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Phew! My Hot Water Smells Like Rotten Eggs

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Taste and odor problems can affect hot or cold water, but hot water problems usually bring complaints of smells like rotten eggs.

The rotten egg odor is caused by hydrogen sulfide (H2S) gas. The odor is repulsive, but the gas is not usually harmful at the low concentrations that occur in a household water system. This is not a problem of health but aesthetics. It is unpleasant to take a shower, wash clothes, or cook with water that smells like decay.

Chemical Causes

Rotten-egg odors result from a chemical process that involves three primary components:

- sulfur (S),
- electrons, and
- bacteria.

Sulfur. Sulfur often appears in water as sulfate ions ($SO4^{-}$), which are quite stable. However, sulfate can convert to sulfides (S) and hydrogen sulfide gas by the gain of eight electrons (negative charges). The gain of negative charges is called a reduction reaction.

Electrons. The sulfate-reduction reaction requires energy. Electrons are the energy source. Excess electrons may occur in water as the result of the decay of organic matter or the corrosion of metals. Sulfate may convert to the less stable sulfur form of sulfide in the presence of excess electrons, but this conversion is not entered into easily. A catalyst is required to speed up the reaction if it is to take place at a rate sufficient to cause the nuisance odor.

Bacteria. The nonpathogenic, sulfate-reducing bacteria, *Desulfuuibrio desulfuricans,* produces enzymes that have the power to accelerate the sulfate-reduction reaction. However, the sulfate-reducing bacteria lack the ability to reduce the sulfates to sulfides without the external energy source provided by the excess free electrons.

All three components of the reaction: the sulfates, the sulfate-reducing bacteria, and the excess electrons must be present for hydrogen sulfide to be produced. The rate of the H2S gas production is determined by how active each component is.

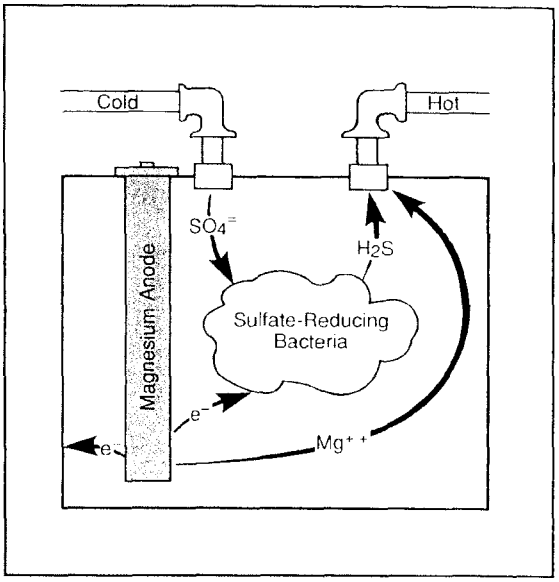

Figure 1 Bacterial action in water heater.

Time. An influencing factor is the length of time that the water is in contact with the reaction. Even at a very low reaction rate, the H2S may build in concentration to objectionable levels given enough time.

If you can substantially reduce any one of the four factors, you can control the odor problem.

H2S in Groundwater

Sulfates occur in most groundwater environments at sufficient levels to form objectionable concentrations of H2S gas. The sulfate-reducing bacteria will grow almost anywhere the other reaction components exist. The water may be in the ground for a near infinite period of time. Therefore, this leaves the availability of electrons as the principle controlling factor for the occurrence of hydrogen sulfide in groundwater. Shallow wells tend to be susceptible to surface water contamination, which may have a high concentration of organics. As a result, shallow wells and private household wells may have a greater problem with the rotten egg odor.

Deep wells that are cased and sealed to state specifications have few organics. In addition, they may lack the nutrients needed to support the bacteria that feed on the few organics available.

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Distribution System **Symposium.. .. see pages 3-6**

H2S Gas Is the Rotten Egg in Water Heaters, Pipes, Wells

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In these wells, the availability of free electrons is limited and little hydrogen sulfide is produced. However, even at an extremely low rate of H2S production, the long time that the water is in contact with the reaction may provide objectionable concentrations of the gas.

The rotten egg odor in groundwater can be controlled at the well. Hydrogen sulfide may be oxidized to sulfur or sulfates by chlorination. Typical chlorine dosage for a deep well in Missouri varies between 0.5 to 1.0 mg/L to control the rotten egg odor plus another 0.5 to 1.0 mg/L for the distribution system.

Water Is Free

Wherever you find it, water is free,
Deep in a well or out of the sea.
Get all you want wherever you go;
Read the simple directions below.

Put a barrel under the spout,
Collect the rain the clouds give out.
While its falling, don't be placid;
Some of those drops are full of acid.

With a bucket you can bring
All you want from pond or spring.
But watch for wiggler or bacillus;
Some of those bugs are sure to
kill us.

Put muddy water in a kettle.
Leave it for the mud to settle.
But that won't get rid of everything,
Better add a shot of chlorine.

Build a dam across a creek
And do it well so it won't leak.
Then lay a pipe, the cost ain't hay.
Be sure to get a right of way..

Dig a hole both deep and round;
That's where lots of water's found.
Pumps are needed, so are`tanks.
You pay for them with more
than thanks.

Your water works adds this last line:
Delivery is where we shine.
We can't sell water because it's free.
We sell pressure. and purity.

This poem appeared in the March 1990 issue of **H2O Hi-Lites,** ***the newsletter of the Massachusetts Water Works Association. If you know*** *who wrote it, please let us know. We'd like to give credit to the poet.*

H2S in the Distribution System

Bacterial activity in the distribution system may he responsible fin- nuisance odor problems and accelerated corrosion of unprotected mains and household plumbing. As the corrosion releases more excess electrons, the activity of the sulfate-reducing bacteria is also accelerated. The corrosion and bacterial activity sustain each other.

The rotten egg odors and bacterial activity in the water supply distribution system may be controlled by the maintenance of adequate chlorine residuals. Chlorine depletion and related problems are enhanced by stagnant water, such as in dead-end mains and within small-diameter household plumbing, where the bacteria can flourish.

H2S in Water Heaters

Water heater tanks can provide an ideal environment for the production of hydrogen sulfide gas. Modern steel water heaters are glass-lined to prevent corrosion. However, it is impossible to assure 100 percent coverage, especially since cracks may occur while the tank is in service.

Anode prevents corrosion. To protect steel exposed by small cracks in the glass coating, a long rod, or anode, is used to provide cathodic protection. The rod is usually made of magnesium, which corrodes more easily than steel. This corrosion frees many electrons that provide a protective film over the cracks in the glass. The steel will not corrode as long as the magnesium anode remains in the tank.

The number of electrons liberated by the corrosion of the magnesium anode may greatly exceed the amount required to protect the exposed steel of the water heater tank. The excess electrons provide the energy needed by the sulfate-reducing bacteria to produce H2S gas.

Conditions are right. The sulfate-reducing bacteria thrive in the temperature range of most water heaters. In addition, the water heater tank provides for an extended contact time. Where there are many free electrons due to the corrosion of the anode, the hot water heater can be a major contributor to rotten egg odor problems. If the odor is not detected at the cold water tap, the water heater is probably to blame for odor problems.

Aggravating the problem. Many household activities can aggravate the problem: infrequent use of hot water, such as with vacation homes or being away for a weekend, or the use of iron plumbing, which is more likely to corrode than copper or PVC. A water softener reduces CaCO3 levels, reducing protection from corrosion.

Remedies

Replace the magnesium anode. Magnesium is commonly used for cathodic protection anodes because it provides much corrosion protection at the least cost. However, this level of protection is often not needed. Consult a reputable dealer of water heaters for a replacement anode that provides protection without supporting the sulfate-reduction reaction that causes the H2S gas.

Chlorination. Maintaining a chlorine residual of L mg/L throughout the distribution system inhibits bacterial activity. In a nonchlorinated system, homeowners may disinfect and flush their water heater tanks with a chlorine bleach solution. This may solve the problem for weeks at a time.

Kill the bacteria with increased heat. Sulfate-reducing bacteria dies at about 140°F (60°C). Water heaters are factory set at 140°F ± 10°F (60°C ± 6°C), which is the medium setting on the temperature control dial. Increasing the temperature to the high setting 160°F (71°C), for several hours should kill the sulfate-reducing bacteria, then flushing to remove the dead cells should control the odor until the population of bacteria recovers.

CAUTION: The hot water tank must have an operable pressure relief valve, otherwise this method of treatment may be dangerous. The temperature setting must be reduced following treatment to prevent scalding hot water and to avoid high energy costs.

Periodic flushing of low-flow water lines. Flushing low-flow lines and looping water mains to eliminate dead ends will reduce problems associated with bacterial activity.

Editor's Note: *Some water heater manufacturers have switched to aluminu.m alloy modes. See the October* 1989 Opflow *for more information.*