Manganese Treatment Methods

Treatment of manganese can be achieved through different methods ranging from manganese sequestering to physical removal, or through the use of processes such as: pressure filtration, membranes, biological filtration and ion exchange. The exact process that is the best fit depends on raw water quality, treatment goals, site size, operator availability, capital costs, and operations and maintenance costs.

Sequestering

Many water systems manage manganese levels through sequestering. Sequestering binds manganese in water to prevent oxidizing on contact with air or chlorine and helps prevent staining of fixtures. However, sequestering is only effective for manganese up to about 0.1 mg/L. Sequestering is ineffective at higher temperatures in hot water tanks, and the manganese will fall out of the solution becoming a nuisance to water customers. Additionally, during sequestering, manganese is not removed, so the potential health impacts remain.

Pressure Filtration

Pressure filtration involves the use of oxidative and/or adsorptive type media for manganese removal. Many systems utilize Manganese Greensand or GreensandPlus coupled with anthracite. There are several proprietary products that may be used in lieu of Greensand, which may be able to provide the needed treatment at higher hydraulic loading rates. Pilot testing of whichever process is under consideration is recommended to verify that the process will successfully treat the water, identify loading rates, run times and chemical dosages.

Typical Vertical Pressure Filter

Depending on the type of media used, chlorine or potassium permanganate are commonly used pre-treatment for oxidation and/or adsorption of manganese and regeneration of the media. It may be necessary to adjust the pH to attain optimum treatment, depending on the quality of the raw water.

Pressure filters may be vertical or horizontal configurations, allowing for customization depending on space available and additional factors such as backwash hydraulics and if future vessels may be needed. Pressure filters also allow for the design of a pump-thru system eliminating the need for a clearwell and the associated finished water pumps.

Membranes

Membranes are another method for removal of manganese, capable of treating waters with higher manganese levels than conventional pressure filtration may be able to achieve. Membranes used for manganese removal include immersed membranes and pressure cartridges. The immersed membranes are low energy and open-to-atmosphere. Pressure cartridges allow for a smaller footprint than the immersed type, but require additional pumping. Both require the use of a clearwell, pump-thru is not an option since the immersed membranes are open-to-atmosphere and the pressure cartridges must be protected from system hydraulics.

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Typical Pressure Cartridge Membrane

A chlorine residual will need to be maintained into the distribution system, since the water will come into contact with air during treatment. Membranes require frequent flushing and cleaning, with several chemicals not necessarily needed for treatment, but needed to keep the membranes performing at design levels. Additionally, the flushed and cleaning water needs to be neutralized prior to disposal.

There are several membrane pore sizes available including microfiltration, ultrafiltration, nanofiltration and reverse osmosis. The exact pore size membrane needed is a factor of the water quality and desired treatment levels. Microfiltration is not typically granted much log virus removal since the pore size is too large relative to the virus size. Ultrafiltration, nanofiltration and reverse osmosis membranes may provide some virus log credit removal relative to the Groundwater Rule. Some states allow up to 4 log virus removal, depending on the pore size of the membrane, but become more expensive to purchase and operate. A challenge or demonstration test may be needed to determine the exact log credit removal achievable for the selected membrane, depending on state requirements.

Biological Filtration

Biological filtration is a relatively new technology as compared with conventional pressure filtration. From the exterior, this process looks similar to pressure filtration. Treatment inside the vessel relies on manganese consuming bacteria supported by specialized filter media and the manganese within the water supply. This process is capable of removing higher levels of manganese at higher loading rates, allowing for a smaller process footprint. The only chemical needed is for pH adjustment to optimum levels required to support the biological life of the manganese consuming bacteria. Post-filter disinfection is required. This process also requires a fairly constant operation; brief shutdowns may be performed, such as overnight. Extended shutdowns will require re-establishment of biological life.

Ion Exchange

Typical Ion Exchange Cylinder System

Ion exchange is a treatment process that operates through exchange of ions in water with ions from an insoluble, permanent, solid resin bed. The resin media selected is dependent on the contaminant to be removed. Media beds are either positively or negatively charged to provide cation or anion exchange. Over time as water flows through the resin bed, the media becomes exhausted and must be regenerated on or off site or disposed of. Ion exchange can treat moderate levels of manganese, but can become fouled by higher levels. Ion exchange requires minimal operator attention and no backwashing. A smaller footprint may be possible, as compared with conventional pressure filtration. Ion exchange has high resin replacement costs making it inefficient for larger facilities; however, this process may be economical for a very small facility due to the low labor

costs. An evaluation would be needed to compare the capital, operation and maintenance costs, including labor and the cost to replace the resin.

Pre-Treatment Processes

A pre-treatment clarification process may be needed in cases of extremely high manganese to prevent premature fouling of the primary facility process.

Summary

Selection of the exact process to meet your manganese treatment needs should be done after careful consideration of the advantages and disadvantages of each method. First identify your goals. What are you hoping to achieve and is manganese removal necessary? Once you have decided treatment is needed, complete a treatment feasibility study. Compare processes through evaluating ability to treat, needed operator attention, capital, operation and maintenance costs. Complete pilot testing of processes prior to committing to one process to make sure it is the best fit for your system. Our engineers have experience in working with water system suppliers on the manganese issue. CEI can work with you to determine which technology is the right fit for your system.

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