

Legionnaires' Disease

Best Technology for Control of Infection from Operation of Cooling Tower Systems

TAB 10/05

Background

Legionnaires' Disease was recognized as a specific bacterial disease, caused by legionella pneumophila, after it killed 34 members of the American Legion who contracted an acute pneumonia infection while attending the 1976 Legion convention in Philadelphia. Spread of the disease is generally linked to water systems, with cooling towers being a prominent source. For instance, in July, 1995, three deaths and thirteen confirmed cases were linked to the cooling tower system at the Chambersburg, PA, hospital. Industry is not immune, as shown in March, 2001, where four employees at the Ford Motor Company, Cleveland, OH, casting plant contracted Legionnaires' Disease, resulting in two deaths. Recent estimates by the Centers for Disease Control (CDC) and the Occupational Health and Safety Administration (OSHA) show annual infection rates between 10,000 and 25,000+ in the United States alone. **Legionnaires' Disease is a deadly menace in any commercial or industrial facility equipped with a cooling tower system.** Recent data shows that the mortality rate for the disease is typically 5 to 15%, with rates as high as 30% when less resistant populations are exposed!

The Legionnaires' Disease bacterium, legionella pneumophila (legionella), is really quite common, being found in most soils throughout the world. It becomes a public health and safety problem when it reproduces in large numbers in a suitable water environment and is subsequently dispersed into the air. A respiratory infection results when a sufficient number of the airborne bacteria are inhaled. Cooling towers are a preferred site for growth of the bacteria, often providing favorable conditions for reproduction and subsequent dispersal via the aerosols produced during cooling tower operation. Other water systems, such as building hot water supplies, chilled water systems, potable water supplies, and industrial quench systems; have also been found to harbor sufficient bacteria to cause infection should the water be dispersed into the air.

Once the specific problem presented by Legionnaires' Disease was recognized as relates to cooling tower system operations, health related organizations worldwide such as CDC, OSHA, and US Veterans Administration (USVA); and industrial associations involved with cooling tower systems such as the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), Cooling Technology Institute (CTI) and Association of Water Technologies (AWT); instituted on-going research programs to devise monitoring and control methods.

Problem

As could be expected from the number, and differing primary missions, of the various groups involved, a large number of often confusing, and sometimes conflicting, opinions and recommendations have resulted concerning control and monitoring of legionella in cooling tower systems.

For instance, the main recommendation, to date, by the CDC for control of legionella in cooling tower systems is summed up as "control total biological activity in water systems via routine use of USEPA approved biocides and keep the systems clean". Concern is also expressed about the "high cost of an environmental investigation and of instituting control measures". Routine monitoring is not recommended since "the relationship between the results of water cultures and the risk of legionellosis remains undefined".

ASHRAE emphasizes mechanical control as shown by "more emphasis should be placed on clean equipment in excellent repair" and "having a water treatment program including a biocide". While these practices are recommended, a disclaimer is also presented in "although using these practices will not guarantee that a system -- will be free of legionella, they should reduce the chance of the systems becoming heavily colonized with these bacteria". No specific recommendations are made as to monitoring, though it is noted that "the only reliable method for testing for the presence of legionella in a system is by culturing" and "the results of single tests must be interpreted cautiously".

In their standard EC 1.7, effective January 1, 2001, the Joint Commission for the Accreditation of Healthcare Organizations (JCAHO) requires that all accredited facilities have a management program to "reduce the potential for organizational-acquired illness" and "managing pathogenic biological agents in cooling towers --". While the accredited facility is required to control legionella in their cooling towers, little guidance is provided on the actual how-to and what is considered acceptable "managing".

In comparison to these rather vague recommendations, both OSHA and CTI have concluded that the best control practice for legionella in cooling towers is to **"feed a source of halogen (chlorine or bromine) continuously and maintain a free residual"**. CTI recommends a free residual of 0.5 to 1.0 mg/l, while OSHA recommends a minimum free residual of 1 mg/l.

Neither organization recommends routine monitoring for legionella due to cited problems such as:

- An infectious dose level for legionella has not been established
- Legionella can rapidly colonize a previously "clean" system
- Simple detection of legionella in a cooling tower system does not mean there is a risk of disease.
- Culture based test methods for legionella have a 10 to 14 day turn around time, too long for the testing to be used as an effective control parameter.

OSHA does, however, provide guidelines relating legionella test results in cooling tower water to recommended actions as follows:

legionella level	recommended action
100 + cfu/ml	prompt cleaning and/or biocide treatment of system
1000 + cfu/ml	immediate cleaning and/or biocide treatment, take prompt steps to prevent employee exposure

Other regulatory agencies have taken more definite positions; many European and Australian public health agencies require that all cooling towers be operated with continuous halogenation, specific monitoring and reporting guidelines are in place to enforce the requirement. Some American agencies, such as the Allegheny County (PA) Health Department, now recommend that institutions, such as health care facilities, undertake routine legionella testing.

All operators of cooling towers have both an ethical and a legal obligation to prevent transmission of disease to their employees, customers, patients, and the general public. The legal liability associated with operating a cooling tower without the best technology for control and monitoring of legionella is very substantial. In the past ten years, many large firms have been forced into bankruptcy by civil suits based on such health and safety issues.

The real problem thus presented to operators of cooling towers is determining the best technology for control and monitoring of legionella, and implementing it in a cost effective, documented manner.

Field Experience/Product Development

ProChemTech International is a designer/supplier of cooling tower systems and water management programs for operating systems; and operates cooling towers at its own manufacturing plants. We have reviewed the many recommendations, guidelines, and position statements; and conducted a four year legionella monitoring program, analytical work by the Special Pathogens Laboratory of the USVA covering over 150 ProChemTech managed cooling systems. (Note that the cost of a single legionella analysis by this world class laboratory is less than \$100, is this "high cost"?)

We have found that legionella monitoring is a valuable tool for adjustment of cooling water management programs to minimize the level of legionella present in cooling water when combined with routine biological testing of recirculated cooling waters, using control points of 10,000 colonies per ml maximum, measured using plate counts; or 2000 RLU maximum, measured using the ATP method. Legionella testing on a twice a year basis was effectively used as a means of assessing the effectiveness of the water management program in keeping this specific bacteria under control.

Using the OSHA action levels as the control points for legionella in our water management programs, legionella testing was used to both initiate and verify effectiveness of the actions taken. Due to action level work on several systems, we have documented the effectiveness of halogen biocides against legionella. These findings support the on-going research in the United Kingdom, and by Dr. Janet Stout, USVA, that has demonstrated that oxidizing biocides, such as chlorine, bromine, chlorine dioxide, and ozone; were more effective at controlling Legionella than non-oxidizing biocides; such as glutaraldehyde, quaternary amines, and isothiazolin. We can thus conclude that any effective water treatment program must incorporate routine use of an oxidizing biocide for control of legionella.

Our company has developed a unique, patent pending, process for cost effective halogenation of cooling towers, the ElectroBrom Biocide System. The ElectroBrom unit is basically an electrochemical cell that converts a non-hazardous mixed salt water solution into bromine at the customer's site via electrolysis. Units are sized from the "MiniBrom" capable of just over one (1) pound per day of bromine production and suitable for many smaller HVAC applications, to large units, producing up to 90 lb/day and usable in the largest power plant cooling tower.

In addition to the ElectroBrom Biocide System, our firm has developed and manufactures a liquid "stabilized bromine" which is an economical halogen biocide. For those installations that do not wish to install any additional equipment, use of stabilized bromine is a simple, economical means to add a halogen oxidizing biocide to a water management program using just a timer and chemical pump.

Problem Solution

At present, the best technology for control of legionella can be defined as follows:

- Provide routine halogenation to maintain a total residual of 0.5 to 1.5 mg/l in the cooling water for a period of one (1) hour after the dose.
- Maintain routine biological control of the cooling water by keeping standard plate counts below 10,000 cfu/ml, and/or ATP test results below 2000 RLU.
- Maintain the cooling system in good mechanical condition.

- Maintain the cooling system to minimize scale, corrosion, deposition, and biological fouling.
- Maintain good records of all biological and chemical testing on the system and any corrective changes made, with results obtained.
- Utilize the OSHA guidelines on recommended actions relative to legionella test results.

Our commercialization of both stabilized bromine and the ElectroBrom Biocide System makes routine halogenation the safest, most cost effective means to control legionella available. Use of either of these technologies eliminates the remaining technical and financial reasons against halogenation technology for control of legionella in cooling towers.

Internet Technical Resources

www.ashrae - position and guideline papers

www.awt.org - excellent summary update and statement

www.cdc.gov - lots of clinical data and issues discussion

www.cti.org - excellent guideline for best practices

www.legionella.org - the site for all recent research, testing services

www.osha.gov - guidelines for operation and action, investigation outline

www.legionella.com - commercial testing service

www.hcinfo.com - mix of free publications and commercial consulting services

www.pathcon.com - commercial testing service

Prepared by: Timothy Keister, CWT, FAIC
Chief Chemist

ProChemTech International, Inc.
“The Water Management Company”
Brockway, PA 15824
814-265-0959 **www.prochemtech.com**