The Hidden Dangers Of Manganese In Drinking Water

Source: WaterOnline.com 05.21.2018

By Jim Lauria, VP Sales and Marketing, Mazzei Injector Company, LLC

Evidence indicates that manganese (Mn) is more than a nuisance: it's a threat to health. It's time to get serious about removing it from drinking water

Manganese (Mn) has long been recognized as a nuisance—its brown-to-black stains and metallic taste can make well water unpleasant, to say the least. If you think of drilling a well as a process of mining water, it's no surprise that the mine also yields other minerals dissolved or suspended in the groundwater. In many areas across the U.S. and around the world, there's plenty of manganese to be found. High levels of Mn occur in the U.S. along the Appalachian and Adirondack ranges in the East. In the West, it's common along the Sierras, Cascades and Coastal ranges. Dr. Samantha Ying of the University of California, Riverside studied the Glacial Aquifer that underlies 26 U.S. states and supplies drinking water to 41 million people, and found that 16.4 percent of the wells tested were contaminated with either Mn, arsenic, or both.

Because many countries, including the U.S., do not list manganese as a contaminant—just a nuisance— it is not included in many water quality monitoring protocols, which Ying notes could lead officials to underestimate the number of wells contaminated with the element. A paper by Ying in *Environmental Science and Technology* alludes to a growing body of research that indicates that manganese may present a significant threat to health and development.

For example, Dr. Brad Racette of the University of Washington in St. Louis, Missouri, has studied welders who are routinely exposed to high levels of Mn and found a correlation with increased occurrence of manganism - a long-recognized syndrome that resembles Parkinson's Disease, with symptoms that range from slurred speech and loss of balance to an emotionless, mask-like set of the face. The inhalation of Mn appears to kill neurons in a part of the brain called the striatum, which is also affected by Parkinson's Disease.

You don't have to be a welder to encounter Mn at levels that are raising concerns. For instance, neural damage can occur in children exposed to well water with high manganese levels. A study of 362 students in Quebec noted that the average IQ of children who consumed well water that was in

the top 20% for Mn content had IQs an average of 6 points lower than their peers whose water had lower levels of manganese. A 2004 health advisory by EPA noted that manganese (which the report notes is most often encountered in high doses through inhalation or diet rather than in water) can correspond to lower sperm count in adults and developmental delays.

Oxidation Opens Opportunities

Removing manganese (and iron, which often appears alongside it) from water is not very difficult. Oxygenating the water oxidizes the Mn into manganese dioxide (MnO_2) precipitate which can then easily be filtered from the stream. When comparing oxidizing agents, ozone—which contains three oxygen atoms per molecule—is most effective, followed by oxygen (O_2) and then air (21% of which is oxygen).

Other common oxidizing agents include chlorine, chlorine dioxide, potassium permanganate, and sodium permanganate. However, using some form of oxygen as the oxidizer is the most obvious choice. It's right there in the name of the process.

One of the services Mazzei provides many clients is helping determine the best oxidizing system for their operation. For instance, ozone is an outstanding choice at the industrial or municipal level, especially if generating ozone replaces having to buy, store and handle chemicals like chlorine. Other large facilities may already have an oxygen tank on-site for some other process; in those cases, O_2 becomes a natural pick. At the commercial or home level, plain-and-simple air can provide enough oxygen to do the job, particularly if it is incorporated effectively into the stream.

Highly Efficient Mixing

The Mazzei GDT system illustrates how the process of injecting and mixing an oxidizer into a sidestream can be done with high efficiency.

The oxidizer—ozone, oxygen or air—is drawn into the water as it passes through a venturi injector, whose shape creates a low-pressure flow that pulls the gas into the stream, shearing and mixing it into solution. A Pipeline Flash Reactor (PFR) provides further mixing, maximizing the efficiency of the process and helping ensure the proper mixing and mass transfer of the oxidizer to create MnO_2.

Any entrained bubbles are separated from the flow in a degas separator, which directs undissolved gas through a relief valve, minimizing downstream problems with bubbles in filtration systems. The treated water containing high levels of dissolved oxygen is then directed through Mazzei MTM mixing nozzles into the main stream.

Contact with the dissolved oxygen or ozone quickly results in oxidation, which causes insoluble iron oxide and manganese dioxide particles to form in the stream. Smaller particles are captured in settling and flocculation technologies—plate or tube settlers, ballasted or solid/air flocculation, or sedimentation basins—while filtration through sand or anthracite media, "green sand" (glauconite), catalytic media, biofiltration, membranes, or ion exchange collects larger particles.

Multi-stage approaches, such as a green sand filter before ozonation and a media filter after it, can also be highly effective at removing Mn.

Minimizing DBPs

As with any water treatment process involving chemical transformations, concerns about disinfection byproducts (DBPs) exist with manganese removal. Chlorine and chlorine dioxide can yield haloacetic acids (HAAs), trihalomethanes (THMs), chlorite and bromate. Ozone is gaining popularity in municipal water treatment because it can help avoid generating most of these DBPs; however, care must be taken to prevent the formation of bromates when the combination of high pH, high bromide levels, low dissolved organic carbon and low ammonia levels exist in the presence of high doses of ozone.

Radionucleotides in some water sources, which can render filtration media radioactive, can be a problem. And, of course, the residual solids collected in the Mn and iron treatment process must be disposed of in a proper manner.

The Time Is Now

As science increasingly points to the fact that waterborne manganese is more than a nuisance but is actually a threat to health, water professionals should take a hard look at monitoring for Mn and removing it from water at all levels—not just from individual home wells, but from commercial, industrial and municipal sources as well. We have the technology and the need is increasingly clear. Now is the time to get serious about manganese.

Gas injection system for manganese removal in drinking water.