University of Nevada Cooperative Extension

CSREES Southwest States & Pacific Islands Regional Water Quality Program
Applying knowledge to improve water quality

Fact Sheet–06-68

Shock Chlorination:

Background and Principles

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This fact sheet explains shock chlorination, a procedure often used to disinfect water wells. It explains what shock chlorination is, under what circumstances wells should be disinfected, what chemicals are used to accomplish disinfection, and how to test water to determine if shock chlorination is needed or was effective. The fact sheet is meant as background for "Shock Chlorination: Estimating the Amount of Bleach Needed, (FS-06-69)" and "A Step-by-Step Guide to Shock Chlorinating Wells and Home Water Supplies," (FS-06-70).

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WHEN TO DISINFECT A WELL AND HOME WATER SUPPLY

There are several reasons to disinfect your well. Perhaps the most compelling is when well water does not pass a fecal coliform bacteria test. The fecal coliform test measures the number of fecal coliform bacteria present in a water sample. Fecal coliform bacteria are found only in the fecal matter of warm-blooded animals. Their presence in a sample indicates that the water has been contaminated with feces. Although fecal coliform are usually not harmful, other pathogens may be present in feces.

The fecal coliform test should be performed on a well whenever property ownership changes. Some states and counties now have ordinances requiring such a test. Institutions that finance mortgages and real estate agencies often require this test. You should also test your water if household members are chronically sick with nausea, diarrhea and other gastro-intestinal problems.

Fecal bacteria can be introduced when repairs and maintenance are performed on a well or the plumbing system. Whenever work involves opening a well or exposing the interior of a potable water line, most health codes recommend that the system be disinfected prior to being used again. This is partly because most plumbing supplies are stored in warehouses that have resident pest populations. Feces from pests can easily come in contact with pipes and fittings. Handling contaminated surfaces can also introduce bacteria into piping during plumbing repairs.

In most cases, the easiest way to accomplish well disinfection is through the use of ordinary, unscented household bleach.

It is important to disinfect a well after opening it, even if no parts were replaced. Wells can be easily contaminated with bacteria during inspection, maintenance and repair. When the sanitary well cap is removed, accumulated fecal pellets from rodents can fall into the casing. Wells with steel casings may develop a coating of rust and loose metal flakes can fall into the well. If bacterial spores are attached to the casing they can contaminate water.

A fecal coliform test generally costs less than thirty dollars and results of the test can be expected within a week or two of sampling. See the last part of this fact sheet for a step-by-step description of how to collect a sample for fecal coliform testing.

USE THE PROPER CHEMICALS

Well water disinfection can be accomplished by shock chlorination — a chemical process used to kill bacteria growing in a well and a household water supply system. In most cases this is done with ordinary, unscented household bleach, which contains 5.25% sodium hypochlorite, the active ingredient for disinfection.

Other chemicals are available for disinfecting swimming pools and spas. However, these may contain other ingredients, such as algaecides, slimicides, water clarifiers and perfumes that are unsuitable for use in drinking water. Chemicals that have a bromine base (indicated by chemicals that have names that include bromo, bromate, bromite or bromide) should never be used for drinking water disinfection. Always check the label of a product before using it to disinfect a drinking water well. If you have doubts about the suitability of a chemical for water disinfection, contact the manufacturer to determine if the product is suitable for use with drinking water supplies.

THE PRINCIPLE OF CONTACT TIME

In order to be effective, a disinfectant, such as chlorine, must be dissolved in water in a concentration that will be lethal to bacteria, and the bacteria must exposed long enough to be effected. In the water treatment industry this is characterized as C_t, the product of concentration of the disinfectant and the number of minutes that this concentration is present in water and in contact with bacteria:

$$C_t = \text{Concentration of disinfectant (mg/l)} \times \text{time (minutes)}$$

The contact time needed varies with chemical and physical characteristics of water, including temperature, pH and presence of substances in water that combine with chlorine to make it ineffective in killing bacteria. Chlorine works better at warmer temperatures than colder temperatures and at lower pH than higher pH.

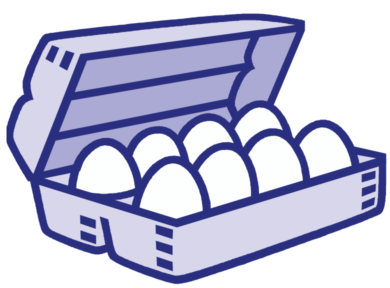
Different micro-organisms are more resistant to chlorine than others. *Giardia* is a parasite often found in water in a form that resists chlorination. As a result, many public water suppliers use contact times that, in combination with other parts of the water treatment system, should ensure that *Giardia* will be killed during treatment. Because *Giardia* is more resistant to chlorine than other micro-organisms, such as fecal coliform, contact times sufficient to kill *Giardia* should ensure that other pathogens are killed as well.

As an example, with water than has a pH of 8.0 and minimum temperature of 41°F a concentration of 3.0 mg/l of free chlorine should be maintained for at least 96 minutes to ensure that 99.9% of Giardia is inactivated. This is represented as a C_t of 289 mg·min/l.

Homeowners may have difficulties determining the proper C_t to disinfect water, in part because they may not be able to determine how much chlorine is actually free in water and they may not be able to measure the pH. We recommend that homeowners create solutions of at least 250 ppm chlorine and that they allow the solutions to stand for at least twelve hours. Although this is far in excess of recommended values of C_t for public water supply treatment, the high concentration and long contact period ensure that even if substances in the water combine with chlorine, and temperatures and pH conditions are suboptimal, all bacteria will be removed.

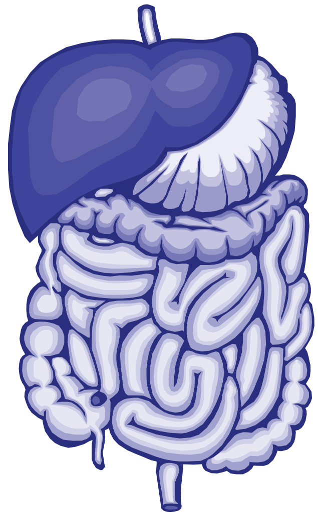
COMMON CAUSES OF TASTE, ODOR AND COLOR PROBLEMS

One of the most common concerns about well water is related to a rotten egg smell, usually due to the presence of hydrogen sulfide gas dissolved in water. Often the problem is related to bacteria that are living in the well or the household plumbing system. Hydrogen sulfide is a byproduct of bacteria



A rotten egg smell, usually due to dissolved hydrogen sulfide gas, is a common concern about well water.

that use sulfate as an energy source. When sulfate is metabolized the ions are reduced to sulfide, which combine with hydrogen to produce hydrogen sulfide gas. This is the same gas that is produced when anaerobic bacteria metabolize sulfur-containing proteins in eggs, leading to a characteristic "rotten-egg" odor. Generally, water with more than 1 ppm of dissolved hydrogen sulfide is unpalatable because of very strong odor. The odor is likely to be even stronger in hot water, because hydrogen sulfide is released as water temperature increases.



Fecal bacteria are adapted to the human digestive system. Some fecal-borne pathogens such as Giardia also survive outside the digestive system.

SOURCES OF FECAL COLIFORM

Naturally occurring bacteria exist almost everywhere and most are harmless to humans. Most aquifers have bacteria that metabolize soil minerals, organic compounds and even other micro-organisms. The bacteria most harmful to human health are likely to be those introduced into aquifers and wells from human and animal feces.

Fecal bacteria are adapted to pH and temperature ranges in the digestive system of the human body. The human digestive system is warm, acidic, and full of enzymes that break down food. Micro-organisms adapted to these conditions are more dangerous to humans than those that are adapted to living in the temperature and pH ranges typical of aquifers and wells.

This type of micro-organism can be introduced directly when fecal material enters a well, for example when rodents enter the well casing. For this reason, it is important to check the well cap to be sure that it covers the casing and allows little room for rodents to pass through.

Fecal coliform can also be introduced if heavy rains or nearby irrigation flood the wellhead, especially if the casing is cracked or the well seal is breached.

TESTING FOR COLIFORM IN WATER

Fecal coliform bacteria tests must be run by a certified drinking water analysis laboratory and all sampling procedures must be followed carefully to ensure that the sample results are meaningful.

Water may be analyzed by the Nevada State Health Laboratory, or by privately managed laboratory. If you choose a private laboratory, make sure that it is certified by the Nevada Division of Environmental Protection to test for bacteria in drinking water. For a list of certified laboratories, see http://ndep.nv.gov/bwqp/Lab/CertifiedLabs/certifiedLabs.aspx. Cost of the routine analysis varies with private labs, so ask for rates in advance.

It is very important to understand all instructions before taking and submitting a sample. Use a sterile sampling container provided by the laboratory that will do the analysis. The steps described for sample collection below are critical for preventing contamination and preserving the sample.

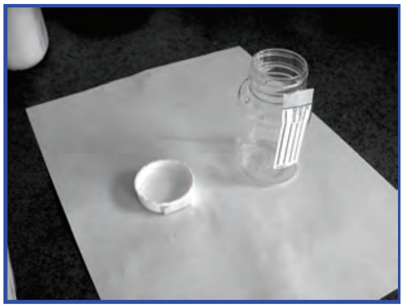
- Obtain a sampling bottle from a certified drinking water analysis laboratory. These bottles are sterile, sealed, and often contain a small amount of chemical powder (thiosulfate) that is used to dechlorinate water.

- Select a sampling outlet that is of concern or is closest to the well head (for example a kitchen sink, or outside tap). A sample taken from the tap closest to the well head will help to determine if the well itself is contaminated. If it is accompanied by a sample from a faucet from which water is frequently consumed (such as the kitchen sink), results of both can be compared to determine if the source of contamination is in household plumbing or the aquifer.

- Prior to taking a sample, remove any hoses or sprinklers. It is also helpful to remove faucet aerators.

- Turn on the water and allow it to flow for 2-3 minutes. Flow should be at a moderate rate to avoid splashing or overflow when filling the sample bottle.

- Carefully unscrew the sampling bottle cap and place it on a clean sheet of paper with the interior of the cap facing up. Do not touch or breathe on the interior of the cap or bottle.



- Fill water to the level recommended by the certified drinking water analysis laboratory. Do not overfill. Carefully replace the lid on the sample bottle, being sure to not touch the interior of the sample bottle or lid. Tighten the cap firmly to ensure that no water leaks out.

- Complete any forms and be sure to include all information requested, especially your name, address, the address from which the sample was collected, the location in the household where the sample was obtained and the date and time the sample was collected.

- The sample should be submitted as quickly as possible, at most within 30 hours of collection. If samples must be stored, be sure that storage temperatures are less than 50° F, but above freezing. Samples should never be frozen or warmer than 50° F before being submitted to the laboratory.

- Be sure to check that the laboratory can provide a valid analysis when submitting the sample. Some facilities do not process samples on weekends and holidays and will not perform tests if they feel that the sample will not be processed within the time limit of 30 hours from collection.

INTERPRETING THE TEST RESULTS

Ideally, no fecal coliform bacteria should be found in a sample from a drinking water source. If sample analysis indicates that coliform are present in the water, it may be useful to test again to be sure that the first test was correct. If the second sample confirms results of the first test, shock chlorinate the well and household plumbing to disinfect the system.

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Additional Resources:

A Step-by-Step Guide to Shock Chlorinating Wells and Home Water Supplies," (FS-06-70)

Water Testing for Private Well Owners (SP-00-02: www.unce.unr.edu/publications/SP00/SP0020.pdf)

Matching Drinking Water Quality Problems to Treatment Methods (SP-00-19: www.unce.unr.edu/publications/SP00/SP0019.pdf)

Drinking Water Quality in Nevada (FS-00-46: www.unce.unr.edu/publications/FS00/FS0046.pdf)

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