Hazardous Chemicals Used in Water Treatment

1.0 Introduction

The primary goals of advanced water treatment in heating, ventilating, and air-conditioning (HVAC) systems are to prevent mineral scale formation, control biological activity, and inhibit corrosion. These problems traditionally have been addressed by means of chemical additives. Difficult to administer, monitor, and control, chemical additives are ultimately discharged into the environment where they can: (a) contaminate soil, surface and ground waters, (b) concentrate in water treatment plants as residuals, and (c) be directly aspirated by people exposed to the mist created by cooling tower drift.

Chemical water treatment of cooling systems has a myriad of options. Yet all options have one common concern: every toxic chemical used to treat these systems will eventually be released into the environment.

Water treatment in cooling towers, for example, requires the balancing of multiple chemicals for controlling biological growth (including pathogens such as Legionella), controlling corrosion, and controlling scaling. The biocides and corrosion inhibitors are the most toxic. Because of their effect on the environment and human health, several chemicals once used in cooling towers are now banned, such as chromates (as addressed in the Hollywood film Erin Brokovich) and tributyl tin. Their substitutes, though less toxic, are not benign.

2.0 A Profile of Chemical Water-Treatment Constituents and Their Impact on Human Health and the Environment

The table on the following page lists 10 major types of chemicals used in the water treatment of cooling systems. Each chemical is addressed in terms of its:

- intended function (e.g., as a biocide, scale inhibitor, or corrosion inhibitor),
- potential pathway of release into the environment, and
- associated environmental and/or human health issues.

Hazardous Chemicals Used in Water Treatment

A Profile of Chemical Water-Treatment Constituents			
Constituent	**Function**	**Pathway of Release**	**Environmental Issue**
Copper	Biocide/Algaecide	Cooling Tower Drift System Blowdown	• An aquatic toxin.
			• Generally not eliminated via POTW.
			• EPA: A "Priority Toxic Pollutant."
Copper	Biocide/Algaecide	Cooling Tower Drift System Blowdown	• An aquatic toxin.
			• Employee Health & Safety concern.
			• POTW: severe operational problems.
Oxidizing Biocides (Chlorine and Bromine)	Biocide	Cooling Tower Drift System Blowdown	• An aquatic toxin.
		Air Emissions (Chlorine gas)	• POTW: severe operational problems.
			• Daughter products of reaction with organics are more toxic than biocide.
			(These include chloroform and other known and suspected carcinogens.)
			• 90% of the chlorine added is released into the environment by air emissions.
			• EPA was close to banning oxidizing biocides in all the Great Lake States.
Ozone	Biocide	Air Emissions (Smog)	• Ground level pollutant.
			• Health & Safety Issue with indoor sump (indoor-air quality).
			• Unstable (explosive) and must be generated on-site.
Silver	Biocide	Cooling Tower Drift System Blowdown	• Aquatic and human toxin.
			• Generally not eliminated by POTW.
Molybdenates	Corrosion Inhibitor	Cooling Tower Drift System Blowdown	• Reports to sludge in POTW and then enters biosphere with subsequent use of sludge as a fertilizer.
			• Has been demonstrated to livestock health.
			• A voluntary ban is in effect in Boston.
Phosphates	Corrosion Inhibitor Scale Inhibitor	Cooling Tower Drift System Blowdown	• EPA was close to banning oxidizing biocides in all the Great Lake States.
Zinc	Corrosion Inhibitor	Cooling Tower Drift System Blowdown	• Aquatic toxin.
			• Generally not eliminated by POTW.
			• EPA: A "Priority Toxic Pollutant."
Brine	Scale Inhibitor (Regeneration of water softeners.)	Softener Backwash	• POTW: severe operational problems (corrosion)..
Sulfuric Acid	Scale Inhibitor	Cooling Tower Drift System Blowdown	• Health & Safety Issue (can cause severe burns).

3.0 Potential Chlorine Exposure to Human Health and the Environment

The anticipated volume of chemicals that would be required for cooling tower water treatment by a large facility is significant. Chlorine is the most common biocide used in cooling towers. The building represented in the following table has 5,000 tons of cooling capacity. The table estimates the volumes of chlorine required, assuming that the cooling system will run at an average of 50% capacity for 12 hours per day for 8 months a year.

ESTIMATED CHLORINE USAGE UNDER CHEMICAL TREATMENT	
Average Capacity	2,500 tons
Recirculating Water Flow (3 gpm/ton)	7,500 gpm
Evaporation Rate (1.8 gph/ton)	4,500 gph
Blowdown at 4 Cycles of Concentration	1.500 gph
Water Blowdown per Year (8 months @ 12 hrs/day)	4.3 million gallons
Estimate of Chlorine for Treatment (0.3 lbs/million lbs of recirculation)	1.125 lbs/hr = 1.125 gph liquid chlorine
Annual Chlorine Use	3,240 lbs or 3,240 gallons chlorine
Annual Water Release @ 1.0 ppm residue	35.8 lbs of chlorine
Annual Air Emissions (balance)	3,204.2 lbs of chlorine

Fortunately, the above table has its cooling system under ProMoss™ control, thereby preventing over 3,000 pounds of chlorine from being discharged into the environment each year.