Treating bacterial infestations in water supply wells*

Bacterial contamination is a common water well problem. Bad taste and odor, along with red water, and ultimately reduced pumping capacity, can be the direct result of a bacterial infestation.

The culprits in bacteria contamination cases can be attributed to one or two sources: iron-oxidizing bacteria or sulfate-reducing bacteria. The common types of iron bacteria found in many wells are aerobic (requiring free oxygen). Aerobic bacteria oxidize ferrous iron and manganese, using the energy derived to promote the growth of threadlike slimes, and depositing large amounts of ferric hydroxide. Natural waters which contain iron and manganese are very susceptible to this bacteria.

The sulfate-reducing bacteria are usually the anaerobic type (able to live in the absence of free oxygen). These organisms often exist in the deeper wells, but they can also be found in shallow wells principally contaminated with aerobic bacteria.

Iron bacteria is almost universally present in the topsoil, readily available to infect wells while they are being drilled, while they are being worked on (such as having pumps pulled or set), and while they are left open to the atmosphere. It is unclear whether iron bacteria exist in shallow ground water before wells are constructed.

Iron bacteria frequently develop in wells when sufficient iron and/or manganese is present in groundwater, along with dissolved organic material, bicarbonate, or carbon dioxide. This usually occurs when the total iron and manganese concentration is 0.35 milligrams per liter (mg/L) or more.

A water user complaint might be that the water "tastes like oil", "tastes rotten", "smells like rotten eggs", "stains everything red (or black)", "makes lousy coffee', or variations of these. Unfortunately, a bacteria contaminated well can have all of these symptoms.

While these problems are being reported, the well will probably be losing some of its pumping capability or - at the very least - it will require more drawdown to produce the same amount of water. This is due to the bacteria reducing the permeability of the water-producing formation through deposition of their metabolic by-products (e.g., “slime”) or from their very presence in large numbers.

It will probably be necessary to hire a contractor to thoroughly clean and rehabilitate the well, if the well plugging has progressed too far. If minor problems are noted and corrected early, it may be possible to operate the well for many years without undue rehabilitation expense. The corrective action is to keep the well clean and clear of bacterial contamination by periodically treating the well with a bactericide.

Oxidation is the most common method of killing bacteria and removing the organic sludge they produce. Chlorine is a strong oxidizing agent and serves as a very effective bactericide. It can oxidize or literally "burn up" organic material. Chlorine has advantages as a bactericide since it is inexpensive, readily available, and accepted by the most public health officials as suitable for use in potable water supply wells.

A chlorine concentration of as little as 100 mg/L can be used for routine disinfection of a well following well repair, pump repair, or new pump installation. A stronger treatment solution concentration of 400 to 2,000 mg/L is desirable for treating wells contaminated with bacteria. The amount of solution and the procedure used to obtain contact are very important.

A well owner or operator can use a fairly simple method to chlorinate their own well or wells. First, determine the amount of water in the open well bore by measuring the depth to water and the depth of the well. Subtract the water depth from the well depth to determine the feet of standing water in the well. Multiply this figure by the gallons per foot in the well casing. (*Please refer to table below.*) Multiply this open-hole volume by 2.5, since most wells are gravel packed. This gives a total volume that approximates the amount of water in the well bore and the gravel pack.

Diameter in inches of screen and casing	Volume of water in gallons per foot of open hole depth
6	1.5
8	2.6
10	4.1
12	5.9
16	10.4
18	13.3

Bacteria will generally be growing in the well casing and on the pump, in the gravel pack, and at the face of the bore hole. As infestations increase, they grow further out from the bore of the well, occupying a large volume which requires larger and larger treatment volumes. The minimum amount of treatment solution to be used should displace all of the water in both the open well bore and the gravel pack in the annular space.

An example of the amount of treatment solution to use in a 200' x 12" well would be as follows:

200'	*Well depth*
- 50'	*Depth to static water level*
150'	*Feet of water in well*
X 5.9	*Gallons/foot in 12" casing*
885	*Gallons in well bore*
X 2.5	*Multiplier for gravel pack (an approximation)*
2,212.5	*Gallons in well bore and gravel pack*

Next, determine the amount of chlorine that will be needed. Any sodium hypochlorite (liquid) or calcium hypochlorite (granular) may be used. The difference is that they contain various amounts of available chlorine. Most liquid bleaches (such as Clorox®, Purex®, and White Magic®), contain about 5 percent available chlorine, while sodium hypochlorite purchased from a chemical supply company will often contain 10 percent available chlorine.

Calcium hypochlorite is purchased as a white, granular material, typically containing 65 percent available chlorine by weight. HTH® is a common product.

Note: Do **not** use granular calcium hypochlorite to treat a new well to avoid plugging problems. Use sodium hypochlorite with new wells and either calcium hypochlorite or sodium hypochlorite on wells that have been in production for a time.

Quantities of chlorine compounds required per 1,000 gallons of water for treatment solution of desired chlorine concentration.

Chlorine concentration	Sodium hypochlorite		Calcium hypochlorite, 65%
	5%	10%	
100 mg/L	2 gallons	1 gallon	1.3 pounds
500 mg/L	10 gallons	5 gallons	6.4 pounds
1,000 mg/L	20 gallons	10 gallons	12.8 pounds

If a well shows signs of bacteria, or if it has not been cleaned within the past year, then use a chlorine treatment solution of 400 mg/L. Continuing the example of a well needing about 2,200 gallons of treatment solution, the chlorine requirement would be:

1.3	*Pounds of calcium hypochlorite to make a chlorine concentration of 100 mg/L (see Table 2)*
X 4	*(4 = 400 mg/L ÷ 100 mg/L)*
5.2	*Pounds to make a chlorine concentration of 400 mg/1 in 1,000 gallons*
X 2.2	*(2.2 = 2,200 gallons ÷ 1000 gallons)*
11.44	*Pounds of calcium hypochlorite to make a chlorine concentration of 400 mg/1 in 2,200 gallons.*

This should preferably be mixed in an above-ground tank. If a large tank is not available, then use a smaller tank and mix the chlorine proportionately. It is important to use the proper amount of treatment solution. The solution should then be pumped or poured into the well through the pump, if not equipped with a foot valve. If it is equipped with a foot valve, then it will be necessary to introduce the solution into the well by pouring it into the annulus between the pump column pipe and the well casing.

If no mixing tank is available, the chlorine can be mixed in small amounts in a five-gallon bucket and poured into the pump discharge. Then remove the flapper from the check valve and allow the estimated volume of water to flow back into the well through the pump. Getting sufficient chlorine and total volume of treatment solution into the well is important!

Chlorine can only destroy the bacteria that it contacts. It is necessary to agitate the water in the well to disperse the chlorine into as many cracks and crevices as possible. The agitation process can best be accomplished by pumping the treatment solution into an above-ground tank, then allowing it to drain back into the well.

If no tank is available, then start-and-stop the pump to surge the water, but do not allow any of the treatment solution to leave the well. The agitation process should continue for at least two hours. Then the chlorine solution should be allowed to stay in the well for another eight to ten hours.

Pump the treatment solution to waste using a surging action. That is, start the pump, let it run a couple of minutes, and shut it off. Wait two minutes, turn it on and repeat the process. As the surging continues, the time that the pump stays on can be extended. Thus all of the treatment solution and dissolved material will be removed from the well.

When the water begins to clear, pump the well continuously until only a slight chlorine odor remains in the water. It will probably require four to eight hours of pumping prior to reconnecting the pump to the system.

Treating your well this way once or twice a year will reduce the bacteria problem considerably. It is also reasonable to expect that this process will increase the useful life of your well and extend the time before it is necessary to perform major rehabilitation work on the well.

Another recommended practice is to disinfect the well bore every time work is required that involves lifting the pump. In other words, if a pump is pulled for repair, chlorinate the well immediately and leave the solution in the well while the pump is being repaired. A chlorine concentration of 100 mg/1 is satisfactory for this purpose if the well is presumed free of bacteria at the time.

The entire pump should be washed down with a chlorine solution before reinstallation. This procedure is talked about, but is seldom performed conscientiously. Well owners and operators should insist upon it. This practice will assist in keeping the well clean and free of bacterial contamination.

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