

QUESTIONS REGARDING CHLORINE AND CHLORAMINE REMOVAL FROM WATER

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Q: Is it necessary to remove disinfectants from drinking water in a home setting?

A: No, chlorinated and chloraminated water is deemed safe for people and animals to drink, and for all other general uses including bathing. The removal of either chlorine or chloramine from drinking water is not necessary for public health but some customers may elect to do so for common household purposes based on personal preference.

Chloramine is not a persistent disinfectant and decomposes easily from a chemistry point of view (Valentine et al, 1998) but for water supply purposes chloramine is stable and it takes days to dissipate in the absence of substances exerting chloramine demand (Wilczak et al., 2003b). Therefore, it is not practical to remove chloramine by letting an open container of water stand because it may take days for chloramine to dissipate.

However, chloramine is very easily and almost instantaneously removed by preparing a cup of tea or coffee, preparing food (e.g., making a soup with a chicken stock). Adding fruit to a water pitcher (e.g., slicing peeled orange into a 1-gal water pitcher) will neutralize chloramine within 30 minutes. If desired, chloramine and ammonia can be completely removed from the water by boiling; however, it will take 20 minutes of gentle boil to do that. Just a short boil of water to prepare tea or coffee removed about 30% of chloramine. Conversely, chlorine was not as consistently removed by boiling in SFPUC tests.

If desired, both chlorine and chloramine can be removed for drinking water purposes by an activated carbon filter point of use device that can be installed on a kitchen faucet. If desired, both chlorine and chloramine can be removed for bathing purposes by dissolving Vitamin C in the bath water (1000 mg Vitamin C tablet will neutralize chloramine in an average bathtub). SFPUC does not recommend that customers remove disinfectants from drinking water. Customers desiring to do so should consult with their physician.

Q: Why is it important to remove both chlorine and chloramine from the tap water used for hemodialysis treatment of kidney dialysis patients?

A: While tap water is safe for drinking, bathing and other household uses, it is not acceptable for use in hemodialysis. People can safely drink chloraminated water because their digestive process neutralizes chloramine before it enters the bloodstream. But, just like with fish that take chloramine directly into their bloodstream through their gills, the membranes used for hemodialysis do not remove chloramine. In fact, the hemodialysis fluid must be free of even traces of compounds that are safe to drink.

Residual disinfectants, particulates, organics, ions and remaining microorganisms are removed prior to hemodialysis units. The average person consumes approximately 2 liters of water per day in different forms (juice, coffee, etc.), whereas a patient on hemodialysis uses anywhere from 90 to 190 liters of water (in the dialysate) per treatment. In the dialyzer the blood is separated from the dialysate by a semi-permeable membrane, which is only selective with respect to molecular size but is not contaminant specific. The recommended maximum concentrations for hemodialysis water are 0.5 mg/L chlorine and 0.1 mg/L chloramine (Amato, 2005).

Carbon adsorption is used to remove either chlorine or chloramine because both of them destroy red blood cells. Chlorine and chloramine are not removed by the reverse osmosis membrane and can also damage the membrane. At least two carbon beds are required in series for a total of 10

minutes empty bed contact time at the maximum flowrate to remove either chlorine or chloramine, followed by a 1 to 5-um filter to remove carbon fines before the reverse osmosis unit (Amato, 2005).

Q: Why are some industrial users advised to remove chloramine but people are not?

A: Chloramine is added to the water for public health protection. Distilled or deionized water is required for many industrial processes and products. On the other hand, distilled or deionized water would not be appropriate for distribution and consumption due to its corrosivity, taste, and health impacts. Three special user groups, kidney dialysis patients, aquarium owners, and businesses or industries that use water in their manufacturing processes may need to remove chloramine from the water prior to use as they did with chlorine. Products to remove or neutralize chloramine are readily available.

Biotechnology companies and breweries must take treatment precautions for both chlorine and chloramine. Beer manufacturers must remove chlorine and chloramine because either will inhibit the growth of yeast. Photo labs may need to remove chlorine or chloramine from the water because it may interfere with the chemicals used to develop the film and may adversely impact the colors in the final print. Chip manufacturers and pharmaceutical companies have very specific water quality requirements for their manufacturing process.

Q: What methods are used by the industry to remove chloramine and ammonia?

A: In the water industry, the most widely practiced methods of dechlorination are the addition of reducing agents, for example, sulfite compounds, hydrogen peroxide and ascorbic acid - Vitamin C (Tikkanen et al., 2001). Granular activated carbon (GAC) filters are also used for dechlorination (Kirmeyer et al., 2004). Breakpoint chlorination is used routinely by some utilities to remove chloramine and/or ammonia in the source water or to avoid blending chlorinated and chloraminated water. During breakpoint chlorination, excess chlorine in chloraminated water consumes the available ammonia and the remaining disinfectant residual exists as chlorine.

Q: How much time will it take for chlorine and chloramine to dissipate when left standing?

A: While both chlorine and chloramine residuals decrease with time, chloramine decreases more slowly than chlorine. Chlorine may take days to dissipate in a pitcher left on a counter and it will take longer for chloramine. The decomposition rate will be faster when the water is exposed to air and sunlight (Wilczak et al., 2003b). Chloramine, like chlorine, will eventually dissipate completely over time but it is not practical to let the water sit for it to dissipate. Other methods may be used to remove chloramine if desired for aesthetic reasons.

Q: Can chlorine and chloramine be removed by boiling?

A: Boiling the water for 20 minutes will remove chloramine and ammonia. SFPUC does not recommend for customers to boil water for such long periods of time because it is not necessary from a public health perspective and poses risk of scalding. However, such tests demonstrate that chloramine is not a persistent chemical, which does not remain in the water after cooking. Additionally, many foods and drinks rapidly neutralize chloramine without the necessity of boiling (e.g., tea, coffee, chicken stock, orange juice, etc.).

Q: Can charcoal filters remove chloramine?

A: Charcoal or granular activated carbon (GAC) filter can reduce chloramine concentrations of 1 to 2 mg/L to less than 0.1 mg/L. The GAC filter may be followed by a reverse osmosis (RO) filter to remove the carbon fines. RO should not be used alone as chloramine will pass through the membrane and may damage the RO membrane elements (some RO units are resistant to chlorine and chloramine). A GAC filter will remove chloramine, allowing RO to effectively remove other constituents.

Q: Are GAC filters certified and if so by whom?

A: As a public agency, the SFPUC does not test, endorse or recommend specific water filtration products. Contact the NSF International, a nonprofit organization that independently tests and certifies drinking water filtration products. Website: [NSF International](http://www.nsf.org), phone: 877-867-3435.

The removal of chloramine is not necessary from a public health perspective; however, some customers may chose to remove either chlorine or chloramine for drinking purposes. Several units are certified and listed on the NSF International website <http://www.nsf.org/Certified/DWTU/> (accessed November 7, 2007) for the removal of chloramine: smaller units certified at flows below 1 gpm (service cycle from 300 to 1600 gal) are appropriate for drinking water applications at a kitchen faucet, larger units certified at 5 gpm (service cycle from 15,000 to 84,000 gal) could be used for other uses if desired. NSF International verifies claims of 85% chloramine removal of 3 mg/L. GAC filters, if desired, need to be installed on the kitchen sink cold water tap as filter effectiveness decreases in warm or hot water. The removal of disinfectant from the water may increase the potential of bacterial regrowth in plumbing.

Q: Can Vitamin C be used to remove chlorine and chloramine for bathing purposes?

A: Exposures via respiration do not occur from use of chloraminated drinking water. Based on personal preference, some individuals may choose to reduce exposure to chlorine or chloramine. Vitamin C (ascorbic acid) has recently been included in AWWA Standard (AWWA, 2005b) as one of the methods for dechlorination of disinfected water mains. SFPUC and other utilities have used Vitamin C for dechlorination prior to environmental discharges of chlorinated and chloraminated water. Since ascorbic acid is weakly acidic, the pH of water may decrease slightly (Tikkanen et al., 2001). Ascorbic acid has been used for a long time as one of the dechlorinating agents for preservation of chlorinated or chloraminated water samples for laboratory analysis.

The removal of chloramine is not necessary from a public health perspective; however, some customers may chose to remove either chlorine or chloramine for bathing purposes. There are no NSF International certified point of use devices utilizing Vitamin C, however SFPUC determined that 1000 mg of Vitamin C (tablets purchased in a grocery store, crushed and mixed in with the bath water) remove chloramine completely in a medium size bathtub without significantly depressing pH. Shower attachments containing Vitamin C can be purchased on the Internet, as well as effervescent Vitamin C bath tablets. The 1000 mg effervescent Vitamin C tablets dissolved readily without residue but may depress pH more than regular Vitamin C tablets purchased in grocery stores. Some shower attachments with Vitamin C marketed on the Internet are effective in removing chloramine; however, the claims posted on the Internet as to their replacement frequency appear to overestimate the duration when the shower attachment is effective. There are reports of the benefits of Vitamin C for skin care (Griffith, 1998) and various cosmetics are available in stores that contain Vitamin C. SFPUC does not recommend for customers to use Vitamin C for bathing purposes and anyone desiring to do that should consult with their physician.

Q: What are other simple methods to remove chloramine for drinking water purposes?

A: The removal of chloramine is not necessary from a public health perspective; however, some customers may choose to remove chloramine for aesthetic reasons. Placing a few slices of fruit (e.g., orange, lime, lemon, mango, strawberries) or vegetable (cucumber) in a water pitcher will effectively dechlorinate the water within a few hours. A peeled and sliced medium size orange can be used for a 1-gal water pitcher and will completely dechlorinate the water in 30 minutes. The fruit can then be removed from the water. The water pH will become closer to neutral or acidic (if lime or lemon is used). The ammonia will not be removed but most of the fruits contribute some or more ammonia than the drinking water.

Preparing a cup of tea (black, green, caffeinated, decaffeinated, herbal) also removes chloramine, as does coffee prepared in a common coffee maker.

Q: What are the methods for removing chloramine from fish aquariums?

A: Just as with chlorine, chloramine can harm saltwater and freshwater fish, reptiles, shellfish, and amphibians that live in water, because they take chloramine directly into their bloodstream through their gills. People and animals that don't live in water can safely drink chloraminated water because their digestive process neutralizes chloramine before it enters the bloodstream. Effective procedures are available to remove chloramine and ammonia. Commercial establishments and hobbyists involved in fish rearing need to take precautions to prevent losses. There are two methods that can be used to remove or neutralize chloramine before adding water to a fish tank, pond, or aquarium: (1) GAC filtration system specifically designed to remove chloramine, or (2) conditioner or additive that contains a dechlorinating chemical for both ammonia and chlorine. Products are available at local pet and aquarium supply stores. Residential and commercial fish owners are advised to verify which method is best for them with their pet store or aquatic/aquarium retailer.

If too much dechlorinating agent is added to the aquarium or pond water, it may bind up the oxygen in the water. In this case, the fish may suffocate. It is important to carefully follow the label instructions.