By Ed Maas, Hellenbrand, Inc.

Iron in Your Water Supply

Iron is one of the most troubling contaminants we deal with in traditional water treatment. It can be simple to deal with or very complex.

Where Does Iron Come From?

First let's review the fundamentals of our water supply. Most of our water used for domestic, commercial or industrial uses comes from either surface water or ground water. Typical surface water supplies are void of iron. The majority of our water supplies is ground water from wells that may be less than 100 feet deep to thousands of feet deep. The water we use today is the same water that has been here since the beginning of time. Water continuously travels through the hydrologic cycle. The hydrologic cycle is nature's way of purifying water by evaporating surface water from the earth. As it reaches high levels in the atmosphere it condenses, forming clouds that eventually become so saturated that the moisture falls back to the Earth in the form of rain, snow, hail or fog. As this moisture falls on the surface of the Earth, some of it soaks into the ground, and some of it runs off to streams, rivers and oceans.

The water that soaks into the earth percolates through the upper layers of the geological strata and eventually recollects in porous ground strata known as zones of saturation. Wells are drilled into the Earth until they reach these zones. More than 5 percent of the Earth's upper geological layers contain iron. Water is known to be the universal solvent, it dissolves a little bit of everything it touches. As water percolates through the Earth, it dissolves minerals that are in the soil such as iron, manganese, calcium and magnesium just to name a few. Because the geology of the Earth varies from one region to another, so does ground water. Ground water supplies may have a little iron or extremely high amounts of iron. It may be naturally soft or so hard that it is virtually unusable for domestic purposes. It may be acidic or very alkaline. Out of all of these variables, which are a direct result of the geology of any particular region, iron can be the most troublesome for water use. Iron is considered to be one of the most unstable minerals in our ground water supply.

As water percolates through the ground strata it dissolves the iron from the iron ore deposits as ferrous bicarbonate [$Fe(HCO_3)_2$], sometimes referred to as "clear water iron." When iron is dissolved in water you cannot see it. Iron normally wants to revert back to its natural state as iron ore. Iron very easily comes out of solution and precipitates to a solid particle of ferric hydroxide [$Fe(OH)_3$] often referred to as "red water iron." Simple changes to the water supply such as temperature, pressure or even a change of pH can promote the change from clear water iron to red water iron. The addition of oxygen to a water supply may easily casue this conversion. Generally speaking, the higher the pH, the faster this reaction can take place. Iron will precipitate to a solid particle much faster at a pH of 8 than at a pH of 6. Thus, the pH of the water supply has a major impact on iron precipitation.

Iron's Effects

The effects of iron in a water supply are numerous. Iron will stain fixtures, water-using appliances or surfaces that the iron-laden water contacts. These stains may vary from a light yellow to a red or light brown color. Iron can give water a metallic taste that may be considered unpalatable. Iron may provide odors that are undesirable for domestic use. Iron can foul water softeners and water-using appliances, and it can plug water pipes or heat exchangers. While none of these effects are hazardous to humans, water processing or the environment, they cause consumers to spend hundreds and even thousands of dollars to clean and maintain appliances, homes and factories every year. In the process of cleaning and maintaining our homes or factories, we quite often use cleaning solutions that may be toxic or hazardous to people and the environment, and all at a substantial expense. In most instances, it is more practical and economical to remove the iron from the water supply before we use it than to deal with the effects of clear and red water iron.

Iron Types

Successful reduction of iron starts with proper identification of iron and other water characteristics that may affect the iron reduction process. Proper testing and analysis of a water supply accomplishes this. At minimum, a water supply should be tested for total hardness, total dissolved solids, pH, alkalinity, iron, manganese, tannins and iron bacteria. Often times iron or iron-related symptoms are misdiagnosed and the wrong equipment may be applied. When this happens, typically the equipment only will work for a short period of time if at all, and then it may become fouled with iron. Most iron-reducing processes are designed to reduce either clear water iron or red water iron. Let's identify other types of iron that may cause typical symptoms associated with iron.

- **Sequestered iron** is only found in municipal water supplies. A sequestering agent has been added to the water supply while the iron is in the ferrous state (dissolved or clear water) with the intent to keep the iron in the clear water state. By encapsulating the iron ion with a sequestering agent, you prevent the oxidation or conversion of the iron to the ferric (red water) state. Unfortunately, many sequestering agents break down before water passes though homes and factories as it was intended. It also should be noted that sequestering agents prevent successful reduction of iron through most iron-reducing systems.

- **Heme iron**, as it is sometimes referred to, is iron that has formed a compound with organics that are in a water supply. This compound does not react to traditional iron-reducing technologies and typically passes through these systems. Often, additional technologies will be needed to remove the organics from the water supply to achieve acceptable iron reduction.

- **Iron bacteria** probably is the most often misdiagnosed iron-related problem in our water supply systems. Many times an iron reduction system may be employed that actually will help these nuisance bacteria to grow and exacerbate the iron problem for the consumer. Iron bacteria are live

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organisms that require oxygen as well as a food source (iron) to thrive and grow. While iron bacteria is not harmful to humans or animals regarding consumption, its presence and growth in a water supply system can plug water pumps, pipes and water treatment equipment. That will cause loss of water pressure as well as the typical symptoms of staining, foul tastes and odors. Chlorination is the best known technology available to address iron bacteria. Iron bacteria should be controlled upstream of iron reduction equipment.

Iron Reduction

Iron reduction can be simple once you properly identify the type of iron in a water supply and have a good understanding of the water characteristics. There are two basic technologies that are employed for iron reduction: ion exchange and oxidation/filtration.

Ion Exchange. Ferrous iron is a cation that in limited amounts easily can be removed with an ion exchange process (water softener). As a general guideline, many manufacturers will recommend a limit not to exceed 2 to 5 parts per million of clear water iron (ferrous bicarbonate). Because variables in the water supply and the application have an impact on the success of the ion exchange process, it is best to consult with a professional water treatment dealer in your region to determine if the ion exchange process will work for your application.

Oxidation/filtration typically is employed where the iron levels are high, (greater than 2 to 5 parts per million) or the pH may be high (greater than 8) even when the iron level may be minimal. This process introduces oxygen to the water supply to convert the clear water iron (ferrous bicarbonate) to red water iron (ferric hydroxide). Once the iron is converted to a solid particle, simple filtration will remove it from the water supply. Today, an automatic backwashing filter generally is chosen to filter out the precipitated iron particles. It is important to make sure the filter is backwashed on a regular schedule to prevent the filter bed from becoming fouled. Many manufacturers recommend that intervals between backwash cycles never exceed three days, and more frequent backwashing is recommended in many applications. Backwash intervals are based on specific water supplies, applications and daily usage.

When iron reduction is required, consult with a local professional water treatment dealer to obtain advice on which technology may best fit your application. WQP

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