NebGuide
University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources
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G1275
(Revised February 2010)

Drinking Water: Sulfur (Sulfate and Hydrogen Sulfide)

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Two forms of sulfur are common in drinking water supplies. Neither usually creates a health risk, and with proper testing and treatment will not be a nuisance.

Sources of Sulfate and Hydrogen Sulfide in Drinking Water

Sulfate

Sulfates are a combination of sulfur and oxygen and are a part of naturally occurring minerals in some soil and rock formations that contain groundwater. The sulfur mineral dissolves over time and is released into the groundwater that supplies domestic water.

Hydrogen Sulfide

Hydrogen sulfide gas can also occur naturally in some groundwater. It is formed from decomposing underground deposits of organic matter, such as decaying plant material. It is found in deep or shallow wells and also can enter surface water through springs, although it quickly escapes to the atmosphere. Hydrogen sulfide often is present in wells drilled in shale or sandstone, or near coal or peat deposits or oil fields. However, naturally occurring deposits are not the primary source of hydrogen sulfide found in drinking water.

Sulfur-reducing bacteria, which use sulfur as an energy source, are the primary producers of large quantities of hydrogen sulfide in drinking water. These nonpathogenic (not disease-causing) bacteria chemically change naturally occurring sulfates in water to hydrogen sulfide. Sulfur-reducing bacteria live in oxygen-deficient environments such as deep wells, plumbing systems, water softeners, and water heaters. These bacteria can flourish on the hot water side of a water distribution system.

A third potential source of hydrogen sulfide odor in drinking water is a hot water heater. Occasionally, the magnesium corrosion control rod present in many hot water heaters can chemically change naturally occurring sulfates to hydrogen sulfide.

A related nuisance problem that can result from sulfate in water is sulfur-oxidizing bacteria. These nonpathogenic bacteria convert sulfide into sulfate, producing a dark slime that can clog plumbing and/or stain clothing. Blackening of water or dark slime coating the inside of toilet tanks may indicate a sulfur-oxidizing bacteria problem. Sulfur-oxidizing bacteria are less common than sulfur-reducing bacteria.

Indications of Sulfate and Hydrogen Sulfide

Sulfate

Sulfate minerals can cause scale buildup in water pipes similar to other minerals and may be associated with a bitter taste in water. Sulfate in drinking water can have a temporary laxative effect on people.

Sulfate can make cleaning clothes difficult. Using chlorine bleach in water containing sulfur may reduce the cleaning power of detergents.

Hydrogen Sulfide

Hydrogen sulfide gas produces an offensive rotten egg odor and taste in the water. In some cases, the odor may be noticeable only when the water is initially turned on or when hot water is run. Heat allows the gas to escape from the water into the air which may cause the odor to be especially offensive in a shower.

A nuisance associated with hydrogen sulfide includes its corrosiveness to metals such as iron, steel, copper, and brass. It can tarnish silverware and discolor copper and brass utensils. Hydrogen sulfide also can cause yellow or black stains on kitchen and bathroom fixtures. Coffee, tea, and other beverages made with water containing hydrogen sulfide may be discolored, and the appearance and taste of cooked foods can be affected.

High concentrations of dissolved hydrogen sulfide also can foul the resin bed of an ion exchange water softener. When a hydrogen sulfide odor occurs in treated water (softened or filtered) and no hydrogen sulfide is detected in the nontreated water, it usually indicates the presence of some form of sulfate-reducing bacteria in the water delivery system (e.g., pipes, water heater, water softener, water filter). Water softeners provide a convenient environment for these bacteria to grow. A "salt-loving" bacteria, that uses sulfates as an energy source, may produce a black slime inside water softeners.

Potential Health Effects of Sulfate and Hydrogen Sulfide in Drinking Water

Sulfate

Sulfate may have a laxative effect that can lead to dehydration and is of special concern for infants. With time, people become acclimated to the sulfate and the symptoms disappear. Sulfur-oxidizing bacteria pose no known human health risk.

Hydrogen Sulfide

Hydrogen sulfide is flammable and poisonous. Usually it is not a health risk at concentrations present in household water. However, when water containing hydrogen sulfide is released in confined areas such as a shower, it is possible for the hydrogen sulfide concentration in the area to reach a concentration capable of causing nausea and illness. In very extreme cases, it could be possible to build up concentrations high enough to cause death. Sulfur-reducing bacteria themselves pose no known health risk as a result of ingestion or skin exposure.

Testing for Sulfate and Hydrogen Sulfide

Public Water Supplies

Public water system operators are required to provide annual water quality reports, referred to as consumer confidence reports (CCRs). The CCR may include information about the sulfate or hydrogen sulfide content of the water provided by the utility. You also can contact the water supplier and ask for this information.

Private Water

Sulfate

Consumers wanting to know the concentration of sulfate in a private water supply can have the water tested at their own expense. Sulfate testing is provided for a fee by some government and commercial water testing laboratories. See NebGuide G1614, *Drinking Water: Certified Water Testing Laboratories in Nebraska* for a list of laboratories in Nebraska providing water testing. However, not all laboratories are approved to test for sulfate.

Select a laboratory and contact them to obtain a drinking water sulfate test kit. This kit will contain a sample bottle, an information form, sampling instructions, and a return mailing box.

The sampling instructions provide information on how to collect the sample. Follow these instructions carefully to avoid contamination and to obtain a representative sample. Promptly mail the sample with the completed information form to the laboratory. Take the sample on a day when it can be mailed to arrive at the laboratory Monday through Thursday. Avoid weekends or holidays which may delay the mail or lab analysis.

Hydrogen Sulfide

Hydrogen sulfide is one of a few water contaminants that can be detected at low concentrations by the human senses, and the offensive odor of hydrogen sulfide gas generally makes testing unnecessary. Most people recognize the rotten egg or sulfur odor and proceed to correct the problem. Since hydrogen sulfide is a gas that is dissolved in water and can vaporize (escape) from it, laboratory analysis of hydrogen sulfide in water requires the sample be stabilized or the test be conducted at the water source site. Contact the water testing laboratory for specific instructions if there is a need to test for hydrogen sulfide.

Interpreting Test Results

Public Water Supply

Sulfate

The U.S. Environmental Protection Agency (EPA) standards for public drinking water fall into two categories — Primary Standards and Secondary Standards.

Primary Standards are based on health considerations and are designed to protect people from three classes of toxic pollutants — pathogens, radioactive elements, and toxic chemicals.

Secondary Standards are based on taste, odor, color, corrosivity, foaming, and staining properties of water. Sulfate is classified under the secondary maximum contaminant level (SMCL) standards. The SMCL for sulfate in drinking water is 250 milligrams per liter (mg/l), sometimes expressed as 250 parts per million (ppm).

Hydrogen Sulfide

Although many impurities are regulated by Primary or Secondary Drinking Water Standards set by the EPA, hydrogen sulfide is not regulated. A concentration high enough to be a drinking water health hazard also makes the water unpalatable.

Private Water Supply

Sulfate

Users of private drinking water supplies may voluntarily consider the EPA guidelines for sulfate in public water supplies as a guideline in assessing the quality of their water supply. If sulfate concentrations are above the 250 ppm SMCL recommended for public water supplies, private drinking water users might voluntarily seek to reduce the sulfate concentration in their water.

Hydrogen Sulfide

The odor of water with as little as 0.5 ppm of hydrogen sulfide concentration is detectable by most people. Concentrations less than 1 ppm give the water a musty or swampy odor. A 1-2 ppm hydrogen sulfide concentration gives water a rotten egg odor and makes the water very corrosive to plumbing. If hydrogen sulfide concentrations make water undesirable, water users might voluntarily try to reduce the concentration in their water.

Options for Managing Sulfate and Hydrogen Sulfide in Drinking Water

Public Water Supplies

Secondary standards are established as guides to manage taste, odor, and color of water. Drinking water suppliers are not required by federal or state law to meet secondary standards. If sulfate or hydrogen sulfide levels in drinking water are higher than desired, some public water suppliers voluntarily reduce sulfate or hydrogen sulfide from the water.

Private Water Supplies

Sulfate

Several methods of removing sulfate from water are available. The treatment selected depends on many factors, including the concentration of sulfate in the water, the amount of iron and manganese in the water, and if bacterial contamination must also be treated. The best option also depends on how much treated water is needed or desired. Point-of-use (POU) units can be used to treat small quantities of water needed for drinking and cooking. Point-of-entry (POE) units can be used to treat all water used in a home.

Two POU methods for treating small quantities of water include distillation and reverse osmosis. These are usually installed at the kitchen faucet and are used to treat water used for drinking and cooking.

For more information on distillation, see NebGuide G1493, *Drinking Water Treatment: Distillation*.

For more information on reverse osmosis, see NebGuide G1490, *Drinking Water Treatment: Reverse Osmosis*.

The most common POE method of treating all of the water used in a home is ion exchange. This process works similar to a water softener. Ion-exchange resin, contained inside the unit, adsorbs sulfate. When the resin is loaded to full capacity with sulfate, treatment ceases. The resin then must be "regenerated" with a brine solution before further treatment can occur.

Hydrogen Sulfide

Existing treatment systems that can be used for hydrogen sulfide include activated carbon filtration, oxidizing filters, oxidization followed by filtration, and de-aeration. The appropriate treatment method depends, in part, on the hydrogen sulfide concentration.

An activated carbon filter can be used to remove low levels of hydrogen sulfide. The filter must be replaced periodically to maintain performance. Frequency of replacement will depend on daily water use and the concentration of hydrogen sulfide in the water. For more information on carbon filters, see NebGuide G1489, *Drinking Water Treatment: Activated Carbon*.

Hydrogen sulfide concentrations up to about 6 ppm can be removed using an oxidizing filter (same as an iron filter). This filter contains sand with a manganese dioxide coating that changes hydrogen sulfide gas to tiny particles of sulfur that are trapped inside the filter. The sand filter must be backflushed regularly and treated with potassium permanganate to maintain the coating.

Hydrogen sulfide concentrations exceeding 6 ppm can be removed by injecting an oxidizing chemical such as household bleach or potassium permanganate to change hydrogen sulfide gas to solid particles of sulfur. The oxidizing chemical should enter the water upstream from a storage or mixing tank to provide at least 20 minutes of contact time between the chemical and water. For more information, see NebGuide G1496, *Drinking Water Treatment: Continuous Chlorination.* Sulfur particles can then be removed using a sediment filter. Excess chlorine can be removed by activated carbon filtration. When potassium permanganate is used, a manganese greensand filter is recommended.

Hydrogen sulfide also can be removed from water by de-aeration. To evaluate de-aeration for your situation, obtain the assistance of a reputable water equipment vendor.

If hydrogen sulfide odor is a result of sulfur-reducing bacteria, performing a shock chlorination procedure may reduce, but not eliminate, the bacteria. This process involves placing a strong chlorine bleach solution into the well. Taps then are opened to draw chlorinated water into all parts of the plumbing system. The chlorinated water is left in the system for several hours or overnight and then flushed out. For more information on shock chlorination see NebGuide G1255 *Drinking Water Treatment: Shock Chlorination*.

If hydrogen sulfide odor is associated primarily with the hot water system, a hot water heater modification may reduce the odor. Replacing the water heater's magnesium corrosion control rod with one made of aluminum or another metal may improve the situation.

Summary

This NebGuide reviewed the sources of sulfur in drinking water and recommended testing and treatment practices.

Sulfate and hydrogen sulfide are both common nuisance contaminants. Although neither is usually a significant health hazard, sulfates can have a temporary laxative effect on humans. Sulfates also may clog plumbing and stain clothing.

Hydrogen sulfide produces an offensive rotten egg odor and taste in the water, especially when the water is heated.

Treatment options depend on the form and quantities in which sulfates and/or hydrogen sulfide occur in untreated water. Small quantities of sulfate may be removed from water using distillation or reverse osmosis, while large quantities may be removed using ion exchange treatment.

Hydrogen sulfide may be reduced or removed by activated carbon filtration, oxidizing filtration or oxidizing chemical injection. Shock chlorination or water heater modification may be effective in some situations.

Acknowledgment

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This publication has been peer reviewed.

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1996, 2004, Revised February 2010