THE AMERICAN WELL OWNER

★ INFORMATION AND ADVICE ABOUT GROUND WATER, WELLS AND WATER SYSTEMS ★

A Quarterly Publication for Well Owners - 2002 Number 1

SOLUTIONS TO MANGANESE PROBLEMS

Manganese (Mn) is very common in soils and sediment. It is commonly found with iron as mineral oxide coatings on the surface of soil and rock grains. When ground water contacts these coatings, the oxides are dissolved and may be transported to your well in the ground water. Manganese is commonly found in water as manganese ions (Mn^{++}) or as manganese bicarbonate ($Mn[HCO_3]^-$). Dissolved manganese is colorless. Manganese coatings are commonly black.

MESSAGE FROM THE PUBLISHER

This issue of The American Well Owner contains practical advice about water problems. Water is a serious business and we make no apology for including technical information. We have tried to keep it understandable and have given you sources of additional information to consult.

The bottom line for the nation's 15 million private well owners is that it is their responsibility to ensure the safety and integrity of their water supply. Most wells do not have problems – but if yours does – make sure that the solution is based on an accurate assessment. There is rarely a one-size-fits-all solution and the more you can understand the reasons for the quality concern, the more likely you are to achieve a practical and cost-effective solution. There is information available at www.privatewell.com and from the many organizations we have listed in the links to help well owners find answers to questions about wells and ground water as a drinking water source.

Andrew Stone

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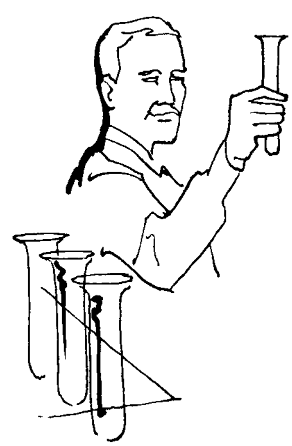
Manganese is an essential trace element that is necessary for good health. The US Environmental Protection Agency (EPA) recommends that the level of manganese in drinking water be less than 0.05 milligrams per liter (mg/L) to avoid aesthetic staining problems. This limit is also enforced by the Food and Drug Administration (FDA) on bottled water products and is considered satisfactory to protect human health by the Centers for Disease Control (CDC) in Atlanta, Georgia. The CDC reported that an Estimated Safe and Adequate Daily Dietary Intake (ESADDI) for manganese for adults is 2 to 5 mg/day. The average adult diet includes 1 to 10 mg/day of manganese. Infants may require only 0.3 to 0.6 mg/day.

If dissolved manganese levels are above 0.05 mg/L, black or gray staining and a bitter metallic taste may result from oxidation of the water. Oxidation and precipitation of manganese will occur when well water mixes with oxygen in the air. This process may begin as ground water containing dissolved manganese enters a well and continues within the building's plumbing. Adding oxidizing cleaning products such as laundry bleach or scouring powders to the water may intensify or speed up the oxidation process. Using these products may cause staining during clothes washing or other situations where the manganese is oxidized, precipitates as a solid and is left behind on a surface.



There are several technologies for reducing the level of manganese in water. Choosing the most efficient treatment will depend on the specific chemistry of the water being treated. It is recommended that the total iron, manganese, hardness, alkalinity and pH of the water be tested by a state-certified laboratory before purchasing equipment.

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Ion Exchange Treatment
Ion exchange using a sodium chloride salt (NaCl) brine solution can remove low concentrations of dissolved manganese when the pH is greater than 6.8. The system should have a forceful backwash (100% bed expansion), preferably in a down flow direction to help remove the relatively heavy manganese oxide particles. The backwash should be scheduled to occur before the softening capacity of the system is exhausted.

Oxidation and Filtration
Oxidation of dissolved manganese creates particles of manganese dioxide (MnO_2). Oxidation treatment is more effective for removing higher concentrations of dissolved manganese than ion exchange. Dissolved manganese generally oxidizes more slowly than iron which means it is relatively slower to form scale (precipitate), but is also harder to remove efficiently (quickly and cost effectively) from a water source by a treatment system.

Oxidation is commonly accomplished with chlorine although some newer home treatment systems are now using ozone (O_3) as the oxidant. Oxidation treatment systems add an oxidant to the raw water in a mixing tank so that enough contact time is created to allow for maximum oxidation. The particles of MnO_2 are then removed from the water by a mechanical filter. This may be followed by an activated carbon filter to remove any excess chlorine. Oxidation with chlorine is most effective when the water pH is greater than 9.5.

Potassium permanganate is a stronger oxidant than chlorine. Treatment with potassium permanganate commonly uses a "greensand" resin bed in conjunction with a regenerative backwash of concentrated potassium permanganate similar to the mechanical operation of an ion exchange water softener system (The potassium permanganate solution substitutes for the salt brine, but note that the permanganate system will not remove calcium carbonate "hardness" from the water). The greensand is a resin coated with manganese oxide. As the raw water passes through the greensand the manganese oxide reacts with the dissolved manganese to form particles that become trapped in the resin bed. The particles must be flushed out during the backwash cycle so that the resin bed does not become clogged and fouled. Greensand systems do not require high dissolved oxygen contents but work best when the water pH is above 7.5.

Oxidizing Filters
Some oxidizing filters are self-contained treatments that precipitate and filter dissolved metals (manganese) in one filter canister/ tank. They must meet specific water chemistry requirements to work effectively. Unlike the greensand systems they do not need regeneration although they must be backwashed to remove the filtered particles. Examples include Birm™ and Filox™. These oxidizing filters work best when the water pH is above 7.5 and the dissolved oxygen content is greater than 15 percent of the manganese concentration.

Water quality problems are not always straight forward to solve. Be sure to get a written contract with your water treatment installer that specifies how any lingering water quality issues will be addressed, who will by responsible financially and what will be done if a water quality concern cannot be satisfactorily treated.

Refer to the Centers for Disease Control website for health information on manganese:
http://www.atsdr.cdc.gov/toxprofiles/tp151.html. Refer to the National Sanitation Foundation (www.nsf.org)
and Water quality Association (www.wqa.org) websites for more manganese treatment information.

Bioterrorism and Your Water Well . . . *continued from page 4*

effective against anthrax, for example. Actual anthrax specimens are under close guard and are not available to recognized testing organizations such as the National Sanitation Foundation International (www.nsf.org) or the Water Quality Association (www.wqa.org). No surrogate for anthrax acceptable for water treatment testing has been identified. Some companies are claiming that their technologies will be satisfactory by extrapolating from existing studies on similar sized and shaped organisms. In many situations, the testing of surrogates is not acceptable to the WQA or NSF as a valid substitute for analysis of the actual microorganism. Before purchasing a treatment system, it is recommended that the NSF or WQA be contacted for the most up to date information on equipment and treatment certifications.

For more information on bioterrorism-related bills in Congress go to the following legislative search engine:
http://thomas.loc.gov/bss/d107query.html. The NACo survey is available at:
http://www.naco.org/programs/homesecurity/emerprep.pdf.

Information about proper well construction can be found through the Water Systems Council at: www.watersystemscouncil.org

Arsenic in Ground Water – An Update

On October 31, 2001 Christine Todd Whitman, Administrator of the Environmental Protection Agency announced that the new arsenic Maximum Contaminant Level (MCL) for public water systems would be 10 parts per billion (ppb), matching the value originally adopted by the Clinton Administration on January 22, 2001. In late January 2001, the Bush Administration initially delayed implementation of the new MCL pending further evaluation of studies completed since the 1999 National Academy of Science (NAS) arsenic assessment. The update evaluations were completed by the NAS on health risks, the National Drinking Water Advisory Board (NDWAB) on implementation costs by small water systems and by the EPA's Science Advisory Board (SAB) on potential benefits.

There are 74,000 public water systems in the nation that must meet this new MCL of which approximately 4,000 will have to install treatment systems or employ other measures to remain in compliance. Of the systems affected by the new MCL, nearly 97 percent serve less than 10,000 people. The systems must be in compliance by 2006.

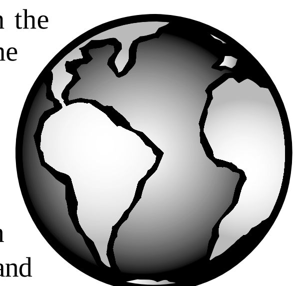
Although the arsenic MCL is not legally enforceable for private wells, the health risk information is relevant to well owners who may use ground water containing arsenic (As). Homeowners with drinking water containing arsenic have several removal techniques to consider. The technologies work best when the form of the arsenic is arsenate [5+ valence, As(V)]. Arsenate will be the predominant form of arsenic in aerobic, oxygen rich water environments. In situations where ground water is anaerobic (low oxygen content), arsenite [3+ valence, As(III)] is likely to be the predominant type of dissolved arsenic. Available information indicates that chlorine, ferric chloride and potassium permanganate are effective at oxidizing As(III) to As(V). Ozone and hydrogen peroxide should also be effective pre-oxidizers for arsenic. The most effective treatments for arsenic removal are reverse osmosis and ion exchange using activated alumina. For most homeowners a Point of Use (POU) system in the kitchen is an appropriate remedy to reduce arsenic levels in drinking water.

A water test for arsenic is on the order of $20 to $30. The Trust recommends that homeowners test their well water once for arsenic. For additional testing recommendations please visit the Trust web site at: www.agwt.org.

The Update Arsenic Evaluations may be viewed at:
NAS Report: http://www.nap.edu/books/0309076293/html/
NDWAB Report: http://www.epa.gov/safewater/ars/ndwac-arsenic-report.pdf
SAB Report: http://www.epa.gov/sab/ec01008.pdf

How Much Water is on the Earth

"Water, water everywhere nor any drop to drink"[1] was the likely cry of castaway sailors on the open ocean. The salt water of the oceans makes up about 97.2 percent of all the water on the earth (total water volume: 1,357,506,000 cubic kilometers [km^3][2]), but cannot be used as a drinking water source without the removal of the dissolved salts it contains. Frozen water in the ice caps and on the mountaintops of the world makes up 2.15 percent of the total water supply. Fresh water comprises the remaining water resource (0.65 %).



Ground water makes up 97.54 percent of the total fresh water supply (8,300,00 km^3), exclusive of frozen water. Water vapor in the atmosphere, soil moisture and seepage and surface water in lakes, rivers and streams comprise the remaining fresh water resource. Half the ground water supply is estimated to lie below depths of one-half mile and is therefore not generally accessible as a source of drinking water. Most private drinking water wells are less than 1,000 feet in depth.

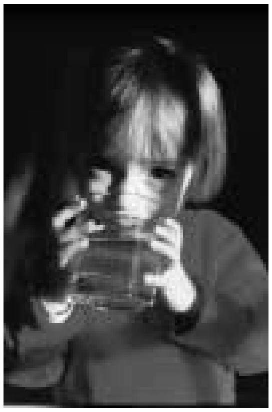
Although 8,300,00 km^3 is a lot of water in the ground, it is not equally distributed around the world. Many countries do not have adequate drinking supplies, satisfactory means of protecting their water resources or educating their citizens about the threats to ground water quality. According to the Water Health Organization (World Water Day Report – 2001), more than a billion people do not have access to safe drinking water because of polluted sources. The table below provides some examples of the range of access:

Percentage of Population with Access to Safe Water

United States	99	Sudan	45
Mexico	72	Ethiopia	18
Pakistan	56		

Each of us is a steward of the world's water resources. We must take care to protect what we have where we find it so that the resource remains available and of good quality for today's needs and for the generations to follow.

1 "The Rime of the Ancient Mariner," by Samuel Taylor Coleridge (1798).
2 The water quantity information in this article is summarized from "The Water Encyclopedia," (2nd Edition 1990) published by Lewis Publishers, Chelsea, Michigan, USA.



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BIOTERRORISM AND YOUR WATER WELL

The events of September 11, 2001 have raised fears and caused many of us to reevaluate our daily activities to reduce the potential of injury or death from possible future terrorist acts. One of the fears considered by many is contamination of drinking water supplies with pathogens. Pathogens are disease-causing organisms such as viruses and certain types of bacteria. Bioterrorism is the use of pathogens to cause illness and death in order to spread fear among a population. Some examples include anthrax, smallpox, Cholera, and Botulinum toxins.

Government officials and municipal water system operators are working hard to secure the infrastructure and water supplies of large water utilities from bioterrorism attacks. Several bills are working through Congress that will appropriate money for these tasks (e.g., House bills HR3448, HR3178 and Senate bill S1593). The National Association of Counties (NACo) completed a survey of 3,066 counties in the United States to assess how prepared our local governments are to handle terrorist attacks. The results indicate that more than half of the 731 smaller counties (those with less than 10,000 people) are unprepared to handle terrorist attacks. Although three-quarters of all county public health departments have authority to quarantine, only about 40 percent of the counties have a plan to enforce a quarantine.

What does this mean to the private well owner?

Good News! Private wells are not likely targets of terrorists. The consensus of bioterrorism experts appears to be that larger water distribution facilities are more probable targets than individual homeowner wells. Sabotage of one large distribution facility would likely create a bigger media sensation and more pervasive fear than would be attained through targeting residential wells. Properly constructed wells use sealed and vented well caps, grouted casing and frequently there are thick soil layers surrounding the well to discourage the infiltration of organisms and chemicals into the well. Under most geologic conditions, it is difficult for pathogens to travel any significant distance in ground water because of the filtering effects of the small pathways within the soil and bedrock. These same attributes plus the widely scattered distribution of private wells in a typical neighborhood would make it difficult for a terrorist to concentrate his effort to harm many residential wells.

Homeowners should be wary of claims by water treatment companies that their equipment will remove the microorganisms likely to be chosen by bioterrorists. Currently, no water treatment devices or technologies have been certified as

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