For more information, contact Fairmont Veterinary Clinic or Dr. Stone.

Decoding Iron and Manganese in Drinking Water

By Jake Anderson, Water Quality Manager, MWI Animal Health Technical Services

Iron (Fe) and manganese (Mn) are two of the most common metallic elements in the crust of the earth, and are present at some level in most U.S. farm well water sources. The concentrations and impact of iron and manganese in well water can be influenced by a multitude of factors, ranging from geographical location of an aquifer to the unique total chemistry of the water itself. If iron and manganese in the source water are not properly addressed, this can lead to problems for swine production from both a mechanical (water flow volume, scale and clogging, evaporative cool pads) and biological (gut health and absorption, pathogens, biofilms, nutritional interaction with nutrients) perspective.

Understanding iron and manganese in barn drinking water

The solubility, or the ability to remain dispersed in solution, of iron and manganese in water is heavily influenced by the pH and the concentration of dissolved oxygen or other oxidants throughout the water well and barn pumping system. The lower the pH (acidity) and the lower the dissolved oxygen concentration, the greater the solubility. Iron in water predominantly exists in two cationic, or "plus charged," oxidation states: iron (II) and iron (III). Iron $^{2+}$ (II) is called ferrous and it is soluble and iron $^{3+}$ (III) is called ferric and it is insoluble. Manganese similarly commonly exits in two oxidation states: the soluble Mn^{2+} (II) and the insoluble Mn^{4+} (IV).

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Iron and manganese in the water system can pose problems for both a maintenance and health or nutrition challenge. Once inside the water system and exposed to higher concentrations of oxidant (oxygen, peroxygen or chlorine/bromine/iodine), both iron and manganese will oxidize to insoluble states, form larger agglomerated

Iron build-up inside of a drinker line.

particles and can precipitate inside the waterlines. Over time, the precipitation of iron and manganese (with or without biofilm-causing microbes) can lead to lower flow and volume capacity in the waterlines. Also, it can lead to fouling and plugging of the drinker nipples. This plugging should not be confused with white or light grey calcium precipitate caused by water hardness. Iron and manganese precipitates are usually brownish red (Fe), or dark grey to black (Mn), respectively **[see photos]**.

"Iron reducing bacteria" can also be present in the aquifer or inside the drinker system and have the ability to actually feed on the iron and manganese in the water, causing them to thrive and worsen the plugging and clogging impact. These bacteria are generally not pathogenic to the animal, but will have negative impact on the palatability of the water and, thus, impact production such as feed efficiency. Iron-reducing bacteria can also produce a slimy brown biofilm on the inside of the waterline and on polymer membranes in pressure regulators. The formation of these biofilms leads to the increased presence of other microbiology, such as coliforms and sulfur-reducing bacteria (and possibly other non-pathogens such as fungi and yeast). The biofilms produced by these bacteria will also

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Iron and manganese build-up inside of a water line.

have a negative impact on the volume and flow function capabilities of the barn drinking water system.

Addressing iron and manganese challenges for your barn's drinking water

Excess iron and manganese can be removed from well water, each with different cost and maintenance structures. There are three methods that are commonly applied in swine production: chemical oxidation and filtration, aeration and filtration, and oxidizing filters with ion exchange systems.

1. **Chemical oxidation and filtration.** Removal by chemical oxidation starts with the addition of an oxidative chemistry such as a liquid chlorine or chlorine dioxide gas safely produced inside of the closed water system in small or diluted volumes, depending on total water pH reduction goals/needs. The chemical fairly quickly oxidizes the iron or manganese to an insoluble state and leads to flocculation (agglomeration to a larger particle) of the dissolved molecules. After the oxidation has taken place, the water passes through a large 20u or smaller particle size filter (or a set of filter media) to remove these particles from the water. Do not rely on the small, spiral-wound or pleated 10" filters common in hog barns; they will plug with Fe/Mn too quickly. This system approach can be used in concert with water disinfection, but will need additional consideration such as sequence, installation location, and the choice of oxidant to produce a residual disinfectant for microbial killing. Contact your MWI Animal Health Territory Manager to learn more about this approach.

2. **Aeration and filtration.** Aeration works similar to chemical oxidation but, instead of using a chemical to do the oxidation, it relies upon oxygen in the air that is being pumped, agitated or spray sparged into the water prior to the clean-air, closed filtering system. After the oxidation has taken place, the water passes through a filter or a set of filter media to remove these particles from the water. This is an approach that can be used for larger systems if the space and footprint is available in-line (contact time), and the levels of Fe and/or Mn are low enough. Filtration can be a simple, large capacity pleated filter(s) or a more expensive, self-back flushing filter.

3. **Oxidizing filters.** Oxidizing filters are "solid state" and can contain a variety of media; one of the more common is manganese-treated green sand. The chemically active media in the filter reacts with the iron and manganese in the water to create solid particles that then get trapped throughout the filter media's empty spaces. Regular backwashing of the filter media by the pumping system is important as the trapped particles can lead to clogging of the system. The filter media oftentimes needs to be regenerated as the manganese coating is used up over time. This is the most (significantly) expensive option, but requires the least amount of upkeep and oversight by farm personnel.

Sources

"Iron (Fe) and Water." Lenntech, 2016, www.lenntech.com/periodic/water/iron/iron-and-water.htm.

Wagnet, L. "Drinking Water Contaminant - Iron and Manganese Bacteria." *Extension*, 6 Dec. 2010, articles.extension.org/pages/31555/drinking-water-contaminant-iron-and-manganese-bacteria.

Metzger, Marianne. "The Relationship Between Iron and pH." *World Wide Drilling Resource*, Jan. 2005.