

of these three representative filters is practically the same.

Suspended Matter.—In the removal of suspended matter from the water there can be no question of the efficiency of mechanical filters of whatever make they may be. That they render the water clear, as tested by the 2-ft. tube, is testified by many observers throughout the country. The effect of filtration is most markedly seen in dealing with very turbid water—for example, from a river in flood. No severer test could be applied than in dealing with the water from the Severn, which is liable to heavy flooding, and which at times contains a very large quantity of insoluble solids. During spring and summer the flow of the river remains fairly constant as regards suspended solids, and at those times alumina is added to the extent of $1\frac{1}{4}$ grains per gallon; but during the autumn and winter when the river is high and floods are common, the amount of alumina added may be raised to $2\frac{1}{2}$ grains per gallon. The clearer the water the less alumina is required. In the summer months the filters are cleansed every twelve hours, but on some occasions during the winter, and fortunately these are few, it may be necessary to wash out the filters every six hours and even every four hours.

The chief difficulty in clarifying the water is the presence of the argillaceous or clayey matter. This fine material sediments slowly. The writer has several times allowed the 2-ft. tube to remain upright for twelve hours, and found that the fine particles had not sedimented even in that time. In dealing with such a water, sedimentation after adding the coagulant, but before passing through the filters, would relieve the work of the filters, and so bring about a better filtrate. Another factor to be considered is that the river may rise quickly, and those in attendance may be taken by surprise before the requisite proportion of alumina is added.

This flood water is very difficult to deal with by any kind of filter without preliminary sedimentation, and perhaps the mechanical filter is preferable to the slow sand filter, which would soon become clogged by the sedimentary material.

Presence of Iron in Solution.—Iron may be found in solution in water from deep wells. It exists in solution in the ferrous state by reason of the presence of carbonic acid, and in the presence of air becomes oxidized, and is precipitated, after which simple filtration will remove nearly all the iron present. If the water is free from pollution, which is probable in the case of a deep well, treatment is only required for the removal of iron. Here the installation of mechanical filters may be all that is necessary.

In the process of removing iron in solution the water must be aerated to cause oxidation and precipitation. Provided aeration is sufficient for complete oxidation, simple filtration through the mechanical filter is all that is necessary for the removal of practically all the iron present.

Coloring Matter.—There appears to be no doubt that mechanical filters act more efficiently than slow sand filters in removing peaty coloring matter. The alumina used in most of the types of mechanical filters seems to form a film which effectively arrests most of the coloring matter, perhaps by a specific mordant action.

Plumbo-Solvent Action.—Plumbo-solvent action is commonly found in moorland waters, the property being due to the presence of peaty acids, which impart an acid reaction to the water. To counteract the action of peaty acids, neutralization may be carried out, as is done in the process of mechanical filtration, by the addition of lime

or sodium carbonate, which is added in sufficient quantity to neutralize the acidity and at the same time re-act on the alumina added to force the coagulant; or, in the case of the filter not using coagulant, by the addition to the filter-bed of magnesium oxide, which is slowly dissolved out.

Very careful investigations have been conducted by several observers, especially with regard to two types of mechanical filter in which coagulant is used. Frankland, in making observations on the Stockport water before and after filtration through Bell's filters, found that the plumbo-solvent was reduced by 76.3 per cent., taking the average of a year's weekly samples. Delépine ascertained that the action of moorland water on lead, after chemical treatment and passage through Bell's filters, was considerably reduced and rendered negligible. Ross and Race, studying both Mather & Platt's and Bell's filters, obtained somewhat similar results, the plumbo-solvent action being reduced to a very small amount or completely abolished, and the water giving a definite alkaline reaction.

Although the methods of determination adopted by these observers were different, their scientific accuracy may be taken for granted. These results, coming from men of a high reputation, give expression to the remarkable efficiency of this method of treating water possessed of a plumbo-solvent action which is dangerous to consumers.

Bacterial Content.—The bacterial content of the water need only be considered in relation to the filtration of water which is polluted, or suspected of being polluted, by excremental matter. Upland or deep well waters are likely to be beyond reproach, and the effect on the bacterial content is only of secondary importance.

In the first place it is necessary to allude to the fact that until a sufficient film of hydrate of alumina forms on the surface of the filtering material, the maximum efficiency of the filtration process cannot be expected. This film, however, quickly forms, and Ross & Race found that, under ordinary circumstances, after washing the percentage of purification obtained at the end of ten minutes' working of the filters was 91.9 in the one and 94.7 in the other.

In experiments carried out in November, 1910, the writer found that Bell's filters, two minutes after washing, gave a percentage purification of 91.9 and 87.0 respectively, in two experiments; and fifteen minutes after washing a percentage purification of 95.9 and 92.4 respectively. The time between washing and efficient action of the filters is thus so small that it may be neglected.

As to the bacterial efficiency of mechanical filters, Frankland showed that, working with Bell's type, an average of 95.7 per cent. purification could be obtained. This average deals with a year's weekly samples of the unfiltered and filtered waters, the unfiltered water containing from 45 to 793 bacteria per c.c., and the filtered water from none to 45 per c.c. This water was obtained from an upland source not exposed to pollution. At York, where mechanical filters are used for preliminary treatment instead of storage before filtration through slow sand filters, the average reduction in the bacterial content of the water, which is obtained from the Ouse, was found to be 86.2 per cent. without the use of a coagulant; but with the addition of 1 grain per gallon of sulphate of alumina, in an experiment lasting six days, an average reduction of 93.37 per cent. was obtained. At Bolton, where Mather & Platt's filters are in use, Ratcliffe (quoted by Ross and Race) found in a series of weekly examina-