Tech Brief
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Tech Brief: Taste and Odor Control

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Summary

Complaints about the taste and smell of drinking water are all too common for many systems. This *Tech Brief* examines common taste and odor problems and provides techniques for dealing with them in the treatment plant.

My Water Tastes Funny

Experienced water system personnel are well aware that most customer complaints are related to taste and odor problems. In fact, one reason that bottled water is popular with people is that taste and odor are less noticeable in the bottled water, or at least that's the perception. By employing certain treatment techniques, plant operators may be able to reduce customer taste and odor complaints.

Here are some typical complaints:

- sewer smell;
- chlorine smell;
- chlorine smell and taste;
- rotten egg smell;
- petroleum smell or taste;
- metallic smell or taste; and
- earthy or fishy smells and tastes.

Addressing taste and odor problems is somewhat challenging for a couple of reasons. First, these issues are, to some extent, "in the nose and tongue of the beholder." In other words, what tastes or smells bad to one person may be perfectly acceptable to another. Second, the factors that contribute to taste and odor problems are classified as secondary drinking water contaminants, meaning that systems aren't mandated to address them. Nonetheless, overcoming these problems can often be accomplished with routine treatment methods, many of them simple and inexpensive.

Sewer Smell

Some taste and odor problems don't come from the treatment process or treatment technique but are due to maintenance issues (or the lack thereof). If water tastes or smells like a sewer or has a musty smell, the culprit is often stale water caused by a lack of turnover, water standing in dead-end lines, long service lines, or little-used lines in a new development. The best way to address this problem is through proper maintenance procedures, including line flushing at regular intervals. Don't forget to account for the water used in line flushing in accountability reports your system may have.

Chlorine Smell

If tap water has a chlorine smell, but taste is not evident, it is possible that the water needs *more* chlorine, oddly enough. The chlorine residual has three parts: combined, free, and total. The sum of the combined chlorine residual and free chlorine residual is the total chlorine residual. When the chlorine demand has been satisfied, the combined residual increases as it combines with organic compounds or ammonia in the water to form chlororganics and chloramines.

These compounds may result in taste and odor problems. Adding more chlorine takes the treated water beyond the breakpoint and provides a free available residual. Figure one shows the breakpoint chlorination curve.

The operator can use a chlorine field test kit to test at the complainant's house for total and free chlorine residuals. If the free chlorine residual is zero or substantially less than the total chlorine residual, there is (or has been) a demand for the chlorine somewhere in the distribution system. To increase the free chlorine residual, flushing the distribution system in the area near the house can work. If flushing doesn't work, the operator should increase the chlorine dosage at the nearest chlorine feeder and then flush the system again. Keep in mind that you have to deal with chlorine by-products and add only enough chlorine to get the free residual close to or equal to the total chlorine residual.

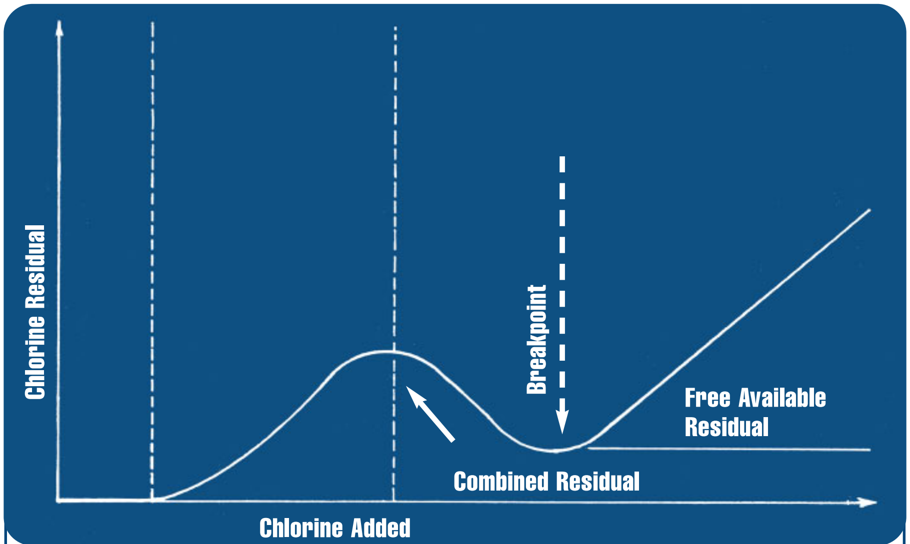

Figure 1 - Breakpoint Chlorination Curve

Source: Water Plant Operation, Volume 1, *California State University, Sacramento,CA Dr. Ken Kerri, Project Director*

To learn more about chlorine, read the articles "Q&A: Disinfection By-products Rule" and "Tech Brief: Chlorine" available on the National Environmental Services Center Web site at *www.nesc.wvu.edu/ndwc*.

Chlorine Smell and Taste

If tap water has a distinct taste *and* smell of chlorine it usually means there is a high chlorine residual in the water—maybe not above the maximum containment level of 4.0 mg/l or ppm, but high enough that the person finds it offensive to the taste.

If the distance from the plant to the end of the lines is long, the system may be chlorinating heavily to maintain a chlorine residual to the end of the distribution system. In this example, the people closest to the chlorination point or plant will probably have higher chlorine residuals, which may generate some complaints. One way to help reduce the heavy dosage would be to add a booster chlorination system in the distribution system. This can be done at a booster pump station, valve vault, or pressure-reducing station, provided there is electricity available to run the small injector pump for the chlorine injection. When sizing the injector pump, take into account the pressure in the line that will receive the injection.

If the system lacks funding or there is no site available to install the booster chlorination system and the chlorine residual is still within the maximum limit, the system can suggest that the customer install an activated carbon filter. This filter will reduce or eliminate the chlorine residual. (If you measure the chlorine residuals at a tap or house with activated carbon filters, you need to do it before the filter.)

During the summer when the weather is the hottest, chlorine dissipates and systems tend to chlorinate more in these months to make up for the demand. Systems may not want to invest in a booster chlorination system for only three or so months out of the year. If your system has a storage tank and if your state permits it, you can dose the water storage tank with a calculated amount of chlorine using the dose equation. This procedure would get the system through the summer months without going through the expense of a chlorination booster station. A drawback, of course, is that someone will have to climb the storage tank to add the chlorine.

Rotten Egg Smell

A smell like rotten eggs is a common complaint in groundwater systems. The rotten egg smell comes from hydrogen sulfide (H_2S). H_2S is not regulated by the national primary drinking water standards but may be regulated at the state level. While H_2S does not usually pose a health risk at low levels (1 to 2 ppm), it is still a nuisance.

If the complaint is with a surface water system, the problem could be low turnover from lack of use or contamination from a sewer. This situation should be investigated immediately. If the complaint is only with the hot water in a customer's house, the problem could be in the hot water tank. The magnesium rod used in heaters for corrosion control can chemically reduce sulfates to H_2S. Replacing the water heater's magnesium corrosion control rod with one made of aluminum or other metal may improve the situation.

The best way to treat water containing H_2S is to aerate the water. Aeration can be done by mechanical or chemical means. Mechanical aeration can be as simple as cascading the water over beads in a vented tank or pumping up to the top of a tower and letting the water fall through orifice plates (also called stack aeration). The more H_2S present, the taller the tower or series of towers must be. This process gives more time to release the H_2S through aeration. Be sure to properly vent the tank or tower to the outside.

Chemical aeration treats the water with oxidizing chemicals, such as potassium permanganate or chlorine, with at least 20 minutes of contact time. Whether you use mechanical or chemical aeration, it must be done before any other treatment or early in the treatment process and before any filters (if filters are used in the treatment process). Other treatment methods include ion exchange, oxidizing filters, manganese greensand filtration, and carbon filtration. Carbon filtration will work if the presence of H_2S is low.

Petroleum Smell or Taste

Petroleum smell or taste sometimes occurs in groundwater systems that may be near areas of naturally occurring gas and oil. Benzene is often the main contaminant in this case, but there may be others as well. The U.S. Environmental Protection Agency's National Primary Drinking Water Standards sets the maximum contaminant level (MCL) for benzene at 0.005 mg/l or ppm with a public health goal of zero. If the contamination is not too severe, the best way to treat groundwater with this problem is to use activated carbon filters as soon as the water is pumped out of the well, then injecting chlorine as an oxidant before it enters a contact tank. The tank allows time for the chlorine to oxidize the contaminant.

The contact tank must be sized according to water consumption to give at least 20 minutes or more of contact time. If the contamination is more severe, aeration by mechanical means, such as stack aeration, along with the activated carbon and chlorine may be necessary. Activated carbon filters must be changed periodically. If this method doesn't work, a new well may have to be drilled, and there is no guarantee that the same problems won't be encountered.

Metallic Smell or Taste

If the water has a low pH, it is acidic and can corrode the inside of metal distribution and copper service lines, causing the material to leach into the water. Keep an eye on the finished water and adjust the low pH with caustic soda, soda ash, or another type of pH adjuster. When using a liquid feeder, mixing the soda ash with warm water will help dissolve the solution before injecting it into the water. Also having the room temperature where the liquid feeder is set at 62°F or higher will keep the caustic soda or soda ash from crystallizing. (Caustic soda crystallizes at about 54°F.)

If the pH adjustment is not working, another way to help prevent corrosion would be to add a sequestering agent, which adds a coating on the inside of the line to protect the metals from corroding and leaching into the water. Typical sequestering agents are sodium hexametaphosphate and zinc orthophosphate. Adding a sequestering agent will also help keep iron and manganese in suspension in the distribution system. When you use zinc orthophosphate, remember that it is a heavy metal and is regulated for land application. If your state allows sludge from water plants to be used in land application or if the sludge from the water plant is piped to a sewage treatment plant, the zinc orthophosphate could cause additional problems.

Earthy or Fishy Smells

Other complaints include earthy or fishy smells and tastes that can usually be traced back to the source water. These problems vary with the changing seasons. One of the culprits could be algae growth. Algae are usually blue-green in color and are easy enough to spot if present in the source water.

If algae bloom is present in the source water, copper sulfate, a blue, odorless, crystalline or grayish powder, can be added to kill the algae. Be sure to check with the manufacturer of the chemical for the proper amount to broadcast on the surface of the water. Some states will not allow copper sulfate to be added to rivers or streams because it kills fish and other aquatic life. But it may be acceptable to add the compound to reservoirs that are source water for drinking purposes. Only add enough to do the job; don't over dose. Several trips to the reservoir at different times of the year might be necessary.

If you can't use copper sulfate for regulatory or other reasons, there are some alternatives. Adding an aeration pump to the source water is one. These mechanical aerators can be operated by battery, solar, or wind power, or direct electrical connection. In addition to eliminating algae, aerators can also reduce H_2S, iron, manganese, and phosphorus.

Another problem occurs in the fall when leaves drop from the trees, and vegetation dies off depositing organic material in the water. Treating the water with potassium permanganate has long been used for taste and odor control under these conditions. Potassium permanganate usually comes in a dark brown liquid or a coarse, dark brown powder that can be dosed with a dry feeder or mixed in a slurry and added via a liquid feeder. Feed the potassium permanganate at the raw water intake to take advantage of the standing time available in the raw water transmission line and to insure that all of the oxidant is used up before the addition of other chemicals, such as chlorine disinfectant, coagulants (such as alum), or activated carbon. Normal dosages of potassium permanganate to control taste and odors ranges between 0.5 and 2.5 mg/l, depending on the degree of raw water contamination. The average dosage is approximately 1.0 mg/l. To determine the dosage and feed rate, jar testing is needed. Residual potassium permanganate analytical methods can be used to determine feed rates as well.

Activated carbon is another treatment option that can be used in conjunction with potassium permanganate. Activated carbon powder can be mixed in a slurry solution and added to the treatment process in the sedimentation basin or on top of the filters. If you use potassium permanganate and activated carbon, you should use up the potassium permanganate before the activated carbon is added. Some operators of very small systems hand-broadcast the powder on the sedimentation basins or filters when only used seasonally. Activated carbon is available in granular form and can be added as a two- to three-inch layer on top of the filters, provided there is room. The granular carbon layer should be removed after a period of time, because it will lose its effectiveness and be detrimental to the filters. Activated carbon will reduce or eliminate the chlorine residual in the finished water, so add it before any post chlorination. Activated carbon can also be used in solid form as extruded carbon filters, although they may be more expensive and would need to be plumbed into the system.

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