CLEMSON EXTENSION

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WATER QUALITY

Iron and Manganese

Iron and manganese are frequently present in domestic water supplies. In well waters, the insoluble iron oxide is converted to the soluble form of ferrous (dissolved) iron. Ferrous iron is colorless in solution, but when it comes in contact with air, it oxidizes readily creating reddish brown, solid particles which are then precipitated as ferric oxide (particles). High concentrations of iron or manganese will cause staining of laundry and porcelain fixtures, and deposits in pipes, tanks and water heaters. In addition, iron may give the water a metallic taste making it unpleasant to drink. Iron bacteria, while considered harmless to health, can be very objectionable, causing slime and staining.

EFFECTS

Presence of iron and manganese in water is not a health problem. In fact, small concentrations are essential to human health. High concentrations do, however, interfere with the appearance and use of the water.

Iron bacteria are living organisms that feed on iron in the water and on iron in pumps, pipes, well casings, tanks and fixtures. They also build slimes in toilet tanks and water heaters, clogging pipes and pumps. They grow either in the presence of light or darkness.

Manganese acts in a similar manner as iron, but forms a brownish-black precipitate. Manganese is rarely found alone in a water source but is generally found with dissolved iron. However, either iron or manganese can each be found in excessive amounts. Manganese reduction and removal is commonly accomplished by the same techniques as for iron removal.

TESTING

The four forms of iron commonly found in drinking water are ferrous, ferric, organic and iron bacteria. When ferrous iron is exposed to air, it turns into ferric iron, which forms a precipitate. Water appears clear when first drawn at the cold water faucet. If the water isn't clear when first drawn, it probably contains ferric iron. Organic iron may give the water color, but does not precipitate or settle out.

A chemical analysis of water should be obtained which will show the type and concentration of iron and manganese present. The decision of which treatment method is best should be made only after careful consideration of many factors. Factors to consider include economics, water quality characteristics, the end use of the water, temperature variances of water to be treated and the limitations of the available treatment technology.

TREATMENT

There are several treatment methods for removing various forms of iron and manganese from home water supplies.

POLYPHOSPHATE FEEDER AND OTHER SOLUTIONS

This device is quite effective and economical if the dissolved iron content is not over 0.3 to 1.0 mg/l. It feeds polyphosphates into the water supply. These chemicals do not remove the iron but literally wrap themselves around it and prevent the iron in solution from causing stains. The advantage of this treatment is its simplicity and low cost. But it won't

take care of iron in its precipitated form. It must be used between the deep well pump and storage tank, before the water is exposed to air. The iron is stabilized in its dissolved form and the water remains clear. The addition of the polyphosphate chemical isn't harmful for drinking purposes. As the phosphate material is depleted a new supply is added.

The oxidation of dissolved iron or manganese in a water source may also be accomplished by feeding solutions of chemical oxidizing agents like chlorine bleach, potassium permanganate or hydrogen peroxide into the water. Small chemical feed pumps, which are electrically wired to operate when the well pump comes on, are used for this method of treatment.

WATER SOFTENER

Some types of water softeners will remove up to 10 mg/l of iron if it is in the ferrous form, at the same time as it removes hardness. However, a softener used to remove iron will eventually become fouled and lose its ability to soften. When this occurs, the softening medium must be replaced or cleaned with an acid bath.

Water softeners treat hard water by adding sodium to the water, a health concern for people on sodium-restricted diets. For this reason, the softener may be connected only to the hot water line leaving cold, unsoftened water for cooking and drinking. In iron/manganese removal, the softener must treat both hot and cold water since sinks and toilet tanks are affected. A separate tap can be installed to provide unsoftened water for cooking and drinking.

Not all water softeners are able to remove iron/manganese from water. The manufacturer's specifications indicate whether or not the equipment is appropriate for iron/manganese removal.

AERATION

Dissolved iron or manganese is easily oxidized to a solid form by aeration (mixing with air). Home water treatment systems use a pressure aerator in which an aspirator mixes air with water from the well. The air is vented, and solid iron or manganese particles are filtered from the water. This method adds no chemicals to the water but is most effective in warm climates. The filter must be backwashed frequently to properly maintain the system. To protect the water from contamination by bacteria in the air, the system should be totally enclosed and only biologically safe water should be used. The appropriate pumping capacity must be maintained for adequate air intake.

An efficient aerator/precipitator/filter removes up to 25 mg/l dissolved iron. Manganese oxidation is slower than that for iron and requires greater quantities of oxygen. Aeration is not recommended for organic complexes containing iron/manganese or water containing iron/manganese bacteria that clog the aspirator and the filter.

OXIDIZING CATALYST FILTER

This iron removal filter contains manganese greensand zeolite, an oxidizing agent which converts soluble ferrous iron to ferric red rust, which is then filtered out. This unit can do a satisfactory job when properly operated, provided the concentration of iron does not exceed about 10 mg/l. The flow of water must be periodically reversed through the tank to wash the accumulation of iron/manganese out of the bed. The manganese oxide surface of the filter has the ability to attract, or absorb, ferrous (dissolved) iron and/or manganese. Potassium permanganate must be added to regenerate the oxidizing material.

Manganese coated media for catalyst/filtration products are very pH sensitive and a 7.O pH in the incoming water is necessary. The most effective iron removal results with catalyst/filter media will be obtained where the inlet water has been adjusted to 7.5 pH or above. For the most efficient manganese reduction, a pH of 8.5 is recommended. If laundry bleach is used for washing and the pH of the water is less than 6.8, the manganese given to the water by the filter may stain the clothes just as iron does. A calcite media filter will raise the pH level to 7.0 or better. A disadvantage of this method is that a flow rate of three or four times the usage rate is required to backwash. This rate is not usually available in a

homewater system, but a local dealer may provide this service. One solution to this problem is the installation of two smaller tanks and backwashing each separately.

SUPERCHLORINATION - DECHLORINATION

A chlorinator or metering device is used to feed small amounts of chlorine into the water. A 5.25 percent sodium hypochlorite solution (readily available as laundry bleach at most supermarkets) is usually used as a source of supply. The chlorine chemically oxidizes the iron or manganese (forming a precipitate) and kills iron bacteria. A fine filter then removes the iron or manganese precipitates. This method is probably the most dependable one for removing excessive amounts of iron (up to 50 mg/l). Make sure the system is tested for trihalomethanes (chloroform) as the chlorination process is known to create this potentially harmful organic chemical in municipal drinking water systems.

TREATMENT OF IRON AND MANGANESE IN HOUSEHOLD WATER

Symptom	Cause	Treatment
Water clear when drawn but red-brown or black particles appear as water stands; red-brown or black stains on fixtures or laundry	Dissolved iron or manganese	Water softener (<5 mg/l iron Aeration (<25 mg/l iron) Manganese greensand (Oxidizing catalyst filter)(<15 mg/l iron + manganese) Superchlorination/ filtration (>10 mg/l) iron Polyphosphate feeder (not in areas with phosphate ban) (<3 mg/l iron)
Water contains red-brown particles when drawn; particles settle out as water stands	Iron particles from corrosion of pipes and equipment	Raise pH with neutralizing filter that also filters particles
Water contains red-brown or black particles when drawn; particles settle out as water stands	Oxidized iron/manganese due to exposure of water to air prior to tap	Particle filter (if quantity of oxidized material is high, use larger filter than inline; e.g., sand filter)
Red-brown or black slime appearing in toilet tank or from faucet	Iron bacteria Manganese bacteria	Kill bacteria masses by shock treatment chlorine potassium permanganate, then filter; may require continuous feed of chlorine or potassium permanganate, then filter
Reddish or black color that remains after 24 hours	Colloidal iron/manganese; Organic-complexed iron/ manganese	Superchlorination