

Legionella Control: an Important Aspect of Cooling Water Treatment

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Introduction

Legionella is a ubiquitous organism, a rod shaped bacteria found in natural water resources viz. rivers, lakes, streams, soil samples and drinking water sources like wells. Following the 1976 American Legion Convention in a hotel in Philadelphia, 34 attendees died and 221 people became ill with pneumonia. The infection was eventually researched and attributed to organisms residing in the water stored in cooling towers, being spread by the air conditioning system itself in aerosolized water droplets. Being associated with the American Legion, the bacterium was named Legionella Pneumophila and the associated disease called Legionnaires disease.

Legionella occur in very low concentrations and typically thrive and proliferate in a warm and damp environment in man-made water systems at temperatures ranging from 20 to 45°C, e.g. cooling tower drifts, lagoons, spas and domestic water systems and even swimming pools, if not treated adequately.

Legionnaires disease is a respiratory infection that usually strikes individuals with weak immune systems. Heavy smokers, especially males above 50 years of age, are more susceptible. Infection results from inhaling airborne water droplets or mist containing viable count of Legionella, which are small enough to pass deep into the lungs and get deposited in the alveoli. The incubation period

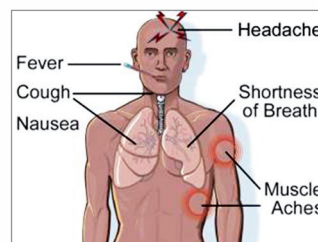


Figure 1: Disease symptoms

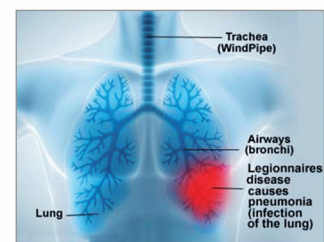


Figure 2: Site of infection

can vary from 2 to 10 days. Symptoms vary from high fever, chills, headache, muscle pain and at times dry cough may develop leading to breathing difficulty and a feeling of disorientation.

Legionella and HVAC Systems

HVAC systems design and installations encompass several factors for consideration such as aesthetics, functional, mechanical and

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indoor air quality. An important aspect to be considered as a part of indoor air quality optimization is to limit the growth and proliferation of the Legionella Pneumophila bacteria. Within the context of HVAC systems, a number of potential breeding grounds for Legionella exist. The most common location for the proliferation and amplification of Legionella within the HVAC system is the cooling tower. The other areas where the bacteria can thrive are sources where standing water may accumulate, such as FCU drain pans, humidifiers etc.

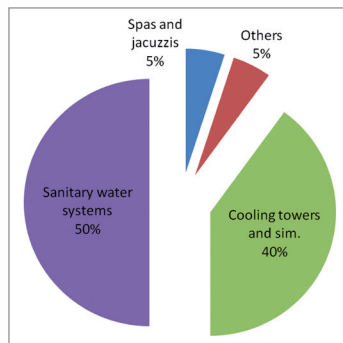


Figure 3: Breeding grounds of Legionella

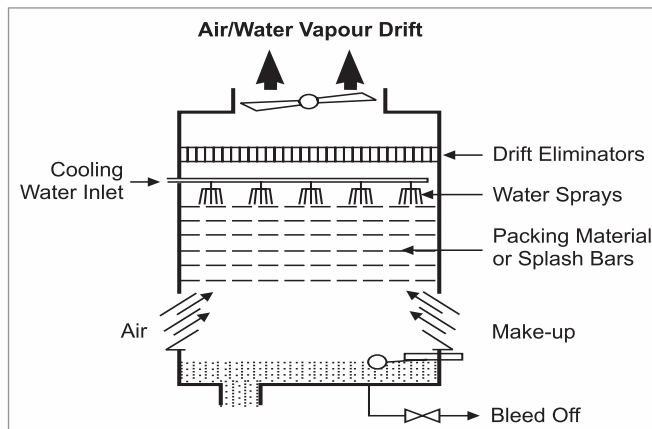


Figure 4: Schematic diagram of a typical cooling tower

ASHRAE Targets Legionnaires' Disease

To help battle Legionellosis, which includes both Legionnaires' disease and Pontiac Fever, ASHRAE is currently developing Standard 188P: "Legionellosis: Risk Management for Building Water Systems." The fourth public review draft of the standard is expected to be approved and made available for public comment soon. The new standard builds on Guideline 12, "Minimizing the Risk of Legionellosis Associated with Building Water Systems," as well as a 2007 World Health Organization document that promoted "Water Safety Plans" to address the risk of Legionnaires' disease.

Role of Cooling Tower in Spreading the Bacteria

Cooling towers are part of large modern air conditioning systems. They are used to cool water and dissipate unwanted heat to the atmosphere through water evaporation. Warm water flows into the top of the cooling tower through spray nozzles (see Figure 4). While the water passes through the nozzles, tiny airborne droplets are formed, providing maximum contact between the water and the air moved through the tower by fans. To prevent droplets from fusing into larger ones, splash bars are placed below the nozzles.

While falling through the tower, some of the water evaporates. Because evaporation consumes heat, the remaining water is cooled. Air pushed through the tower by fans also cools the water. Some droplets, known as drift, are carried out of the tower by the air stream produced by the fans. This water loss is reduced by a drift eliminator positioned at the top of the tower. The cool water collects at the bottom of the tower and is pumped back for another cycle.

A cooling tower, by virtue of its design and function, is itself an ideal bacteria incubator, wherein several conditions exist that are conducive to the survival and transport of Legionella bacteria. Some of the conditions are summarized below:

- A standing pool of water.
- Water temperature that is satisfactory to support Legionella bacteria growth – these bacteria typically proliferate between 20 and 45°C with significant growth occurring between 35 and 44°C.
- Dirt and other particulate matter easily enter the open cooling water system. These can provide nutrients for Legionella bacteria.

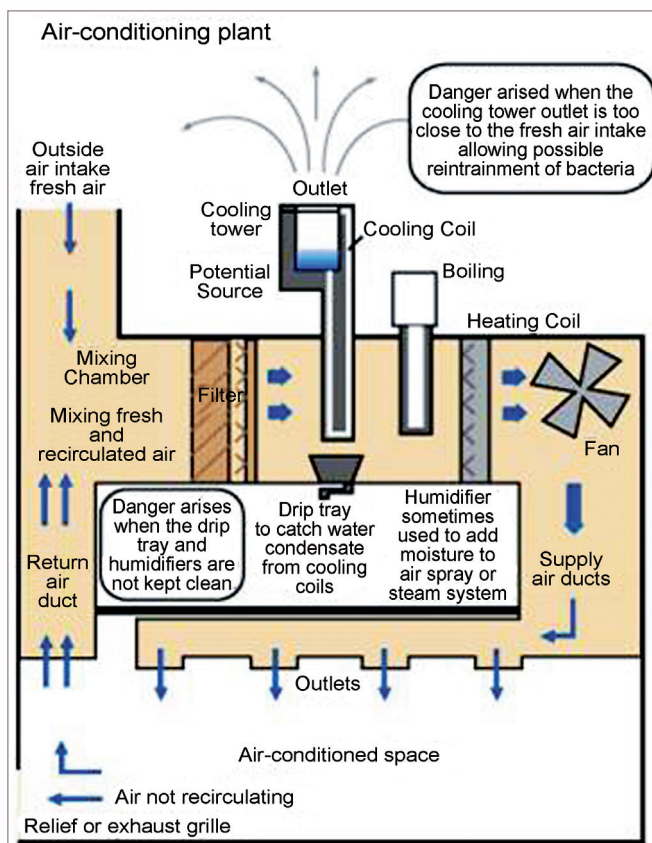


Figure 5: Mitigating the risk of spread of Legionella

- Water mist is generated, allowing the bacteria to become airborne and get dispersed.

In fact, Legionella Pneumophila is typically present in the water samples of nearly all cooling towers. However, the levels of bacteria found in most cases are below those that would typically cause human health effects. So, while the mere presence of the bacteria is not a cause for alarm, control of its level is critical in minimizing the potential for detrimental health effects. Such control can be accomplished through diligent design of the HVAC system, and the administration of an appropriate maintenance program including proper chemical and micro-biologically sound water treatment.

Minimizing Risk by Design

At the design and installation stage of an HVAC system, a number of steps should be taken to limit the potential for growth of this bacterium and to minimize the potential for inhalation, should it become airborne:

- Locate the cooling towers far enough away from outdoor air intakes and other ventilation inlets (such as windows) to eliminate entrainment of water mist in the intake air. Prevailing winds should be considered in selecting a site for the cooling tower and outdoor air intakes.
- Locate cooling tower discharge away from outdoor air intakes, occupied areas, pedestrian walkways and other areas where people may be frequently present.
- Design enclosures for cooling towers to minimize or eliminate the potential for drift from the cooling tower.
- Locate kitchen and bathroom exhausts so that the exhausted air is not brought back into the building through the outdoor air intakes.
- Specify air handling units with sloped, corrosion-resistant drain pans.
- Locate outdoor air intakes to minimize or eliminate the entry of rain-water.

Maintaining a 'Clean' System

Once a system has been properly installed, a number of operation and maintenance tasks can be performed to minimize the potential for elevated levels of the Legionella Pneumophila bacteria. These include:

- Chemically clean and flush the cooling tower before putting it into initial service and before annual start-up (if located in milder climates where seasonal operation is required).
- Ensure easy access to facilitate frequent, routine cleaning and maintenance.
- Maintain a proper water treatment program, including a sound chemical and micro-biocide treatment program to minimize the potential for bacteria growth.
- Perform regularly scheduled quantitative analysis of the cooling tower water for Legionella Pneumophila. Remember that the mere presence of the bacteria should not be cause for alarm.
- Remove standing water from air handling unit drain pans and rectify problems to allow for proper drainage.
- Correct conditions contributing to the collection of standing water near outdoor air intakes.

Conclusion

It can be inferred from the above that controlling Legionella bacteria is not an expensive affair. It involves proper design and thereafter pursuit of an appropriate operation and maintenance schedule, which needs to be followed diligently. With these simple but critical measures, Legionella bacteria can be controlled effectively and maintained below limits that may cause detrimental health effects. It may be noted that specific formulations of biocide combinations have been recommended in guidelines from *Cooling Tower Institute: Best Practices*, along with control limits of bacterial counts to be monitored and maintained. These are not discussed here, being outside the scope of this article. ♦