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G96-1275 Drinking Water: Sulfates and Hydrogen Sulfide

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Drinking Water: Sulfates and Hydrogen Sulfide

This NebGuide discusses recommended practices to manage sulfur in a domestic water supply.

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Two forms of sulfur are commonly found in drinking water supplies: sulfate and hydrogen sulfide. Both forms are nuisances that usually do not pose a health risk at the concentrations found in domestic water supplies.

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 mineral dissolves over time and is released into groundwater.

Hydrogen sulfide

Sulfur-reducing bacteria, which use sulfur as an energy source, are the primary producers of large quantities of hydrogen sulfide. These bacteria chemically change natural 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 usually flourish on the hot water side of a water distribution system.

Hydrogen sulfide gas also occurs 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.

Occasionally, a hot water heater is a source of hydrogen sulfide odor. The magnesium corrosion control rod present in many hot water heaters can chemically reduce naturally occurring sulfates to hydrogen sulfide.

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 that can have a laxative effect on humans and young livestock.

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

Sulfur-oxidizing bacteria produce effects similar to those of iron bacteria. They 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.

Hydrogen Sulfide

Hydrogen sulfide gas produces an offensive "rotten egg" or "sulfur water" 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 forces the gas 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 non-treated water, it usually indicates the presence of some form of sulfate-reducing bacteria in the system. 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

Sulfate

Sulfate may have a laxative effect that can lead to dehydration and is of special concern for infants. With time, people and young livestock will 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, except in very high concentrations. While such concentrations are rare, hydrogen sulfide's presence in drinking water when released in confined areas has been known to cause nausea, illness and, in extreme cases, death.

Water with hydrogen sulfide alone does not cause disease. *In rare cases, however, hydrogen sulfide odor may be from sewage pollution which can contain disease-producing contaminants. When sewage pollution is a suspected source of the sulfur, the water should be tested for coliform bacteria. See NebGuide G90-989, "Drinking Water: Bacteria."*

Sulfur-reducing bacteria pose no known health risk.

Testing

Sulfate

Sulfate testing is provided for a fee by the Nebraska Health and Human Services System and some commercial water testing laboratories. See NebGuide G89-907, *Testing for Drinking Water Quality*, for a list of laboratories in Nebraska providing water testing.

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

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. Hydrogen sulfide is one of a few water contaminants that can be detected at low concentrations by the human senses. The gas readily dissipates when water is exposed to the atmosphere.

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 Sulfate and Hydrogen Sulfide Test Results

Sulfate

The Environmental Protection Agency (EPA) standards for 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 (BASF). A concentration high enough to be a drinking water health hazard also makes the water unpalatable.

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.

Generally, hydrogen sulfide levels are less than 10 ppm but, occasionally, amounts of 50 to 75 ppm are found.

Options

If excessive sulfate or hydrogen sulfide is present in your water supply, you have two basic options - obtain an alternate water supply or use some type of treatment to remove the impurity.

The need for an alternate water supply or impurity removal should be established before making an investment in treatment equipment or an alternate supply. Base the decision on a water analysis by a reputable laboratory and after consulting with your physician to help you evaluate the level of risk.

It may be possible to obtain a satisfactory alternate water supply by drilling a new well in a different location or a deeper well in a different aquifer.

The Conservation and Survey Division of the University of Nebraska-Lincoln can provide general information on the possible location of a water supply with satisfactory quality.

Another alternate source of water is bottled water that can be purchased in stores or direct from bottling companies. This alternative might be considered especially when the primary concern is water for food preparation and drinking.

For more information on bottled water see NebGuide G02-1448, *"Drinking Water: Bottled or Tap?"*

Sulfate

Several methods of removing sulfate from water are available. The treatment method selected depends on many factors including the level of sulfate in the water, the amount of iron and manganese in the water, and if bacterial contamination also must be treated. The option you choose also depends on how much water you need to treat.

Two methods for treating small quantities of water (drinking and cooking only) include distillation and reverse osmosis.

Distillation boils water to form steam that is then cooled and condensed to form pure water. Minerals, such as sulfate, do not vaporize with the steam and are left behind in the boiling chamber. For more information on distillation, see NebGuide G03-1493, *"Drinking Water Treatment: Distillation."*

Reverse osmosis membranes have tiny pores that permit water molecules to pass through, leaving minerals such as sulfate behind. For more information on reverse osmosis, see NebGuide G03-1490, *"Drinking Water Treatment: Reverse Osmosis."*

The most common method of treating large quantities of water 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 salt (sodium chloride) brine solution before further treatment can occur. For more information, see NebGuide G03-1491, *"Drinking Water Treatment: Water Softening."*

Hydrogen Sulfide

Hydrogen sulfide formation may be reduced in some instances. Performing a shock chlorination procedure may reduce, but does not eliminate, the sulfur reducing 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. See NebGuide G95-1255, *"Shock Chlorination of Domestic Water Supplies,"* for further information on 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.

To remove low levels of hydrogen sulfide, install an activated carbon filter. The filter must be replaced periodically to maintain performance. Frequency of replacement will depend on daily water use and concentration of hydrogen sulfide in the water. For more information on carbon filters, see NebGuide G03-1489, *"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 and using a filter. The oxidizing chemical should enter the water upstream from the storage or mixing tank to provide at least 20 minutes of contact time between the chemical and water. For more information, see NebGuide G03-1496, *"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 can also be removed from water by de-aeration. To evaluate de-aeration for your situation obtain the assistance of a reputable water equipment vendor.

Often the treatment for hydrogen sulfide is the same as for iron and manganese, allowing removal of all three contaminants in one process. See NebGuide G96-1280, *"Drinking Water: Iron and Manganese."*

Summary

Sulfates 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 and young livestock. 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 shock chlorination, water heater modification, activated carbon filtration, oxidizing filtration or oxidizing chemical injection. Often treatment for hydrogen sulfide is the same as for iron and manganese, allowing the removal of all three contaminants in one process.

Other Related Publications

G04-1539, An Introduction To Drinking Water
G02-1471, Decommissioning Water Wells: An Owner's Guide

Drinking Water Contaminant Series

G89-907, Testing for Drinking Water Quality
G90-989, Drinking Water: Bacteria
G96-1274, Drinking Water: Hard Water
G96-1275, Drinking Water: Sulfates and Hydrogen Sulfide
G96-1279, Drinking Water: Nitrate-Nitrogen
G96-1280, Drinking Water: Iron and Manganese
G96-1282, Drinking Water: Man-made Chemicals
G97-1333, Drinking Water: Lead
G98-1360, Drinking Water: Copper
G98-1376, Drinking Water: Fluoride
G98-1369, Drinking Water: Nitrate and Methemoglobinemia
G02-1448, Drinking Water: Bottled or Tap?

Drinking Water Treatment Series

EC03-703, Drinking Water Treatment: An Overview
G03-1488, Drinking Water Treatment: What You Need To Know When Selecting Water Treatment Equipment
G03-1489, Drinking Water Treatment: Activated Carbon Filtration
G03-1490, Drinking Water Treatment: Reverse Osmosis
G03-1491, Drinking Water Treatment: Water Softening (Ion Exchange)
G03-1492, Drinking Water Treatment: Sediment Filtration
G03-1493, Drinking Water Treatment: Distillation
G03-1496, Drinking Water Treatment: Continuous Chlorination
G95-1255, Shock Chlorination of Domestic Water Supplies
G03-1494, Drinking Water Treatment Emergency Procedures
G04-1536, Drinking Water Treatment: Storing An Emergency Supply
NF02-505, Drinking Water: Chloramines Water Disinfection in Omaha Metropolitan Utilities District

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