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Drinking Water: Chloramines Water Disinfection in Omaha Metropolitan Utilities District

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Drinking Water: Chloramines Water Disinfection in Omaha Metropolitan Utilities District

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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 publication discusses the disinfection process used by Metropolitan Utilities District and how it will change in 2002.

Water Disinfection

Why disinfect a public drinking water supply?

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 Health and Human Services System (HHSS) Department of Regulation and Licensure administers the Safe Drinking Water Act in Nebraska.

Public drinking water is regulated for more than 90 contaminants. Water that meets these standards may not be pure, but it will be safe for human consumption. Bacteria and other pathogenic (disease-causing) organisms are among those regulated by the Safe Drinking Water Act. When considering the safety of drinking water, bacteria and other pathogenic organisms are 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. Disinfection reduces pathogenic organisms in water to levels designated safe by public health standards. This prevents disease transmission.

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 (see *Figure 1*).

What disinfection process is currently being used in the Omaha area Metropolitan Utilities District?

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 supplies has occurred since the early 1900s and continues in many communities today.

The Metropolitan Utilities District (M.U.D.) serves more than 170,000 water customers in the Omaha metropolitan area. M.U.D. uses chlorination for both primary and secondary water disinfection. Primary disinfection kills or inactivates pathogens in water at the water treatment plant. Secondary disinfection provides a residual as the water leaves the

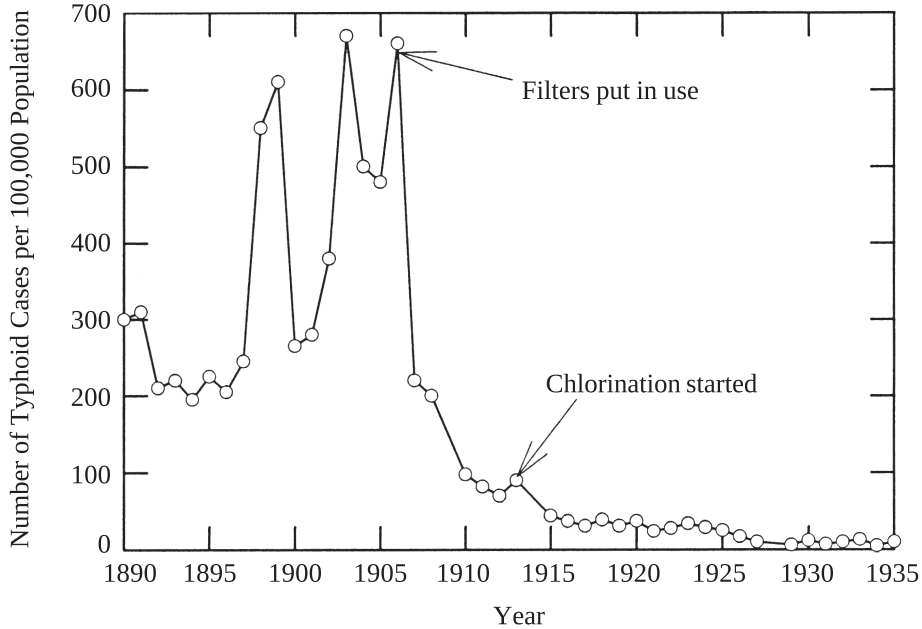

Figure 1. Typhoid fever cases per 100,000 population in Philadelphia.

treatment plant to control microbiological growth in the distribution system.

Why change the disinfection process?

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 time. Therefore, THMs are a suspected carcinogen for people. EPA previously set a standard of 100 parts per billion as the maximum level of THMs allowed in drinking water. A new EPA regulation — the Stage 1 Disinfection Byproduct Rule — will lower the maximum allowable level for THMs to 80 parts per billion. Some public water suppliers, including M.U.D., currently in compliance with the EPA standard for THMs, may exceed the new standard unless they change the treatment scheme for their plants, such as changing the type of disinfectant used.

With the current chlorination process, water treated by M.U.D. averages 74 parts per billion THMs; however, occasionally it might exceed the new EPA standard. To avoid this, M.U.D. is changing the way it disinfects water to reduce the production of THMs.

What disinfection process will be used in the future?

Chloramines have been used for water disinfection in the United States and Canada for decades. Approximately 20 percent of the public water systems in the United States use chloramines as a disinfection agent, including systems in Lincoln, Nebraska; Council Bluffs, Iowa; and Denver, Colorado. Also, a number of other communities recently switched to chloramine use as a disinfectant; these communities include Los Angles, California; Virginia Beach, Virginia; Sioux Falls, South Dakota; and Indianapolis, Indiana.

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. The current state of scientific knowledge shows chloramine disinfection byproducts pose less health risk than chlorine disinfection byproducts or water that is not disinfected.

Chloraminated water is safe for most uses; however, there are two notable exceptions: kidney dialysis and fish environments. Read the section in this publication on "Using chloraminated water" for additional information on using chloraminated water for kidney dialysis and aquatic environments.

M.U.D. is changing how it disinfects drinking water and will begin using chloramines in the process. Estimated costs to use chloramines are $3.7 million for capital improvements and $200,000 per year for operation. It is estimated the change will occur in fall/winter 2002. M.U.D. will continue to use chlorine for primary disinfection, but will use chloramines for secondary disinfection. Adding chloramines to the disinfection process will reduce the production of THMs.

The conversion to chloramines will take several days while the chlorinated water is flushed out of the distribution system and replaced by chloraminated water. During this period, it is possible that localized, short-term episodes of fishy or chlorine tastes and odors may occur. In rare cases, these episodes of fishy or chlorine tastes and odors may occur during the next few years when the water quality in the Missouri River changes rapidly, making it difficult to change the chemical dosage used in treatment. Such nuisance events are expected to occur less often than in the past due to chlorination. These unpleasant tastes and odors may be due to concentration spikes of chloramines passing through the system and are not harmful to humans.

Understanding Chloraminated Water

Taste and Odor

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

pH

The pH of the water will remain the same as it was with 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

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. Populations including pregnant women, infants and children, people on low-sodium diets, people with diabetes, kidney dialysis patients, and others can safely consume chloraminated water. 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 be used safely to wash 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.

Irrigation

Chloraminated water is safe for landscape irrigation. The small amount of chloramines in the water should not affect any type of plant, including turfgrass, ornamentals, vegetables, and trees.

Swimming Pool/Hot Tub Management

The treatment of water with chloramines will not affect the way you manage your swimming pool or hot tub. You will still need to add chlorine 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 since water enters through the gill structure and goes directly into the bloodstream. Once in the bloodstream, chloramines bind with the iron in the hemoglobin, reducing the blood's ability to carry oxygen. 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 or neutralized before water can safely be added to fish tanks, aquariums or ponds. It may be possible to add a small amount of untreated chloraminated water to an aquarium or pond to make up for evaporation loss, but the only way to know for sure is to monitor for total chlorine residual. Total chlorine test kits are available from pet stores, pool supply stores, and chemical supply houses. Make sure that the kit is for “total chlorine” or “combined chlorine” and not “free chlorine”. A free chlorine test of chloraminated water would result in erroneous readings and might not indicate a situation that could actually be toxic to fish.

Chloramines are a combination of chlorine and ammonia. As they break down, either naturally or through the use of dechlorination chemicals, ammonia is freed. 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. High levels of ammonia, however, 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.

Kidney Dialysis

During the dialysis process, water comes in contact with the blood across a permeable membrane. Chloramines in that water would be toxic, just as chlorine is 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. They currently treat water to remove chlorine. Some modifications to the process may be necessary to remove chloramines. M.U.D. will notify all medical facilities before it begins using chloramines in the water treatment process. People with home dialysis machines should check with their physicians and equipment suppliers.

Other Considerations

If you are involved in a hobby or vocation in which a process or product might be affected by water chemistry, contact your equipment manufacturer or chemical supplier to determine if chloramines will affect it. Clubs or associations connected with your hobby or vocation might have additional information.

Chloramine Removal

Many water treatment techniques and equipment are used to alter and improve the quality of water. Several commonly used ones are not effective in removing chloramines. Worth noting are reverse osmosis 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 chloramine removal.

Two effective methods for removing chloramines include using a chemical to neutralize chloramine or using a granular activated carbon filter. Most pet stores sell chemicals for dechloraminating water and can provide use recommendations. Remember that chemicals that remove only chlorine will not remove chloramines.

When using a carbon filter, ensure that it contains high quality granular activated carbon. Carbon filters should be operated at a slow rate to allow sufficient contact time for effective chloramine 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 the filter is renewed. Check with the supplier for proper operation of equipment for chloramine removal.

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. As the owner or user of a home water treatment device, it is your responsibility to ensure proper operation through monitoring, maintenance, and service.

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