Iron, manganese and related bacteria

Iron and manganese are part of the "troublesome trio" in water purification. Sulfate, as host for sulfate-reducing bacteria that create hydrogen sulfide gas, is the third member of this triumvirate. These water constituents share the following attributes: highly annoying, difficult to treat, and unregulated even in public water systems. All three are listed on the EPA's secondary standards, the non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects (such as taste, odor, or color).

Iron and manganese are common minerals found in the earth's crust and can be dissolved as water percolates through rocks and soils. Iron in municipal water may come from iron transmission pipes. Iron and manganese are much bigger potential problems in wells, but municipal water that has iron levels above the EPA's secondary (voluntary) level of 300 parts per billion, or 0.3 milligrams per liter, may not be pleasing to drink even though it may actually be safe. Noticeable effects include a metallic odor and/or taste and staining of plumbing fixtures.

Municipal water may be "rusty," depending on the type of pipes coming into a building, where the site is located on the water-distribution grid, and the system-wide demand for water. Municipal water systems commonly flush out water lines to remove insoluble iron and sediment deposited in the lines.

Iron and manganese do not pose any well-documented adverse health risks at the levels commonly present in groundwater, but there are some growing concerns with manganese in particular. The chemical forms of iron in water are not readily absorbed by the body.

Ferrous iron is colorless; but when it makes contact with air, it oxidizes readily, creating reddish-brown, solid particles that settle out as ferric oxide. Manganese is similar to iron but forms a brownish-black precipitate and stains. Manganese is less commonly found in groundwater than iron, rarely found alone in a water source, and generally found with dissolved iron. Iron and manganese are chemically similar and cause similar problems, with the most severe problem being staining. Soaps and detergents are not effective in removing iron and manganese stains, and the use of chlorine bleach and alkaline builders such as sodium carbonate may actually intensify staining.

Non-pathogenic bacteria may feed on iron or manganese in water and can cause a jelly-like slime, either reddish-brown (iron) or blackish-brown (manganese). The term "iron bacteria" is collectively used to describe a group of autotrophic bacteria that derive their carbon from CO_2 and consume (oxidize) and dissolve the clear-water forms of iron and manganese into an insoluble form and deposit it in the slimy, gelatinous material that surrounds their cells. These bacterial accumulations are often detected in toilet tanks.

Several types of bacteria are known to feed upon iron and manganese as part of their normal metabolic process and can do so in the presence or absence of light. This biofouling can cause discoloration of water, corrosion of metal water-system components, and can create an unpleasant odor and cause clogging when colonies break away from surfaces where they have accumulated.

The most common origin of iron bacteria in wells is entry during well drilling or pump installation. They may be present in pumps, pipes and well casing. A well with confirmed iron bacteria should be shock-chlorinated. Chlorination with a diluted solution of 5.25 percent sodium hypochlorite (common household bleach) is the most common disinfection method. Before a domestic well is put into service, it should be disinfected to remove all types of bacteria, including iron bacteria.

The best way to reduce iron, manganese and related bacteria is to determine the water chemistry of the source water with a comprehensive lab test. The critical factors for iron and manganese removal are the concentrations of these constituents, pH (acidity/alkalinity), hardness, dissolved oxygen level, and conductivity of the water.

Iron and manganese reduction are accomplished by the same methods and the most common techniques include sequestering chemicals (such as polyphosphates; for "clear water" forms only), ion exchange (water softening), chemical oxidation (chlorination/filtration), oxidizing filters (greensand or zeolite), venturi aeration, ozonation, and physical filtration. There is no independent verification that magnetic/electronic iron and manganese removal devices are effective. Carbon filtration is ineffective.

Forms of Iron, Manganese	Common Description
Ferrous iron	Dissolved or clear-water iron
Ferric iron	Particulate or insoluble red-water iron
Colloidal iron	Ferric iron in suspension
Bacterial iron	Iron befouling or slime
Organic iron	Iron combined with dissolved organics
Manganous manganese	Dissolved or clear-water manganese
Manganic manganese	Particulate or insoluble manganese

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Reverse osmosis will remove iron and manganese, but it is only effective if the proper pre-treatment additives are used.

The most promising new solution for iron, manganese and sulfate reduction is the dissolved oxygen generator, which provides total reduction by electrolytically producing oxygen from the water itself, and which offers great advantages over conventional oxidation or chemical additives. Oxygen generators (titanium plates) produce microbubbles of pure oxygen. The oxygen microbubbles react with dissolved iron and manganese and convert them into filterable forms. The device works on a real-time basis, and no retention time is needed. The oxygen bubbles created are 400 times smaller than standard aeration bubbles. To filter out the oxidized particles created in this process, the system is followed with any one of a variety of filtration systems. Dissolved-oxygen generation is the greenest technology known for removing iron and manganese, as well as hydrogen sulfide odor.

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A short glossary of regional building terms

adobe: sun-dried earthen bricks; and houses made of adobe bricks

arroyo: gully, dry wash

banco: simple adobe bench built at base of interior wall

canales: drainspouts extending out from parapet of flat roof, designed to protect adobe wall from water

corbel: scroll-shaped wood bracket used to support a viga

latilla: juniper or alder branches employed above vigas in ceilings, and used for coyote fences

nicho: niche in interior adobe wall used for storage and display

Northern New Mexico style: Spanish-Pueblo-style house with pitched tin roof and long portál

portál: porch, sometimes with roof supported by vigas projecting from house, the outside beams supported by posts.

Spanish-Pueblo Revival style: House having walls of earth-colored adobe (or facsimile), flat roof with canales, vigas projecting from exterior walls; typically one story.

Territorial Revival style: Pueblo style modified with brick coping around roofline, milled-woodwork details such as pedimented lintels on window frames, and square portal posts.

viga: debarked log used as ceiling beam