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Drinking Water Treatment

Continuous Chlorination

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Continuous chlorination can be an effective method to disinfect drinking water.

Continuous chlorination can effectively disinfect drinking water. It also can be one step in the process of removing iron, manganese, or hydrogen sulfide. Continuous chlorination should not be a substitute for a sanitary water supply. Protecting the water supply from contamination should be the primary goal for assuring good water quality. Continuous chlorination can be a costly and complex treatment process and is often only considered after other options are exhausted. This guide discusses the principles, processes, and requirements of continuous chlorination systems for the domestic (household) user.

Contaminants Treated by Continuous Chlorination

Continuous chlorination can treat drinking water containing pathogenic (disease-causing) bacteria, viruses, and other microorganisms, to produce drinking water considered by public health officials to be essentially pathogen free. Continuous chlorination can also be used to manage nuisance bacteria.

In addition, chlorine will oxidize iron and manganese so they can be filtered out and will oxidize hydrogen sulfide to reduce nuisance odors.

Contaminants Not Treated by Continuous Chlorination

Chlorine will not remove nitrate from water. It will not remove heavy metals, calcium and magnesium (hard water minerals), fluoride, and many other compounds. The concentration of chlorine typically applied for disinfection will not adequately destroy protozoan cysts such as Giardia and Cryptosporidium. These contaminants are not normally found in Nebraska groundwater but may be present in contaminated surface water. How effective the removal or destruction of microbial contaminants by chlorination will be depends on numerous factors discussed later, under Treatment Principles.

No one piece of treatment equipment manages all contaminants. All treatment methods have limitations, and often situations require a combination of treatment processes to effectively treat the water. Refer to Extension Circular EC703, *Drinking Water Treatment: An Overview for a discussion of possible water quality problems and appropriate treatments*. Further information can be obtained from the appropriate treatment guide in the Drinking Water Treatment series, available online at the website, http://water.unl.edu/drinkingwater.

Water Testing

Regardless of the water treatment system being considered, the water first should be tested to determine what substances are present and at what concentrations. Public water systems are routinely tested for contaminants. Water utilities are required to publish Consumer Confidence Reports (CCRs), which inform consumers on the source of the water, contaminants that are present, potential health effects of those contaminants, and methods of treatment used by the utility. Depending on the number of customers served by the utility, CCRs may be mailed, published in newspapers, or posted on the Internet. A copy of the CCR can be obtained by contacting the local water utility. Public supplies must conform to federal standards established by the Safe Drinking Water Act. If contaminants exceed the Maximum Contaminant Level (MCL), the water must be treated by the water utility to correct the problem and/or another source of water suitable for drinking must be provided.

In contrast, monitoring private water systems is the responsibility of the homeowner or water user. Therefore, contamination is more likely to go undetected in a private water supply. Knowledge of the contaminants present in the water should guide the testing, since it is not economically feasible to test for all possible contaminants. It is essential to know what contaminants are present, their quantities, and reasons for their removal (e.g., to reduce contaminants posing health risks, to remove tastes or odors, etc.) before selecting treatment methods or equipment. For information on testing private drinking water for three common contaminants for which continuous chlorination might be considered—bacteria, iron and manganese, and hydrogen sulfide—see NebGuides *Drinking Water: Bacteria* (G1826), *Drinking Water: Iron and Manganese* (G1714), and *Drinking Water: Sulfates and Hydrogen Sulfide* (G1275).

Treatment Principles

The *best* option for assuring good water quality is protecting the water source from contamination in the first place. If your water supply does become contaminated, removing the source of contamination is the ideal solution. Chlorination should not be a substitute for a sanitary water supply. Because of the cost and management requirements of continuous chlorination, many water treatment professionals will suggest drilling a new well (or in some cases moving the source of contamination, such as a septic tank) as a preferable option over continuous chlorination.

The disinfecting effectiveness of chlorine depends on the concentration in the water, the amount of time it is in contact with the water prior to use (contact time), the water temperature, water pH, and the characteristics of the contaminants and water supply. When chlorine is added to water, it reacts with microorganisms, certain chemicals, plant material, and compounds that can cause taste, odor, or color in the water. These components "tie up" some of the chlorine, which is called "chlorine demand." The chlorine that does not react with these contaminants is free, or residual, chlorine. The breakpoint is the concentration of chlorine that just meets the chlorine demand so that a higher concentration would allow for some residual chlorine. It is important to have enough chlorine in the water to meet the chlorine demand and allow for residual disinfection. Test kits are available from plumbing or water supply equipment dealers for testing chlorine in private systems. Be certain the kit used tests free chlorine, not total chlorine.

The concentration of free chlorine necessary for adequate disinfection is system-dependent; the chlorine concentration depends on the amount and type of contamination present, water pH, and temperature, etc. Consult your water treatment specialist for guidance on the proper free chorine residual concentration for your situation.

Household chlorination systems may provide a higher free chlorine concentration than the typical 0.3–0.5 ppm (parts per million) concentration used for chlorination of public water supplies. The distribution system of a public water system provides a much longer contact time than a household plumbing system so a lower concentration may be used for disinfection. Piping in home water systems generally provides very limited contact time for chlorination since the time between the pump and the nearest faucet is usually one minute or less. A coil of plastic pipe may be used to increase the contact time within the system. The length of pipe needed depends on the flow rate and the pipe diameter; consult a water treatment professional to determine the length needed for your system.

Other features such as storage tanks with baffles or mixers may be installed by professionals to increase contact time so lower chlorine concentrations typical of public systems can be used. Other systems increase contact time by chlorinating the water in the well before it is pumped to the house. For information on different types of chlorination systems, see the discussion on treatment equipment later in this guide.

The reaction of chlorine with trace concentration of naturally occurring organic matter can produce compounds such as trihalomethanes (THMs) as by-products of the disinfection. These may increase the risk of certain cancers. The EPA mandates that public water systems have less than 80 parts per billion (ppb) of THMs in their treated water. THMs are primarily a concern for surface water supplies. Groundwater rarely has high levels of organic matter so exposure to THMs from chlorinating private well water is generally low. Also, exposure can vary with season, contact time, and water chemistry. Though there is a risk associated with consuming THMs in chlorinated water, the health risks associated with consuming pathogen-contaminated water are far greater.

Chlorine concentrations used for disinfecting water are not toxic to humans or animals. The concentration can be high enough, however, to create a taste or odor that some people find objectionable. Activated carbon filtration following chlorination may be used to remove residual chlorine and the taste and odor associated with it. In addition, activated carbon filtration can be effective in removing some THMs and other trace disinfection by-products from drinking water. Activated carbon filters will need periodic replacement according to manufacturer's instructions. See NebGuide G1489, *Drinking Water Treatment: Activated Carbon Filtration* for further information on the activated carbon filtration process.

Equipment

Chlorine is available in dry form as either a powder or pellets (calcium hypochlorite) or in liquid form (sodium hypochlorite). Both forms of chlorine must be stored in accordance with the manufacturers' recommendations for safety purposes and to maintain the chemical integrity of the product. Chlorine gas as used by public utilities is too dangerous and costly for household use.

There are three common types of chlorinators for continuous chlorination of a home drinking water supply: a chemical feed pump, an injection device, and a tablet chlorinator. Because the effectiveness of the disinfection is a function of contact time, in each type of chlorinator the chlorine should be introduced into the water as close to the source as possible. This will allow the chlorine a longer contact time with the water.

Figure 1 shows a chemical feed pump chlorinator. A fixed amount of chlorine solution is delivered with each pump discharge stroke. The amount delivered can be adjusted by changing the length of the discharge stroke, the speed of the pump, or the running time of the pump. The feed pump should be wired to the water well pump pressure switch so that the chemical pump operates only when the water well pump is operating. The system should also have a device to indicate when the chlorine solution supply is low or if the chemical pump fails.

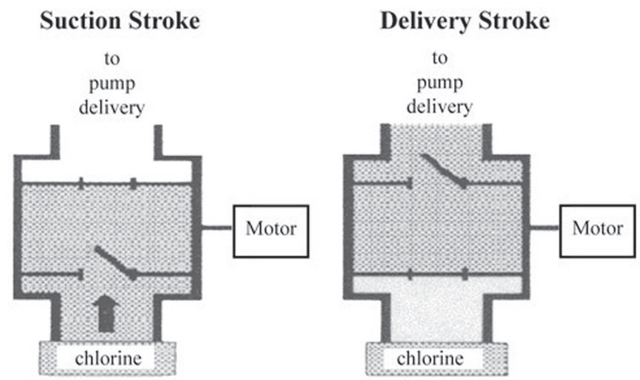

Figure 1. Chemical feed pump chlorinator (from *Chlorination of Drinking Water*, Wagenet, L., and Lemley, A., Cornell Cooperative Extension, New York State College of Human Ecology).

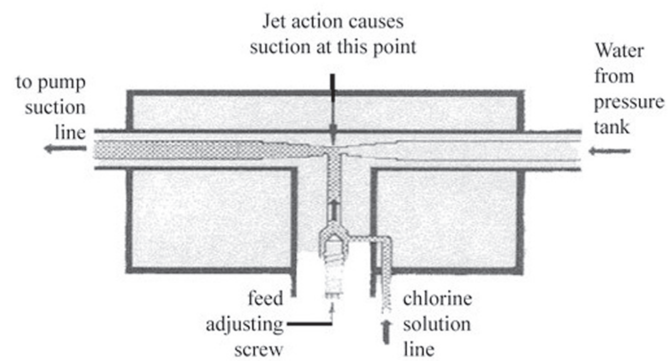

Figure 2. Injection type chlorinator (from *Chlorination of Drinking Water*, Wagenet, L., and Lemley, A., Cornell Cooperative Extension, New York State College of Human Ecology).

Figure 2 shows a chlorine injection device. This device, also known as an aspirator, draws chlorine into the water supply system by jet action. The amount of chlorine drawn in can be adjusted by the feed screw.

Figure 3 shows two tablet chlorinators. The tablet chlorinator in A) feeds dry chlorination pellets directly into the well casing so water is disinfected at the source prior to pumping. Water washes past the pellets, dissolves them, and flows to the pump inlet screen where it mixes with water from the bottom of the well. The tablet chlorinator in B) circulates a small amount of water through a container of tablets before re-entering the water supply system. The amount of water allowed to circulate through the tablet container determines the chlorine concentration and can be adjusted by the restrictor valve.

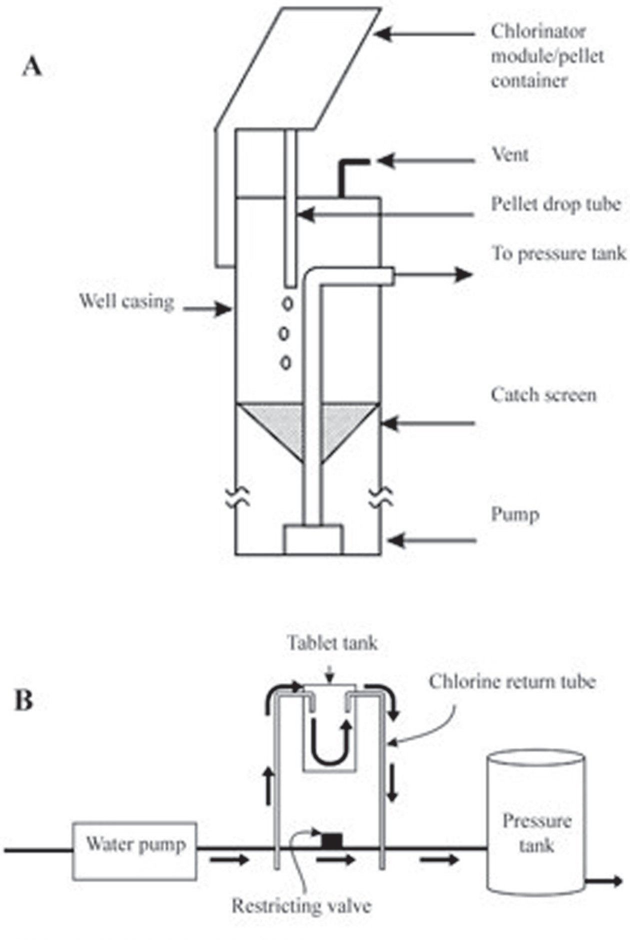

Figure 3. Tablet-type chlorinators.

Selection Requirements

Federal, state, or local laws do not regulate continuous chlorination home systems; the industry is self-regulated. The NSF (formerly known as the National Sanitation Foundation) and the Water Quality Association (WQA) evaluate performance, construction, advertising, and operation manual information. The NSF program establishes performance standards that must be met for endorsement and certification. The WQA program uses the same NSF standards and provides equivalent American National Standards Institute (ANSI) accredited product certifications. WQA certified products carry the Water Quality Association Gold Seal. Though these certifications and validations should not be the only criteria for choosing a continuous chlorination system, they are helpful to ensure effectiveness of the system.

Other important guidelines for consumers purchasing drinking water treatment equipment are discussed in NebGuide G1488, *Drinking Water Treatment: What You Need to Know When Selecting Water Treatment Equipment*(. The NebGuide series on drinking water treatment focuses on contaminants most likely to be encountered in Nebraska drinking water supplies.

Summary

Drinking water treatment using continuous chlorination disinfects a water supply. It destroys pathogenic bacteria, viruses, some parasites and other microorganisms, as well as nuisance bacteria. It also oxidizes iron and manganese so they can be filtered out, and oxidizes hydrogen sulfide in order to reduce nuisance odors. Continuous chlorination is a complex and relatively expensive treatment process. It requires continuous monitoring and knowledgeable management. Using continuous chlorination to control bacteria should not be considered without consulting a professional and fully exploring other options, such as drilling a new well or eliminating the source of contamination.

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This publication has been peer reviewed.
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