Rapid | 24,000,000 | 11,000 |
| Watertown, N.Y. | Rapid | 8,000,000 | 11,250 |
| Weighted averages | Slow | | \$32,600 |
| | Rapid | | 12,100 |

(a) Cost of preliminary filters included.

(b) Cost of Dalecarlia Reservoir not included. Cost of McMillan Park Reservoir included, and also cost of remodeling Georgetown Reservoir, as well as cost of coagulating basin.

(c) Cost of large plain sedimentation basin not included.

(d) Cost of softening works not included.

The above figures show that the approximate relative cost of building the slow sand and rapid sand filter plants mentioned was \$32,600 and \$12,100 respectively, per million gallons daily capacity. At 5 per cent. the fixed charges on these sums would amount to \$4.47 and \$1.66, respectively, per million gallons of water filtered.

Operation and Maintenance.—The cost of operation and maintenance of filtration plants in a large measure, varies, of course, with the quality of the raw water. In a general way the following examples will serve to show the charges ordinarily made against the operation and maintenance of representative water filter plants in this country.

Cost of operation and maintenance of slow sand and rapid sand filtration plants.

| Year. | City. | Kind of sand filters. | Average volume of water filtered daily. | Cost of operation and maintenance per million gallons of water filtered. |
|------------------------|-----------------------|-----------------------|---|--|
| 1911 | Albany, N.Y. | Slow | 20,000,000 | \$2.50 |
| 1912 | Pittsburgh, Pa. .. | Slow | 100,000,000 | 3.41 |
| 1911 | Philadelphia, Pa. .. | Slow (a) | 9,000,000 | 5.62 |
| 1911 | Philadelphia, Pa. .. | Slow (b) | 13,000,000 | 3.59 |
| 1911 | Philadelphia, Pa. .. | Slow (c) | 38,000,000 | 3.88 |
| 1911 | Philadelphia, Pa. .. | Slow (d) | 202,000,000 | 1.91 |
| 1912 | Washington, D.C. .. | Slow | 62,000,000 | 4.01 |
| 1912 | Cincinnati, Ohio .. | Rapid | 50,000,000 | 4.12 |
| 1911 | Harrisburg, Pa. .. | Rapid | 9,000,000 | 3.93 |
| 1912 | Little Falls, N.J. .. | Rapid | 30,000,000 | 3.20 |
| 1912 | Louisville, Ky. ... | Rapid | 25,000,000 | 3.48 |
| 1912 | New Orleans, La. ... | Rapid | 16,000,000 | 6.32 |
| Weighted Average | Slow | | | \$2.86 |
| | Rapid | | | 4.04 |

(a) Lower Roxborough; (b) Upper Roxborough; (c) Belmont; (d) Torresdale.