How Do We Keep Smelly Bacteria Out of Hot Water Taps?

Question of the Month

by John Stubbart

Q **We have received several customer complaints regarding a foul, sulfur-like odor from hot water at the tap. All locations have water heaters that are less than 5 years old. Could thermophilic sulfur-reducing bacteria (SRB) account for the smell? Do these grow in water heaters? If so, can we test for them? How? If SRB are in the water, what is the best way to get rid of them and keep them from coming back?**

A. In systems I have operated, we had sulfur smells in hard groundwater and in hot water heaters that had limited or irregular use. If your cold water samples don't release an odor or routine water quality tests (turbidity, pH, chlorine, total coliform) on cold water feed indicate no obvious problems, and no sediment or other foreign material appears at the taps, then you're right, SRB could be your problem.

SRB are serious nuisance organisms because they can cause corrosion as well as severe taste-and-odor problems. These nonpathogenic, anaerobic bacteria form enzymes that have a sulfate-reduction reaction, which creates hydrogen sulfide (H_2S) gas and produces the rotten-egg odor. The bacteria can also react with dissolved metals, such as iron, to generate black deposits. Other coliforms can also create rotten egg smells, but SRB are the most common.

Usually, SRB grow upstream from where the problem is noticed, where bacterial fouling, stagnant water, or another factor has removed oxygen from the water. The lack of oxygen and a sufficient amount of organic materials are conditions that allow these bacteria to thrive. They usually grow in protected places and are often surrounded by other bacteria that can mask their presence. The foul smell often comes from seldom-used locations. Bacteriological tests can confirm SRB presence.

The most common types of SRBs are *Thiobacillus, Beggiatoa, Thiothrix,* and *Thiopedia,* which can be colorless, purple, or green. Besides odor, primary indicators of these types of SRB include tubercles or corrosion of metallic surfaces.

Black slime in a toilet bowl or tank can come from other common SRB, particularly *Desulfovibrio* and *Desulfotomaculum,* which produce H_2S that reacts with the iron, manganese, or other metallic materials in the water to form black metallic sulfides that break up during flushing and produce thread-like strings. Often these slimes are not allied with the rotten-egg smell associated with H_2S.

Hot water tanks make an ideal environment for the production of H_2S gas. The corrosion of the anode in the tank frees electrons that become fuel for the SRB to produce H_2S. The water temperatures in the tanks support the bacteria and allow a longer contact time with the water.

Eradicating SRB

SRB are not easy to deal with because they form a slime using other bacteria to protect themselves. You may never eliminate SRB completely from your water system, but you can control them and work with customers to reduce problems in their residences.

For the hot water problem, you can suggest to your customers that they work with a reputable water heater dealer to replace the magnesium anode in their tanks with another type of anode. Reducing the electrons reduces the SRB. An easier solution may be to increase the hot water setting to at least 160° F (71° C) for several hours because SRB die at about 140° F (60° C). (Water heaters are usually factory set at about 140° F.) The tank should then be flushed with a bleach solution to remove the dead organisms. Make sure the tank has an operating pressure relief valve, otherwise the temperature increase may be dangerous to the system. Also, the temperature should be reduced after cleaning to prevent scalding and high-energy use.

As the water distributor, you can help by maintaining a 1 mg/L chlorine residual

continued on page 8

John Stubbart is the AWWA Small Systems Manager.

Question (from page 7)

throughout your system to inhibit SRB growth. Keeping flow rates up with chlorinated water and increasing use in the affected area — perhaps through a flushing program — will also help. A simple test to monitor for SRB problems is testing for dissolved oxygen (DO); a lack of DO, when compared to other sites, will indicate conditions favorable for SRB growth. Looping systems to avoid dead ends will reduce stagnant water in the system and help maintain chlorine residuals. A good backflow program will help keep bacteria from getting into your system.

Treatment options include disinfection, acidification, and physical cleaning. High doses of chlorine will oxidize the sulfides. With any of these practices, remember to

- ensure the system has been flushed and cleaned thoroughly before starting the treatment program.
- apply the highest recommended dosage of disinfectants and penetrants (acids) and use the longest contact time for the selected treatment program.
- increase the dissolved oxygen in the water to suppress SRB activity.
- consider ongoing or routine application of disinfectants and penetrants to reduce the rate of recovery of the SRB from the "shock" effect of using the high dosage.

Another common treatment practice is diffused aeration, which is a process of passing air or nitrogen through water to physically strip H_2S.

How best to balance treatments is still being debated. Balancing the effective removal of sulfide with lower chlorine demand and the reduction or elimination of colloidal sulfur is the goal. A study by Steven J. Duranceau showed that pretreatment with either sulfuric acid (H_2SO_4) or carbon dioxide (CO_2) to pH 6.0 removed more than 95 percent of sulfides in air stripping tower-feed water with sulfide concentrations of 2.5 mg/L. Carbonic acid (H_2CO_3) offers several advantages over H_2SO_4. It is safer to handle and provides equivalent sulfide removal without loss of alkalinity. In addition, corrosivity indexes indicate that finished water pretreated with H_2CO_3 is less corrosive than water pretreated with H_2SO_4.

For More Information

Opflow has published related articles that you may find useful: "Common Customer Complaints: 'My Hot Water Stinks,'" June 2000; and "Iron Bacteria Still Bugging Operators," Question of the Month, December 2000. Both are available in the *Opflow Online* archives at <www.awwa.org/communications/opflow>. Also of interest is "Phew, My Hot Water Smells Like Rotten Eggs," July 1990.

Also, *Journal AWWA* has published numerous articles on the topic, including "Sulfide and Oxidizing Bacteria: Their Role in Air Stripping," in October 1998, and the study by Duranceau et al., "Comparison of Mineral Acid Pretreatments for Sulfide Removal" in May 1999.

Related products available from the AWWA Bookstore are

- M7, *Problem Organisms in Water: Identification and Treatment*
- M12, *Simplified Procedures for Water Examination,* fifth edition
- M48, *Waterborne Pathogens*
- *An Operator's Guide to Bacteriological Testing*
- *Handbook of Drinking Water Quality,* second edition
- *Taste and Odor: An Operator's Toolbox,* video

To order, visit the AWWA Bookstore at <www.awwa.org/bookstore>, call 1-800-926-7337, or e-mail custsvc@awwa.org.

A good, simple information source on this subject is the Water Quality Association website at <www.wqa.org/consumer/newindex.cfm?do=Investigate>.