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# Chloramines Water Disinfection: Omaha Metropolitan Utilities District and Lincoln Water System

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Bacteria and other disease-causing organisms in drinking water can cause intestinal infections, dysentery and a variety of other illnesses. Water disinfection reduces disease-causing organisms and prevents the transmission of disease. This NebGuide discusses the disinfection process used by the Omaha Metropolitan Utilities District and Lincoln Water System.

## Disinfection of Public Water Supplies

A public drinking water supply is defined as a system that provides piped water for human consumption to at least 15 service connections or regularly serves at least 25 individuals. All water supplied by a public water system is regulated by the U.S. Environmental Protection Agency (EPA) under the Federal Safe Drinking Water Act. The Nebraska Department of Health and Human Services (DHHS) Department of Regulation and Licensure administers the Safe Drinking Water Act in Nebraska.

Public drinking water is regulated for more than 90 different contaminants. Water that meets these standards may not be pure but will be safe for human consumption. Bacteria and other pathogenic (disease-causing) organisms are among those regulated by the Safe Drinking Water Act. The presence of bacteria and other pathogenic organisms in drinking water is a concern because they can cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera and gastroenteritis, among other illnesses. Whether a person contracts these diseases from water depends on the type of pathogen, the number of organisms in the water, the strength of the organism, the volume of water ingested and the susceptibility of the individual. Purification of drinking water containing pathogenic organisms requires specific treatment called disinfection, which reduces the pathogenic organisms to levels designated safe by public health standards. This prevents disease transmission. Both primary and secondary water disinfection can be used in a public drinking water supply. Primary disinfection kills or inactivates pathogens in water at the water treatment plant. Secondary disinfection provides a residual to control microbial growth as the water moves through the distribution system.

Historically, disinfection has played a major role in eliminating the threat of waterborne disease from bacteria. For example, Philadelphia saw a drop in the annual number of typhoid cases per 100,000 people from more than 80 to less than 5 after disinfection was added to the Philadelphia water system in 1913.

## Disinfection With Chlorine

Public water suppliers often use chlorine to disinfect water. Chlorination effectively destroys most pathogenic organisms and helps control microbiological growth in the distribution system, although, at normal dosage rates, chlorine may not kill all cysts. Chlorination used with filtration effectively manages pathogenic organisms in drinking water supplies. The practice of chlorinating public water drinking supplies has occurred since the early 1900s and continues in many communities today.

During the disinfection process at the treatment plant and while the water is in the distribution system waiting to be used, chlorine can combine with naturally occurring organics in the water to form a family of chemical compounds known as Disinfection Byproducts (DBPs), which include trihalomethanes (THMs). EPA tests determined THMs were carcinogenic when consumed by laboratory animals in large quantities over a prolonged period of time. Therefore, THMs are a suspected carcinogen for people. The EPA Stage 1 Disinfection Byproduct Rule established a standard of 80 parts per billion (ppb) as the maximum level of THMs allowed in public drinking water. The use of chlorine for both primary and secondary disinfection could result in THMs in excess of the 80 ppb standard in some water supplies.

Omaha Metropolitan Utilities District (M.U.D.) previously used chlorine for both primary and secondary disinfection. Chlorine-treated water averaged 74 ppb THMs. Omaha M.U.D. could have exceeded the standard on occasion if it continued to disinfect water using chlorine for both primary and secondary disinfection. Therefore, beginning in 2003

Omaha M.U.D. began using chloramines for secondary water disinfection to reduce the production of THMs. The Lincoln Water System began using chloramines for secondary water disinfection in the 1930s.

## Disinfection With Chloramines

Chloramines are a disinfectant formed when chlorine is combined with ammonia. They are composed of three chemicals: monochloramine, dichloramine and trichloramine. Monochloramine is preferred for water disinfection because of its biocidal properties and minimal taste and odor. In the disinfection process, chloramines react more slowly than chlorine but stay active longer. Chloramines form much smaller concentrations of the disinfection byproduct THMs, as compared with chlorine when mixed with organics in water. However, recent research identified trace amounts of other disinfection byproducts (such as n-nitrosodimethylamine) created by using chloramines. Research is being conducted to learn if these byproducts are harmful to humans in the concentrations that they occur in drinking water. Currently, scientific knowledge shows chloramines disinfection by-products pose less health risk than chlorine disinfection byproducts or water that is not disinfected.

Chloramines have been used for water disinfection in the United States and Canada for decades. Approximately a quarter of the public water systems in the U.S. use chloramines as a disinfection agent, including Council Bluffs, IA; and Denver, CO.

Omaha M.U.D. uses chlorine for primary disinfection (at the water treatment plant), and chloramines for secondary disinfection (in the water distribution system). This results in water that averages about 40 ppb THMs. The Lincoln Water System uses ozone in the east plant and chlorine in the west plant for primary disinfection, and both plants use chloramines for secondary disinfection. Lincoln Water System chloramines-treated water averages about 20 ppb THMs.

The EPA has established a Maximum Residual Disinfectant Level (MRDL) for chloramines of 4 parts per million (ppm). This is the highest level of a disinfectant allowed in public drinking water. In Lincoln and Omaha, chloramines concentrations at the tap typically range from 0.5 to 2.3 ppm. Chloramines break down naturally over time. Therefore, the chloramines level can vary within either system and in water delivered at any given tap. In general, water delivered in portions of the distribution system closer to the treatment plant will contain chloramines in higher concentrations. Conversely, the chloramines concentration may be lower in water delivered farther from the treatment plant.

## Comparing Chlorinated and Chloraminated Water

### Taste and odor

Water disinfected with chloramines generally has less of a chlorine taste and odor than water disinfected with free chlorine.

### pH

The pH of the water is the same with chloramines or chlorine disinfection.

### Corrosivity

Increased chloramines may lead to accelerated corrosion. This can contribute to the degradation of elastomers such as gaskets in distribution systems.

## Using Chloraminated Water

Chloraminated water is safe for most uses we have for water every day. However, there are two notable exceptions: kidney dialysis and fish environments.

### Human consumption

If chloramines were to enter the blood stream, they would be toxic. However, the digestive process neutralizes chloramines in water before they reach the blood stream. Therefore, chloraminated water is safe to use for cooking and drinking. People can safely consume chloraminated water. This is true for the general population, including specific populations such as pregnant women, infants and children, people on low-sodium diets, people with diabetes, kidney dialysis patients and others. People who are overly sensitive to chemicals should check with their physicians if they are concerned.

### Personal hygiene

Chloraminated water is safe for bathing and all other hygienic tasks. It can safely be used if individuals have a cut and can even be used to wash an open wound. Although chloramines in the blood stream would be toxic, virtually no water actually enters the bloodstream in these circumstances.

### Kidney dialysis

In the dialysis process, water comes in contact with the blood across a permeable membrane. Chloramines in that water would be toxic, just as chlorine would be toxic, and must be removed from water used in kidney dialysis machines.

Medical centers that perform dialysis are responsible for purifying the water that enters dialysis machines. People with home dialysis machines should check with their physicians and equipment suppliers for use recommendations.

**(Note: This publication is not a substitute for professional medical advice. People with questions or concerns related to this issue should consult their physician.)**

### Irrigation

Chloraminated water is safe for landscape irrigation. The small amount of chloramines in the water should have no effect on plants including turf (grass), ornamentals, vegetables and trees.

### Swimming pool/hot tub management

The treatment of water with chloramines will not affect the way a swimming pool or hot tub is managed. Chlorine will still need to be added to achieve a chlorine residual to retard algae and bacteria growth.

### Pets and other animals

Chloraminated water is safe for pets and other animals to consume, with the exception of fish, reptiles, amphibians and crustaceans. Chloramines are toxic to fish because they pass through the gills, directly enter the bloodstream and bind with the iron in the hemoglobin, causing a reduction in the blood's oxygen-carrying ability. This ultimately results in the fish suffocating from lack of oxygen. Chloramines are toxic to all fresh and salt water fish and must be removed, neutralized or reduced to a safe level before water can safely be used in fish tanks, aquariums or ponds.

Chloramines residuals in water used to keep fish should be kept below 0.1 ppm. In some cases, the concentration of chloramines in tap water may be at or below this level. This could occur at taps farthest removed from the water treatment plant, where the chloramines concentration may have been reduced due to the natural breakdown of the disinfectant. In other cases, the process of dilution might make it possible to add small amounts of untreated chloraminated water containing concentrations greater than 0.1 ppm to an aquarium or pond to make up for evaporation loss. To accurately determine the chloramines concentration in aquatic environments, monitor for total chlorine residual. Total chlorine test kits are available from pet stores, pool supply stores and chemical supply houses. The kit must be for "total chlorine" or "combined chlorine" and not "free chlorine." A free chlorine test of chloraminated water would result in erroneous readings.

Chloramines are a combination of chlorine and ammonia. As they break down, either naturally or through the use of chemicals, ammonia is freed up. All fish produce some ammonia as a natural byproduct and ammonia levels produced as chloramines break down may be tolerable in individual tanks or ponds. However, high levels of ammonia can be toxic to fish, reptiles and crustaceans. Commercial products are available at pet supply stores to remove excess ammonia.

Biological filters, natural zeolites and pH control methods are also effective in reducing the toxic effects of ammonia.

## Other Considerations

Some hobbies or vocations may involve a process or product that could be impacted by water chemistry. Individuals involved in such a hobby or vocation should contact appropriate equipment manufacturers or chemical suppliers to determine if chloramines will affect their product or process. Clubs or associations connected with such hobbies or vocations might be additional sources of information.

## Chloramines Removal

Many water treatment techniques and equipment are used to alter and improve water quality. Several commonly used water treatment techniques are **not** effective in removing chloramines. Worth noting are reverse osmosis units and water softening units, neither of which effectively remove chloramines. In addition, boiling water does not effectively remove chloramines. And unlike chlorine, which dissipates when water sits for a few days, chloramines may take weeks to disappear. While sunlight and aeration help remove chloramines from water, allowing water to sit is not a reliable method of chloramines removal.

Two effective methods for removing chloramines include using a chemical to neutralize chloramines or using a granular-activated carbon filter. Most pet stores sell chemicals for dechloraminating water and have recommendations for use. Keep in mind that chemicals to remove only chlorine will not remove chloramines.

When using a carbon filter, it must contain high quality granular-activated carbon. Carbon filters should be operated at a slow rate to allow sufficient contact time for effective chloramines removal. Testing the treated water will help determine the optimum filtration rate. Filters must be monitored carefully to determine when the carbon media has reached the end of its useful life and needs to be changed. Manufacturers often indicate the maximum number of gallons that can be filtered before renewal of the filter is required. Check with the supplier for proper operation and maintenance of chloramines removal equipment.

A carbon filter also will remove chlorine, hydrogen sulfide, organics, THMs, some pesticides and radon, if present in the water. Unserviced or improperly serviced equipment may deliver surges of water with high levels of some of these contaminants. The owner or user of a home water treatment device is responsible for ensuring proper operation through monitoring, maintenance and service. Also, unserviced or improperly serviced filters can provide an excellent environment for some non-pathogenic bacteria to grow. There is little risk to healthy people from these bacteria, but it may be of some concern for the very young, the very old and those with weakened immune systems. Concerned individuals should consult their physician.

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