APSP The Association of Pool & Spa Professionals®

REFLECT SUCCESS

Fact Sheet

Chloraminated Tap Water

Revised – June 2010

Brought to you by the APSP Recreational Water Quality Committee

I. INTRODUCTION

This fact sheet will describe the chloramination process for tap water, the reasons for chloramination, and the impact of chloraminated water on pools and spas.

Many pool and spa operators understand that the primary source of "combined chlorine" in pools and spas is from the reaction of chlorine sanitizer with bather perspiration and waste; however, another potential source is chloraminated tap water, which may be used for fill and make up water. When pool and spa operators use tap water to fill pools and spas, they may be adding considerable concentrations of combined chlorine.

II. SUMMARY OF CHARACTERISTICS

Chloramination is a process that mixes free chlorine (usually chlorine gas) and ammonia to form chloramines. The process is often used by water treatment authorities to treat drinking water. EPA estimates that over 50 percent of large systems serving at least 10,000 people use chloramination.

- The chloramination process may produce any of three inorganic chloramines: (1) monochloramine (NH_2Cl), (2) dichloramine ($NHCl_2$), and (3) trichloramine (nitrogen trichloride, NCl_3).
- Monochloramine (NH_2Cl) is the preferred chloramine in tap water (treated drinking water). Monochloramine is an oxidizer and has been found to be effective in controlling bacteria re-growth.
- Compared to chlorine, monochloramine is more stable and lasts longer in the water distribution system.
- The combined chlorine in chloraminated tap water is primarily monochloramine, and possibly a little dichloramine.
- The mixture of chloramines will depend on pH, chlorine/ammonia ratio, temperature, alkalinity, and contact time.
- Monochloramine and dichloramine can be effectively removed by chlorine.

- Dichloramine and trichloramine are undesirable because of their objectionable taste and odor.
- To produce predominantly monochloramine and to minimize complaints, the chloramination process is operated with a chlorine/ammonia ratio less than 5:1 (typically 3:1 to 4:1).
- The typical concentration of chloramines in treated drinking water is 1 ppm to 3 ppm as Cl_2.

III. GENERAL DESCRIPTION

Tap water has been disinfected with chlorine since the early 1900's (White 1992). In addition to being a good disinfectant, chlorine is a strong oxidizer. Chlorine reacts rapidly with other chemicals in the water, but this also yields two unwanted results: (1) chlorine residual depletion, which leaves the water unprotected from bacteria regrowth and (2) formation of unacceptable concentrations of disinfection byproducts (DBPs). Both of these problems can be reduced through the chloramination process. In addition to these advantages, chloramines can also be used to address biofilm in the distribution pipelines.

Pools and Spas. The combined chlorine in pools and spas is a combination of inorganic chloramines (monochloramine and dichloramine), organic chloramines (chlorinated creatinine, chlorinated uric acid), and other chlorinated organic waste materials. Monochloramine can be effectively removed by chlorine. It is difficult, however, to remove organic chloramines.

IV. REMEDIAL STEPS FOR POOLS & SPAS

Fresh Fills. If possible, it is best to avoid using chloraminated tap water for fresh fills of pools and spas. If you must use chloraminated water as fill water, take the following remedial steps after filling the pool or spa: (1) If necessary, adjust the pH up to 7.4-7.8 and (2) oxidize the pool/spa using a non-stabilized chlorine oxidizer at 5-10 times the combined chlorine concentration to achieve an acceptable concentration less than 0.2 ppm.

Make up Water. Make up water is water that is added to a pool or spa to replace water that has been lost from evaporation, splash out, or backwashing. Make up water will not add significant concentrations of combined chlorine. When chloraminated make up water is added to a pool, the impact is much less than when chloraminated water is used to fill a pool. This impact may be of importance only to operators of pools with high bather loads, where compliance with the maximum combined chlorine concentration is difficult.

After adding make up water, the pool water should be tested to determine the concentration of chloramines. If the combined chlorine concentration is unacceptable, the chloramines concentration can be reduced by adjusting the pH to 7.4-7.8 and oxidizing with non-stabilized chlorine at 5-10 times the combined chlorine concentration. After the desired combined chlorine concentration has been attained, balance the pH and alkalinity.

V. NOTES

The Impact of Chloramination on Chlorine Residual Maintenance in Drinking Water Distribution Systems. Chloramination has been found to be effective in controlling bacteria re-growth. Bacteria are harbored in biofilm, which protects them from disinfection. Biofilm is a deposit consisting of microorganisms and microbial products. A biofilm forms in all drinking water distribution systems and in all pool and spa recirculation systems. In the absence of chlorine, any bacteria that escape from biofilm may multiply in the water. Free chlorine ($HOCl/OCl^-$) reacts rapidly with the outer protective mucous layer of a biofilm. Consequently, $HOCl/OCl^-$, at the concentrations used in drinking water (< 4 ppm as Cl_2), is depleted at the surface of the biofilm and nothing remains to penetrate the biofilm and inactivate any bacteria within the biofilm. Furthermore, little or no chlorine residual remains at the end of the distribution system. The chloramination process provides a means to ensure that sanitizer concentrations, in the form of monochloramine, are maintained throughout the distribution system.

The Impact of Chloramination on Disinfection Byproduct Formation. Surface waters used for drinking water supplies contain a significant amount of organic matter from decayed vegetation. When free chlorine is used it continues to react in the distribution systems with this organic matter and produces chlorination disinfection byproducts including trihalomethanes (THM's) and haloacetic acids (HAA's). Many of the THM's and HAA's are suspected human carcinogens and their concentration in drinking water is regulated. When using free chlorine as the disinfectant many water treatment facilities are unable to comply with these regulations. One option to achieve compliance is chloramination. As a result of being a weaker chlorinating agent than chlorine, chloramines tend to form lower amounts of THM's and HAA's.

Testing. Chloraminated water may present a problem with DPD testing of free chlorine concentration. Chloramine concentrations above 1 – 2 ppm can interfere with the free chlorine reading. To overcome this interference, a reagent called thioacetamide, which is available through many test kit manufacturers, should be added immediately after the free chlorine DPD reagents. This freezes the reading and allows an accurate determination. A separate total chlorine test would be required after the free chlorine test.

VI. REFERENCES

1. Gerald F. Connell, *The Chlorination/Chloramination Handbook*, Denver, CO: American Water Works Association, 1996, pp 44-46.
2. George Clifford White, *The Handbook of Chlorination,* 2nd Ed., New York: Van Nostrand Reinhold, 1986, pp 160-170.
3. US. EPA, Alternative Disinfectants and Oxidants, Guidance Manual, April 1999
4. James M. Montgomery, *Water Treatment Principles and Design,* John Wiley & Sons, New York, NY, 1985.
5. Snoeyink, V.L., and Jenkins, D. *Water Chemistry*, Wiley, 1980.
6. Federal register/vol.71, no.2/January 4, 2006.