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THE CONSTRUCTION OF A MODEL FILTER PLANT

THESIS FOR DEGREE OF B. S.

GEORGE HONEYWELL

1926

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The Construction of a Model Filter Plant.

A Thesis

Submitted to the Faculty of the

Michigan State College

of

Agriculture and Applied Science

by

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Candidate for the Degree

of

Bachelor of Science

June 1926.

THEORY

The purpose of this thesis is to give a working model of a modern filter plant. No attempt has been made to follow the design of any one filter plant but merely to give a representative model which will show the different units of a filter plant and how they function.

The action of a filter plant may be outlined in three major operations. First, the mixing of the coagulant with the raw water. Second, the settling of the coagulant. Third, the filtering of the water through the sand beds.

The Theory of Filtration.

In filtering water through sand, the principal results to be accomplished are the removal of visible suspended matter causing turbidity and the bacteria.

Sometimes also the removal of color is an object of importance. Within certain limits, a sand filter is a very efficient device to accomplish these purposes.

The action of a filter is obviously much more than that of a strainer. Large particles are of course removed by this action, but the chief function of the filter is to remove bacteria and particles of sediment of microscopic and sub-microscopic size, and its ability to do this cannot rest on its straining action alone. In part, the sand-bed undoubtedly

ly serves as numerous minute sedimentation chambers, which, owing to their small size and the low velocity of flow, are quite efficient in the removal of the finer suspended particles, including bacteria. In this way particles much smaller than the pore spaces in the sand are removed to a very considerable extent by purely mechanical means. If, however, the process was purely mechanical, the filtered water should be as good at one time as another, but such is not usually the case. As a matter of fact, a sand filter becomes, to a certain degree, more efficient after a period of service, showing that some other factor than purely mechanical removal, functions in the process.

The explanation of the improved action of a "ripened" filter is the formation of a certain amount of slimy sediment or coating around and among the sand grains, especially in the upper layers of the bed. When critically examined, this material is found to contain inorganic matter, as silt, of all kinds, organic substances, as bacteria, algae, diatoms, and material of a colloidal character. This deposit appears to be largely effective in retaining the minute particles and the colloids contained in the water. It is possible that the true explanation of this action will be found to lie in the electrical properties of colloids.

The Use of Coagulants.

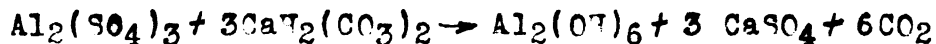
Various chemicals when added to water will combine with certain substances ordinarily present, forming precipitates

which are more or less gelatinous in character. These act as coagulants to collect the finely divided suspended matter into relatively large masses which are thus much more readily removed by sedimentation or filtration.

Color may also frequently be removed to a large extent by this treatment but its greatest use is in connection with the subsidence of turbid waters.

Several substances can be used as coagulants. That most commonly employed is sulphate of Aluminum, which, when introduced into water containing carbonates and bicarbonates of lime and magnesium, is decomposed, the sulphuric acid forming sulphates with the lime and magnesium, while the carbonic acid is set free, and the aluminum unites with the water to form a bulky gelat.-hydroxide.

This precipitates out and constitutes the coag. agent. The chemical reactions are shown by this formula:



The different units of the model are made with glass sides so that one may follow the path of the water from the time it enters until it leaves, and observe the action which takes place in each unit.

The six units in order in which they are used are as follows:

The clear well and sedimentation chamber. The coagulant feeder. The mixer. The coagulating basin. The sand filter, and the storage reservoir.

The clear well allows the coarser particles to settle out and also shows the condition of the water before entering the filter.

The coagulant feeder is an automatic arrangement which keeps a constant amount of Aluminum Sulphate emptying into the water as it enters the mixer.

The mixer is a long narrow channel with buffets arranged to thoroughly mix the coagulant with the water.

After the water leaves the mixer it enters the coagulating basin where it is allowed to stand with little or no movement. The precipitate begins to collect and settle out, entangling and carrying with it a large portion of the solids and bacteria suspended in the water.

The water then enters the filters where it percolates down through the different layers of sand which remove the remainder of the suspended matter.

The filtered water is then collected and run into the storage tank and the process is completed.

After a filter has been in use for a certain length of time it becomes less efficient due to the greater resistance offered to the passage of water through the heavily loaded sand layers. When this condition becomes apparent, shown by the increased loss of head, the filters should be washed. This is accomplished by reversing the flow of water through the filter. This wash water picks up and carries with it the sediment that has been collected by the sand beds and is carried off into the sewers.

The filter is then ready to operate again.

Construction Work.

All the tanks were made with forms of $\angle$ iron 1" x 1" x 1/8".
The bottoms were made of sheet iron and the sides of glass.
1/4" galvanized iron pipe was used throughout with rubber
connections.

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