REMOVAL OF MANGANESE FROM WATER SUPPLIES*

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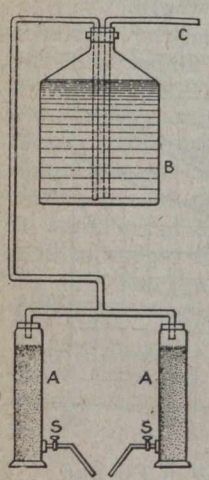
THREE practical methods for the removal of manganese from water have been developed—aeration and filtration through sand, filtration through permutit, and filtration through pyrolusite. The problem of removing manganese has been attacked by most workers in a manner similar to that of removing iron. The usual method for the removal of iron from water is by aeration followed by filtration through sand, and it is generally and successfully used in many plants in the United States and Europe. Iron occurs in most ground waters in the ferrous condition. When the water is aerated the iron is oxidized to the ferric condition and separates as the hydroxide. This combination of oxidation, hydrolysis, and precipitation is the basic principle of the method though the presence of other substances somewhat affects the results. The occurrence of manganese with iron in many waters and its separation as the hydrated dioxide under certain conditions have led to the assumption that the element in water has chemical properties practically similar to those of iron.



Experimental Sand Filters for the Removal of Manganese

Extensive experiments on removal of manganese by this method have been conducted by Thiesing, who worked with a water at Pommerensdorf, Germany. He has concluded that manganese occurring in water as the bicarbonate can be successfully removed by aeration and filtration. Trickling through beds of coke or spraying through nozzles were used as methods of aeration. The removal of carbon dioxide as well as solution of oxygen was found to be important in the process of aeration. Subsequent filtration through sand gave an effluent containing very little manganese; sedimentation effected little removal.

In the United States extensive experiments along similar lines have been conducted by R. S. Weston with several waters containing iron and manganese in Massachusetts. Mr. Weston's problems have dealt chiefly with the removal of iron. A well water containing 0.73 part per million of iron and 0.23 part per million of manganese was treated at Cohasset by being sprayed through nozzles followed by passage through a coke trickling filter and mechanical filters. Satisfactory results were obtained in the experiments and arrangements have been made for construction of a large plant. In experiments at Brookline sprinkling through nozzles followed by passage through a coke trickling filter and slow sand filters decreased the content of iron from 0.6 to 0.2 part per million. The content of manganese of the untreated water was 0.26 part per million; though Weston published no figures concerning the efficiency of the removal of manganese he stated that he found it roughly proportional to that of the removal of iron. A plant for removal of iron and manganese, which has been installed at Middleboro, treats 335,000 gallons of water a day. The water, after it has been sprayed over a coke trickling filter 10 feet deep, flows into a settling basin and through slow sand filters operating at a rate of 10,000,000 gallons per acre per day. The content of iron was decreased from 1.5 to 0.2 part per million and the content of manganese from 0.67 to 0.27 part per million during the first run from September 26th, 1913, to January 12th, 1914. The efficiency of the removal of manganese increased as the plant was operated longer, and the effluent on January 22nd contained 0.10 part per million of manganese.

Barbour performed a similar series of experiments on the well water supply of Lowell, Mass. The waters of the wells differ in content of manganese, the strongest containing 2.0 parts per million. Aeration. sedimentation and sand filtration were tried on an experimental scale. The efficiency of the plant was at first rather erratic, but it finally became possible to reduce the content of manganese to 0.01 part per million. A dark coloration due to precipitated oxides of manganese was observed in the sand bed, and this extended in diminishing amounts to the bottom of the bed. On the basis of this study a plant was erected at a cost of $180,000 for the removal of manganese and iron.

Practically all students of removal of manganese by aeration and filtration have concluded that manganese is much more difficult to remove than iron. The details of the process, such as the amount of aeration and the rate of filtration, differ with the character of the water.

Manganese permutit consists of a zeolite with which a layer of manganese dioxide is incorporated. When a manganese-bearing water is filtered through this medium the manganese is removed from the water by the formation of a lower oxide of manganese by reaction between the manganese in the water and the manganese dioxide in the permutit. At the same time the alkali or alkaline-earth of the silicate is replaced by the manganous compound of the water. The replacement is of minor importance, and the slight extent to which it takes place is dependent on the concentration of manganese in the water. Manganese is added to the permutit not only when manganese permutit is regenerated by potassium permanganate but also when manganese is removed from water by the regenerated permutit; therefore, the content of manganese dioxide increases and the filter medium approaches in composition pure manganese dioxide with each successive regeneration and reduction. As the zeolite can not increase in amount with successive reductions and regenerations the replacement effect must become less and less as the substance is used. These conclusions are in entire accord with that reached independently by Tillmans —that the action of manganese permutit is really the action of manganese dioxide.

Some preliminary experiments made by filtering an aerated artificially prepared manganese-bearing water through a small sand filter showed that no removal of manganese was effected. A mechanical filtration plant has been installed at Mount Vernon, Ill., however, for the purpose of removing manganese as well as effecting hygienic purification of a surface water, and analyses of the water some months after installation of the mechanical filters showed that manganese was being removed by this plant. Manganese is also removed in a filter plant at Anna. Ill., designed for hygienic purification of a surface-water supply. These results seemed contradictory to the negative results obtained on a small scale. Yet, as manganese dioxide had been used successfully for removal of

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