SOME PRACTICAL PROBLEMS IN FILTRATION PLANT OPERATION.*

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IT has occurred to the writer that certain practical problems encountered by him during his experience in the management of mechanical filtration plants may be common elsewhere, and that, therefore, a description of some of these problems and their solution might be of general interest to designing engineers and superintendents of filtration.

Coagulant Piping.

One of the greatest problems lies in getting an ample supply of coagulant solution to the right place at the right time when it is most needed.

When the writer assumed charge of the new Rock Island filter plant in 1911 a 1½-inch lead-lined iron pipe carried the alum solution some three hundred feet to the far end of the coagulating basins, the pipe being laid under the water of the basin. The available head for producing the flow of alum solution was approximately four feet. It was soon found that this line would not carry the required amount of solution because of clogging of the pipe by deposits from the alum, and also because of entrained air. An hydraulic ejector was placed in the line, but while it served to remove the air it did not remove the deposits in the pipe.

More serious difficulties arose when the alum solution began to appear where least expected. Investigation showed leaks at the threaded joints where lead did not meet lead, and also at the bad spots in the piping where the lead lining was deficient. The line was mostly under water, so the difficulties were increased. Whole lengths of pipe were replaced, but the troubles continued.

The lead-lined pipe was replaced with a 2-inch composition conduit which was guaranteed to be unaffected by the alum solution. So it was, but when the water in the basin began to warm up in the spring the conduit expanded and broke at the joints. Expansion joints of rubber hose were inserted, but when cold weather came the conduit contracted and pulled apart. Lead and brass pipe were then tried, but these clogged up with deposits of slimy material.

Mr. C. R. Henderson, manager of the Davenport Water Company, then suggested the use of four-ply rubber hose, which was installed in fifty-foot lengths, and the troubles were eliminated. Whenever the hose clogged up it was removed one length at a time, trod upon to loosen the deposits and then flushed out with water under pressure.

It is only fair to state that recent information from Rock Island shows that fibre conduit is satisfactory when encased in concrete or other suitable material, and is not subjected to extreme changes in temperature.

All coagulant lines in the Minneapolis filtration plant were of 2-inch lead pipe with brass couplings laid with a slope of 1 inch in 10 feet on horizontal runs. The discharge lines from the solution pumps to the overflow tanks which supply the chemical feed controllers gave little trouble from clogging, but the gravity flow lines from the controllers soon began to clog up, as did the pipes at Rock Island. The long runs of lead pipe were difficult to remove for frequent cleaning, and it became more and more difficult to get proper coagulation.

It was decided in 1914 when making additions to the original plant to install open coagulant piping in place of lead pipe on horizontal runs. Consideration was given to open tile laid in concrete, and to a concrete channel; but the scheme finally adopted was 4-inch iron pipe open at the top, made by James B. Clow & Sons from plans prepared by Mr. W. N. Jones, erection engineer. The writer is again indebted to Mr. C. R. Henderson for the suggestion of open coagulant piping, which has solved all of the difficulties formerly experienced. It is readily accessible for cleaning and for painting several times each year with a high grade of graphite or asphalt paint. No leaks have occurred in the pipe during the three years that it has been in service.

The chemical composition of the deposit occurring in the alum lines at Minneapolis may be of interest. The following analysis of a sample was made in the laboratories of the General Chemical Company, Chicago.

$Fe_2(SO_4)_3$	22.60 per cent.
$Fe(OH)_3$	23.11 per cent.
$Al(OH)_3$	24.93 per cent.
SiO	12.32 per cent.
H_2O	15.96 per cent.
CaO	None.
Cl	Trace.

The high cost of brass has led to our using iron flanges for connecting lead to lead, or lead to rubber hose on the discharge lines from the coagulant solution pumps. The iron flange is pushed onto the lead pipe, the end of which is then expanded with a mandrel and bent over so that a lead to lead coupling is obtained at slight expense.

Chemical Solution Agitators.

The agitating devices for the chemical solution tanks were originally of the two-blade impeller type driven by a 3-inch by 13-foot hollow vertical shaft direct connected to a 1,720-revolution-per-minute, 2-horse-power motor. The high speed of the impellers produced excellent agitation of the solutions, but caused the bending of the drive shafts and armature shafts in the motors. Corrosion of the steel shafting and bronze thrust bearing made much trouble and a high cost of maintenance.

It was decided to reduce the speed of the agitators to approximately 600 r.p.m. by means of reduction gears to replace the 6-inch impeller blades with wooden blades three feet long, and to make stead bearings at the centre of the vertical drive shafts. These changes eliminated some of the troubles, but there still remained the corrosion of the bronze bearings and the steel shafts. Also the agitators were very noisy, the motors having been set on a steel deck supported by I-beams over the centre of the tanks.

The 4-inch hollow steel shafts were replaced with square oak shafts 4 inches by 4 inches, the two blades made of one piece of oak and having an upward thrust at an angle of 45 degrees from the horizontal. One horizontal motor of two horse-power and 1,120 revolutions per minute replaced the three vertical motors, and by means of shafting, clutches and worm drive, the speed of the impellers was reduced to approximately ten revolutions per minute. The blades of the impellers were lengthened so as to reach within six inches of the sides of the tanks. The results have been very satisfactory, the noise having been eliminated; one motor does the work of three; there is no more trouble with the shafts or impellers, and the solution is amply agitated.

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