Iron (Fe) and Manganese (Mn) in Groundwater

Iron (Fe) and Manganese (Mn) are metals that occur naturally in soils, rocks and minerals. In the aquifer, groundwater comes in contact with these solid materials dissolving them, releasing their constituents, including Fe and Mn, to the water. At concentrations approaching 0.3 mg/L Fe and 0.05 mg/L Mn, the water's usefulness may become seriously impacted, e.g., there may be a metallic taste to the water and staining of plumbing fixtures may become common. At these concentrations, however, the health risk of dissolved Fe and Mn in drinking water is insignificant.

The extent to which Fe and Mn dissolve in groundwater depends on the amount of oxygen in the water and, to a lesser extent, upon its degree of acidity, i.e., its pH. Iron, for example, can occur in two forms: as Fe^{2+} and as Fe^{3+}. When levels of dissolved oxygen in groundwater are greater than 1-2 mg/L, iron occurs as Fe^{3+}, while at lower dissolved oxygen levels, the iron occurs as Fe^{2+}. Although Fe^{2+} is very soluble, Fe^{3+} will not dissolve appreciably.

If the groundwater is oxygen poor, iron (and manganese) will dissolve more readily, particularly if the pH of the water is on the low side (slightly more acidic). Dissolved oxygen content is typically low in deep aquifers, particularly if the aquifer contains organic matter. Decomposition of the organic matter depletes the oxygen in the water and the iron dissolves as Fe^{2+}. Under these conditions, the dissolved iron is often accompanied by dissolved manganese or hydrogen sulfide (rotten egg smell). When this water is pumped to the surface, the dissolved iron reacts with the oxygen in the atmosphere, changes to Fe^{3+} (i.e., is oxidized) and forms rust-colored

iron minerals. Dissolved manganese may form blackish particulates in the water and cause similar colored stains on fixtures.

Treatment for dissolved iron and manganese takes advantage of the natural process of oxidation, through the use of aeration, i.e., injecting air into the water prior to the tap to precipitate iron and manganese from the water. Chlorine is also an effective oxidizer and will cause iron and manganese to precipitate, plus it provides protection from microbial contaminants. Usually a physical filter follows the treatment so that the particles will not exit through the tap. Additional treatment methods include greensand filters and water softeners. Local suppliers of water treatment devices should be consulted in order to select the best system for a given water supply.

The amount of dissolved iron and manganese in groundwater may vary seasonally for a given well. Usually this is associated with an influx of oxygenated water from the surface during periods of high recharge. This oxygenated water will prevent the iron and manganese from dissolving and the water pumped from the well will have low concentrations of these metals. After the oxygen in the recharge water has been consumed, iron and manganese will again be dissolved and the water will have dissolved iron and manganese characteristics.

A final note is that even though treating the water for dissolved iron after it leaves the well will make the water more palatable, high concentrations of dissolved iron within the well bore may lead to growth of iron bacteria. These bacteria may coat the inside of the casing or any other submerged part of the plumbing in the well and may cause problems. In areas where elevated iron is common, it may be worth while to periodically disinfect the well to keep iron bacterial growth in check.