WATER ONLINE

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Factors Affecting Treatment Of Iron, Manganese And Hydrogen Sulfide With Chlorination And Manganese Dioxide

Source: Clean Water Systems & Stores, Inc.

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There are different treatment processes used to remove iron and manganese from groundwater for potable water supplies. While there are various less commonly used treatment methods available (such as ion exchange), most treatment systems for iron and manganese oxidize the ferrous soluble state of iron to a ferric state so the solid particles can then be filtered out.

This oxidation/filtration approach can be accomplished by completely oxidizing the iron and manganese to a soluble form and then filtering with a multi-media filter (typically sand and anthracite coal), or a catalytic oxidizing media (manganese dioxide).

The removal of iron and manganese from potable water supplies is affected by various chemical and physical characteristics of the water.

In order to filter out iron and manganese from groundwater it is important to realize that the removal process is affected by physical and chemical conditions existing in the untreated water supply. A good design depends on a complete water analysis and careful consideration of the process.

Important Factors Affecting Treatment Include:

Ammonia: Ammonia interferes with the oxidation process. Further complicating the treatment process when chlorination is used as the oxidant, ammonia in raw water interferes with the chlorine disinfection process and free chlorine residual maintenance in the distribution system.

This is due to the rapid reaction of ammonia with chlorine , which can affect the development of adequate CT values (disinfectant concentration multiplied by contact time) for the inactivation of microorganisms. The presence of as little as 1 mg/L of ammonia can raise the amount of oxidation residuals present by 8 to 10 mg/L.

Carbon Dioxide: Carbon dioxide lowers the pH of the water by forming carbonic acid. CO_2 levels can therefore reduce the rate of oxidation.

Hydrogen Sulfide (H_2S): H_2S is a pungent gas sometimes found in groundwater with iron and manganese. Water containing hydrogen sulfide has a strong “rotten-egg” odor. Besides causing tastes and odors, water with H_2S can be corrosive due to the formation of sulfuric acid.

Often sulfur reducing bacteria are also present which can cause slime and odor problems, even after the iron has been removed. H_2S is most common when the pH is less than 7.

Treatment methods for hydrogen sulfide is commonly aeration or oxidation with chlorine to elemental sulfur. Hydrogen sulfide can react with oxidants such as Cl_2, O_3 ClO_2 and H_2O_2 to form polysulfides and hydrogen polysulfide. These compounds cause the water to have a milky color. Proper oxidation of the sulfides in the treatment process is extremely important in the removal of iron and manganese.

Iron Bacteria: Iron bacteria (often the species Crenothrix and/or Callionella, reportedly some of the oldest organisms on Earth) occur naturally in groundwater and are widely present in soil and some surface waters. Wells can easily become contaminated with iron bacteria from the surface by well drilling tools and equipment and/or the infiltration of surface water.

Iron bacteria use ferrous iron as an energy source by oxidizing it to the insoluble ferric iron state. Iron is used in cellular walls and can cause red slimy deposits in well casings and distribution systems.

Iron bacteria is not harmful to health but can reduce well capacity as well as causing staining, tastes, and odor problems. Chlorine can rapidly destroy iron bacteria, but since these bacteria live in biofilms behind a gelatinous layer, care must be taken to penetrate the biofilm.

In some cases the water system may need repeated disinfection with chlorine in order to eliminate the problem. After the iron is removed, a chlorine residual in downstream distribution piping can prevent the re-growth of these bacteria.

Length in Minutes of Reaction: Contact or retention time, after the oxidants are introduced must be carefully considered, often after some pilot testing.

Usually a minimum of 4 minutes, up to 60 minutes is required for complete oxidation depending on conditions and water chemistry. Reactions occur faster at higher pH and slow down at lower pH ranges.

When using a catalytic filter media such as Pro-OX manganese dioxide, the contact time can be cut down to 30 seconds as the media itself is an oxidizer, and complete oxidation occurs on the media.

pH: Rates of oxidation are naturally slower at low pH values (less than 7.0, which is a neutral pH) and faster at higher pH levels.

Temperature: As in most chemical reactions, oxidation occurs more rapidly at higher temperatures and slow down when the water is cold.

Total Organic Carbon (TOC): Some groundwaters contain organic matter that is bound to the iron in a process known as chelation. This can interfere with the ability of the treatment process and additional levels of oxidants and longer contact times may be required as well other chemical additives needed besides oxidizers such as chlorine.

Pre-Treatment With Chlorine and Filtration with Pro-OX Manganese Dioxide Media

A fast and efficient method for removing iron, manganese, and hydrogen sulfide is to chlorinate the raw water, allow 30 to 60 second retention time and then filter with (Pro-OX) manganese dioxide filter media.

A level greater than 0.6 mg/l of oxidant (chlorine) can be injected into the storage tanks and distribution system to inhibit growth of iron and sulfur bacteria.

Water is received from the well source and treated with chlorine to oxidize the iron, manganese and sulfides present. The iron is oxidized to ferric iron. The manganese to the manganic form and sulfides are oxidized to sulfate.

Under some conditions, an additional step using sulfur dioxide can be fed into the water after chlorination, to prevent the formation of polysulfides.

Sulfate is common in water supplies and does not contribute objectionable taste or odor. A sufficient amount of chlorine is added to the water to meet the chemical demand and reach the chlorine breakpoint. A higher residual may be injected depending on conditions.

Using Aeration Alone and Traditional Filter Media

Oxidation of iron and manganese with air can be a cost-effective method since there is no related costs of chemicals and injection systems, however there can be some drawbacks.

The oxidation process with aeration can be much slower and the contact tank required needs to be larger, especially if there are high concentrations of manganese present.

Filter rates (how fast the water can flow through the filter media) are much higher for oxidation/filtration with manganese dioxide media (up to 15 gallons per minute per square foot of filter area), as compared to aeration and filtration with traditional multi-media filters (which often require 3 to 5 GPM per square foot of filter area.

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