Reader Suggestion

What are trihalomethanes?

by Babu Srinivas Madabhushi
NDWC Technical Assistance Specialist

The use of chlorine to disinfect water produces various disinfection byproducts, which have been classified mainly as halogenated and non-halogenated byproducts. These primary byproducts are trihalomethanes (THMs) and haloacetic acids. THMs are the byproducts of chlorination of water that contains natural organic matter. A U.S. Environmental Protection Agency (EPA) survey shows that THMs are present in most chlorinated water supplies. Even though they pose a less acute health risk than do waterborne diseases, THMs are still among the important water quality issues.

The most common THM compounds are dibromochloromethane ($CHClBr_2$), bromoform ($CHBr_3$), chloroform ($CHCl_3$), and dichlorobromomethane ($CHCl_2Br$). The sum of these four compounds is referred to as Total Trihalomethanes (TTHMs).

Why and how are THMs formed?

When chlorine is added to water with organic material, such as algae, river weeds, and decaying leaves, THMs are formed. Residual chlorine molecules react with this harmless organic material to form a group of chlorinated chemical compounds, THMs. They are tasteless and odorless, but harmful and potentially toxic.

The quantity of byproducts formed is determined by several factors, such as the amount and type of organic material present in water, temperature, pH, chlorine dosage, contact time available for chlorine, and bromide concentration in the water.

The organic matter in water mainly consists of a) humic substance, which is the organic portion of soil that remains after prolonged microbial decomposition formed by the decay of leaves, wood, and other vegetable matter; and b) fulvic acid, which is a water soluble substance of low molecular weight that is derived from humus.

At what levels are THMs present in water?

The byproduct concentration is mainly determined by the amount of organic material in the source water. Water facilities that draw water from surface water (lakes, rivers, and reservoirs) produce water with higher levels of THMs than facilities with groundwater (wells and springs) as their source of water. TTHM concentrations range from 0.030 to 0.150 milligrams per liter (mg/l) in surface water and 0.001 to 0.010 mg/l in groundwater. The distribution of these four compounds varies with bromide concentration in water.

EPA is currently regulating TTHMs for small communities as part of the Microbial/Disinfection and Disinfection Byproducts (M/DBP) Rules. Under these rules the allowable TTHM concentrations are 0.080 mg/l of TTHMs, and there are plans to reduce these limits to 0.040 mg/l by the year 2002.

What are the health effects of THMs?

According to a University of Florida report, exposure to THMs may pose an increased risk of cancer. According to Rebekah Grossman, two THMs, chloroform and dibromochloromethane, are carcinogens; and another THM, bromodichloromethane, has been identified as a mutagen, which alters DNA. Mutagens are considered to affect the genetics of future generations in addition to being carcinogenic. A California study indicates that THMs may be responsible for reproductive problems and miscarriage. The study found a miscarriage rate of 15.7 percent for women who drank five or more glasses of cold water containing more than 0.075 mg/l TTHM, compared to a miscarriage rate of 9.5 percent for women with low TTHM exposure. In addition to these risks, TTHMs are linked to bladder cancer, heart, lungs, kidney, liver, and central nervous system damage.

Then why were THMs not regulated for small communities earlier?

The earlier THM regulations only applied to larger systems (those serving more than 10,000 people). EPA, keeping the following factors in mind, believed that exempting smaller systems would not negatively affect the health of small community people because:

a) The majority of smaller systems use groundwater as their source;
b) Small systems usually use less detention time and hence less contact time;
c) Lack of required professional expertise to control the THMs and the necessity of disinfection; and
d) Small systems often use less chlorine.

How can systems reduce THMs?

Drinking water systems can reduce THM formation in several ways.

Continued on next page

Newsletter Provides Biosolids Information

How to best treat and dispose of the residual waste materials that result from wastewater treatment processes (sewage sludge and domestic septage, for example) is a hot topic in many small communities. By managing these wastes as biosolids in accordance with federal, state, and local regulations, communities often can cost-effectively recycle and beneficially apply these wastes to improve soils or to rehabilitate land damaged by mining or other industries.

The Fall 1998 issue of *Pipeline* presents a brief overview of the options small communities have for managing biosolids and some of the requirements of the federal Part 503 regulations. It also includes information about the safety and benefits of biosolids recycling. *Pipeline*, a National Small Flows Clearinghouse (NSFC) publication, is written for the general public. Readers are invited to reproduce and distribute the information in *Pipeline* to help with public education efforts.

Subscriptions and copies of current Pipeline *issues are free plus shipping and handling. Back issues cost 20 cents each plus shipping and handling. To request a copy of the Fall 1998 biosolids issue, item #SFPLNL15, call the NSFC at (304) 293-4191 or (800) 624-8301, or e-mail* nsfc_orders@estd.wvu.edu, *or write to NSFC, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064.*

What are trihalomethanes?

Continued on next page

a) Reduce the organic material before chlorinating the water.
Treatment techniques, such as coagulation, sedimentation, and filtration can remove most of the organic materials. However, activated carbon can be used to remove greater amounts of organic material than can be removed by other techniques.

b) Optimize chlorine usage.

c) Change the point of chlorine addition in the treatment series.
If the point of chlorine addition is moved to a location after sedimentation or filtration, THM production can be reduced as these processes remove parts of the organic matter.

d) Use alternative disinfection methods.
Using a mixture of chlorine and ammonia (chloramine) reduces THM formation. Chloramine also disinfects, but doesn't form THMs. Ozone can be used along with chlorine and chloramine. Chlorine dioxide is another alternative. The combination of disinfectants not only reduces the formation of THMs, but also maintains the residual concentration in the distribution system. But changing the disinfectant may alter the whole treatment process and might affect the removal of other contaminants.

e) Other methods:
These include filtration, aeration, boiling, distillation, commercial home treatment systems or filters, nanofiltration, activated carbon filtering, or leaving tap water standing in a pitcher in the fridge overnight.

For more information about disinfectants, see Tech Brief: Disinfection, item #DWBLPE47.

For further information, comments or suggestions for future On Tap *Q&As, call Madabhushi at (800) 624-8301 or (304) 293-4191. You may also contact him via e-mail at* bmadabhu@wvu.edu.

References:

1. U.S. Environmental Protection Agency Office of Ground Water and Drinking Water. 1998. "Drinking Water Priority Rulemaking: Microbial and Disinfection Byproduct Rule." EPA 815/F/98/0014.
2. University of Florida.1998. Institute of Food and Agricultural Sciences. "Trihalomethanes and Our Water Supply."
3. *Ottawa Citizen*. November 1998. "Federal Panel Ties Tapwater to Cancer."
4. Pontius, Frederic. 1998. "Small Systems to tackle Disinfection Byproducts." *Journal of American Water Works Association.* Denver: American Water Works Association.
5. Chen, P.P.T. and G.B. Rest. 1996. "Disinfection Byproducts, the Techniques of Control," *Journal of Public Works* (36-38).
6. Uza, M., R. LeCraw, L. Fortin, H. Broomer, and A. Edmonds. 1997. "Optimization of WTPs for the Control of Trihalomethanes." Ontario Water and Wastewater Division Conference.
7. Grossman, Rebekah. February 2, 1999. "Tap Water: The Last Taboo." *http://www.wholeliving.com/articles/tapwater.html*
8. "Tech Brief: Disinfection." Summer 1996. *On Tap.* Morgantown: National Drinking Water Clearinghouse. Item #DWBLPE47.

Do you want to learn how the Year 2000 (Y2K) computer problem might affect your drinking water plant? The National Drinking Water Clearinghouse has collected Y2K Web sites at http://www.ndwc.wvu.edu.