Virginia Household Water Quality Program: Sulfate and Hydrogen Sulfide in Household Water

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Private water sources, such as wells and springs, are not regulated by the U.S. Environmental Protection Agency (EPA). Although private well construction regulations exist in Virginia, private water supply owners are responsible for the maintenance of their water systems, for monitoring the quality of their drinking water, and for taking appropriate steps to address problems should they arise.

The EPA public drinking water standards are good guidelines for assessing your water quality. *Primary drinking water standards* apply to contaminants that can adversely affect health and are legally enforceable for public water systems. *Secondary drinking water standards* are non-regulatory guidelines for contaminants that may cause nuisance problems such as bad taste, foul odor, or staining.

Testing your water annually and routinely inspecting and maintaining your water supply system will help keep your water safe. For more information, visit the Virginia Household Water Quality Program website at www.wellwater.bse.vt.edu.

Introduction

Sulfate (SO_4) is a naturally occurring mineral that can be dissolved into groundwater. Hydrogen sulfide (H_2S) is a colorless gas that gives water a distinctive sulfur or "rotten egg" smell and taste, which may be especially noticeable in hot water. The presence of low levels of hydrogen sulfide in household water is not a health hazard, but hydrogen sulfide can make water more corrosive, which can result in leaching of metals present in the plumbing system. The offensive odor and other nuisance problems associated with hydrogen sulfide may make treatment desirable.

Hydrogen sulfide gas in drinking water can originate from several sources. It is often naturally present in wells drilled in shale or sandstone rock formations, or in wells near coal or oil fields. The presence of hydrogen sulfide may be seasonal, and it is frequently present in well water that also contains iron and/or manganese or has a low pH. Hydrogen sulfide may also be produced as a by-product of a type of bacteria that feed on sulfur. Although the presence of these bacteria may affect the taste or odor of water, they do not represent a health risk to humans. The bacteria that produce hydrogen sulfide thrive in low oxygen environments like wells, plumbing systems, and appliances like water softeners and water heaters. Occasionally the "rotten egg" odor associated with hydrogen sulfide gas is only noticeable in hot water. In addition to a possible sulfur bacteria issue in hot water heaters, sulfates can be chemically changed to hydrogen sulfide in some hot water heaters due to a chemical reaction with the heater's magnesium corrosion control rod.

Hydrogen sulfide gas in household water may also indicate sewage contamination, particularly in poorly constructed or shallow wells located near leaky sewer lines or septic drainfields. Sewage contamination can also introduce coliform bacteria and other potentially hazardous contaminants, like nitrates, into your water supply. If sewage contamination is suspected, test your water for coliform bacteria and nitrate.

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Problems Associated With Sulfate and Hydrogen Sulfide

Sulfate

Sulfate (SO_4) may cause water to have a bitter taste. In addition, it may have a laxative effect on humans, especially if they are not accustomed to drinking water containing sulfate. For this reason, the U.S. Environmental Protection Agency (EPA) has established a secondary drinking water standard or *secondary maximum contaminant level* (SMCL) of 250 milligrams per liter (mg/L) for sulfate. High sulfate levels in water are of particular concern with infants, who may suffer from dehydration due to diarrhea. Young livestock may also be at risk. With time, most humans and livestock will become acclimated to sulfate and any associated symptoms will disappear. Like other minerals present in household water, sulfate may cause scale accumulation in or on plumbing fixtures. If present in a water supply system, bacteria that feed on sulfur can produce a dark slime, which can stain clothing and clog plumbing.

Hydrogen Sulfide

Most people can detect hydrogen sulfide (H_2S) in water by the "rotten egg" smell at concentrations of 0.5 to 1.0 mg/L. Although in very rare circumstances hydrogen sulfide gas released from water into closed spaces can build up to toxic or flammable levels, it generally does not present a health risk. While hydrogen sulfide is not regulated by the EPA in public water systems, it can be corrosive to plumbing and exposed metal parts of appliances. It may even corrode stainless steel, and will darken silverware and discolor copper or brass fixtures. Hydrogen sulfide may alter the appearance and taste of hot beverages and cooked foods. It can also interfere with the effectiveness of water softeners by clogging the resin bed.

Testing for Sulfate and Hydrogen Sulfide

The presence of sulfate in household water is easily determined with a laboratory water test. Make sure the analysis you request from the lab includes sulfate and follow sample collection instructions carefully. Treatment is recommended for levels of sulfate higher than the EPA secondary drinking water standard of 250 mg/L.

Although you will probably be able to taste or smell hydrogen sulfide in your water, testing is necessary to determine how much is present so that an appropriate treatment method can be chosen. Because hydrogen sulfide is a gas that is dissolved in water and rapidly diffuses into air, water samples collected to test for hydrogen sulfide must be stabilized immediately. Most laboratories will provide special sample bottles that contain a chemical for this purpose. However, the stabilizing chemical interferes with other tests, so if sewage contamination is suspected, a separate sample should be collected to test for bacteria. When collecting any water sample, carefully follow the laboratory's instructions for proper sample collection. A list of certified laboratories maintained by the Virginia Division of Consolidated Laboratory Services is available at www.wellwater.bse.vt.edu/resources.php.

Treatment Options

Sulfate

Sulfate can be removed from water by distillation, reverse osmosis, or ion exchange. Distillation and reverse osmosis are most suited for treatment of small quantities of water (water to be used for drinking and cooking only). It is not necessary to remove sulfate from all water in your household; only water intended for consumption needs to be treated, and only if sulfate levels are higher than 250 mg/L or are causing a problem.

Distillation involves boiling water and collecting the resulting steam and cooling it in a separate chamber. While distillation does not involve the use of chemicals, it does require energy and releases heat into the surrounding area. Distillation, however, takes longer to produce the processed water than other methods, units can be expensive to operate, and the length of time distilled water is stored may affect its quality. In addition, distilled water has a very "flat" taste, because minerals naturally present in water that help to impart taste are removed during distillation. These devices can be expensive to purchase and maintain.

The Virginia Household Water Quality Program, offered through Virginia Cooperative Extension (VCE), periodically conducts county-based household water sampling clinics where you can learn about the quality of your water supply, proper water supply system maintenance, and, if needed, possible water treatment options. Please contact your local Extension office or visit www.wellwater.bse.vt.edu for more information.

Reverse osmosis (RO) involves forcing water molecules through a semi-permeable membrane. Water passes through the membrane but not most contaminants. Ten to twenty percent of the water entering the RO system exits as treated water, and the other 80 to 90 percent is wastewater, and is diverted to a drain. These systems work best with higher water pressure and often require pretreatment and post-treatment systems to work properly. They have an average lifetime of 3-5 years at which point the membrane must be replaced. These devices can be expensive to purchase and maintain.

Ion exchange devices exchange unwanted constituents in water with less objectionable ones. To remove sulfate, anion exchange units contain resin beads that are covered with chloride, and as water passes through the device, the resin adsorbs the sulfate and releases chloride into the water. Removal of sulfate may be influenced by other contaminants in a water supply, as resins adsorb anions preferentially. Ion exchange system maintenance involves periodically regenerating the resin with a brine solution, which replaces the adsorbed contaminants with chloride ions. The contaminants are discarded with the recharge wastewater. Ion exchange treatment may result in lower pH, and therefore slightly more corrosive water.

Issues with sulfur-using bacteria that produce hydrogen sulfide gas may be controlled by disinfecting the water supply system using shock chlorination. (*Shock Chlorination: Disinfecting Private Household Water Supply Systems, Virginia Cooperative Extenstion publication* 442-663 for more information.) Note that control of sulfur bacteria may only be temporary and routine shock chlorination may be required.

Hydrogen Sulfide

The appropriate treatment method for hydrogen sulfide depends on the concentration of hydrogen sulfide in your water supply. Trace amounts of hydrogen sulfide, up to a few tenths of a milligram per liter (mg/L), can be removed with an activated carbon filter. Periodically replacing the filter is critical to ensure effectiveness. For hydrogen sulfide concentrations up to 6 mg/L, an oxidizing, iron-removal filter containing manganese greensand can be used. Manganese greensand filters must be periodically regenerated with potassium permanganate. Water with a pH below 6.7 may need to be treated with an acid water neutralizer to raise the pH before the water enters the oxidizing filter. For hydrogen sulfide concentrations greater than 6 mg/L, an oxidizing agent like chlorine or potassium permanganate must be injected into the plumbing system. The oxidizing agent must be injected upstream from a holding or mixing tank that provides sufficient holding or contact time for the oxidation process to occur. Once oxidized, the sulfur particles are removed using a sediment filter.

Note: If your water heater is the source of hydrogen sulfide gas, the characteristic odor will be present in hot, but not cold, water. Ask a plumber to check the corrosion control rod in the hot water heater. Installing a corrosion control rod made of aluminum rather than magnesium may address the problem. However, before making any changes, check with the manufacturer of the water heater first to make sure the warranty will not be affected. If hydrogen sulfide is being produced by microorganisms inside your water heater, replacing the corrosion control rod will not solve the problem.

A complete water analysis for contaminants and/or the advice of a certified water treatment professional will help in selecting the specific treatment method appropriate for each application. Consumers should verify manufacturer claims before purchasing any water treatment device by contacting the National Sanitation Foundation (www.nsf.org) or the Water Quality Association (www.wqa.org).

Additional Information

For more information on household water, see the Virginia Cooperative Extension publications listed here:

Virginia Household Water Quality Program website: http://www.wellwater.bse.vt.edu/resources.php.

Virginia Cooperative Extension website: http://pubs.ext.vt.edu/category/home-water-quality.html.

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