Iron

Iron is one of the most plentiful resources and accounts for 5 percent of the Earth's crust. As rainwater infiltrates the soil and underlying geologic formations it dissolves iron, causing it to seep into aquifers that serve as sources of groundwater for wells. Iron can be a troublesome chemical in water supplies. Iron is mainly present in water in two forms: either the soluble ferrous iron or the insoluble ferric iron. Soluble ferrous iron is found in groundwater, in anaerobic reservoirs, in dead-ends in water distribution systems, and in scale (hard mineral coatings) within pipes. Water containing ferrous iron is clear and colorless because the iron is completely dissolved. When soluble ferrous iron is exposed to oxygen or to a disinfectant during water treatment, it oxidizes, causing to the water to turn cloudy and forming a reddish brown substance (insoluble ferric iron). Iron in groundwater, is often associated with other metals, such as manganese and arsenic.

Iron can combine with different naturally occurring organic acids, known as tannins. Tannins are natural organics produced by vegetation and can stain water a tea-color. In fact, the tannins in coffee or tea produce the brown color. When tea or coffee is made with water containing iron, the tannins react with the iron forming a black residue. Organic iron is a compound formed from an organic acid and iron. Organic iron and tannins are more frequently found in shallow wells, or wells under the influence of surface water.

The primary sources of iron in drinking water are natural geologic sources as well as aging and corroding distribution systems and household pipes. Iron-based materials, such as cast iron and galvanized steel, have been widely used in our water distribution systems and household plumbing.

Iron Bacteria

Iron bacteria are organisms that consume iron to survive and, in the process, produce deposits of iron, and a reddish-brown or yellow slime called a "biofilm." Iron bacteria are not harmful to humans, but can make an iron problem much worse. The slime can clog plumbing and cause an offensive odor. This slime or sludge is noticeable in the toilet tank when the lid is removed. Iron bacteria naturally occur in shallow soils and groundwater, and they may be introduced into a well or water system when it is constructed or repaired.

What are the Drinking Water Standards?

The US EPA has set a secondary maximum contaminant level (MCL) standard of 0.3 mg/L or 0.3 ppm (parts per million) iron in drinking water. Changes in taste, odor, and color may be evident when levels are greater than 0.3 ppm.

The Ohio Department of Health has adopted this standard as a non-enforceable health-based standard for private water systems.

What are the Health Effects?

Ingesting iron from drinking water is not directly associated with adverse health effects; although, trace impurities and microorganisms that are absorbed by iron solids may pose health concerns. Iron is considered a secondary or aesthetic contaminant. Iron is an essential mineral for human health in small concentrations (iron deficiency can lead to anemia).

Iron bacteria, that may be associated with iron in water, are not a health problem. Iron may present some concern if certain bacteria have entered a well, since some pathogenic (harmful) organisms require iron to grow, and the presence of iron particles makes elimination of the bacteria more difficult.

The effects associated with iron contamination can be grouped into two categories:

- **Aesthetic effects** are undesirable tastes or odors. Iron in quantities greater than 0.3 milligrams per liter (mg/L) in drinking water can cause an unpleasant metallic taste and rusty color. Taste is a useful indicator of water quality even though taste-free water is not necessarily safe to drink. Taste is also an indicator of the effectiveness of different kinds of treatments that effectively remove iron from drinking water, such as water softening or reverse osmosis treatment systems. Elevated levels of iron in drinking water can also cause a rusty color that can stain laundry or household. Discolored water is one of the most frequent consumer complaints about drinking water.
- **Physical effects** are damages to water equipment and reduced effectiveness of treatment for other contaminants that may present added costs to operations for water utilities. Corrosivity and staining related to corrosion not only affect the aesthetic quality of water, but may also result in distribution system problems. Among other things, corrosion of distribution system pipes can produce sediment or loose deposits that block water flow.

What are the Treatment Options?

Treatment of water containing iron depends on the form(s) of the iron present, the chemistry of the water, and the type of well and water system.

- **Clear-water iron** is most commonly removed with a water softener. Manufacturers report that some units are capable of removing up to 10 mg/L, however 2 to 5 mg/L is a more common limit. A water softener is actually designed to remove hardness minerals like calcium and magnesium. Iron will plug the softener, and must be periodically removed from the softener resin by backwashing. Also, if the water hardness is low and the iron content high, or if the water system allows contact with air, such as occurs in an air-charged “galvanized” pressure tank, a softener will not work well.
- **Red-water iron** can be removed in small quantities by a sediment filter, carbon filter, or water softener, but the treatment system will very quickly plug up. A more common treatment for red-water iron and clear-water iron in concentrations up to 10 or 15 mg/L is a manganese greensand filter, often referred to as an “iron filter.” Aeration (injecting air) or chemical oxidation (usually adding chlorine in the form of calcium or sodium hypochlorite) followed by filtration are options if iron levels exceed 10 mg/L.
- **Organic iron and tannins** present special water treatment challenges. Organic iron and tannins can slow or prevent iron oxidation, so water softeners, aeration systems, and iron filters may not work well. Chemical oxidation followed by filtration may be an option.
- **Treatment options for elimination or reduction of iron bacteria** include physical cleaning of the well followed by chemical disinfection, heat, and chemical treatment. The most common treatment is chlorination of the well and water system, however, this treatment option is often only temporary because the "slime" generated by iron bacteria

provide protection to the bacteria and regrowth occurs in the borehole. Studies have shown that chlorination may also stimulate regrowth of the bacteria that are not killed as a defense mechanism. Professional cleaning of the well by a knowledgeable, registered private water system contractor is recommended. Iron bacteria need iron to survive. Eliminating the bacteria will not eliminate the iron - both well treatment for the bacteria, and water treatment for the iron will be needed.

References and Additional Resources

- US EPA – Iron (http://www.epa.gov/nrmrl/wswrd/cr/corr_res_iron.html)
- Water Resources Council wellcare® information for you about Iron (http://www.watersystemscouncil.org/VAiWebDocs/WSCDocs/1534665INSERT_7C.PDF)
- Minnesota Department of Health - Well Management Iron in Well Water (http://www.health.state.mn.us/divs/eh/wells/waterquality/iron.html)
- Minnesota Department of Health - Well Management Iron Bacteria in Well Water (http://www.health.state.mn.us/divs/eh/wells/waterquality/ironbacteria.html)
- Illinois Department of Health Environmental Fact Sheet – Iron in Drinking Water (http://www.idph.state.il.us/envhealth/factsheets/ironFS.htm)

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