Why Evaporative Coolers Have Not Caused Legionnaires Disease

Introduction

Evaporative coolers are unique water-using devices. They should not be confused with cooling towers or evaporative condensers, which both have been verified as potential legionnaires' disease transmitters. In contrast, Legionnaires' disease is not a problem with evaporative coolers.

Evaporative coolers vary substantially in operation and design from cooling towers and evaporative condensers. There are a variety of types including swamp coolers, air washers, humidifiers, slingers, atomizers and foggers.

Figure 1 illustrates the basic design and operation of a direct evaporative cooler, which cools air by evaporation of water. The resulting cooled air has increased its relative humidity and water content.

This process is used for cooling and/or humidification of such applications as home, office buildings, factories, schools, prisons, livestock confinement buildings and greenhouses. Evaporative cooling is also used in many other controlled environments such as automotive spray paint booths, electronics manufacturing facilities, computer
rooms, vegetable storage buildings and gas turbine air inlets. Indirect evaporative coolers cool air by a combination of water evaporation and heat transfer (see Figure 2). In these units, the heat exchanger is designed with two discreet air passages. Water and air are circulated over the scavenger or secondary air passage of the heat exchanger (tubes or plates), while dry air is passed through the primary air passage. The net effect is air that was cooled without contacting water or increasing in moisture content.

The water used in evaporative coolers is usually from potable supplies as well as from wells, rivers, lakes and reservoirs. This water normally contains dissolved minerals, bacteria (including Legionella) and suspended solids.
The air supplied to the cooler may contain a variety of contaminants including

dust, dirt, bacteria (including Legionella), soluble gases and nutrients. A portion of these impurities are scrubbed by the water. When the water evaporates, only pure water is released.

The amount of accumulation depends on the water and air quality as well as the operation of the evaporative cooler. If the system is regularly drained, cleaned and allowed to dry out, the accumulations will be substantially reduced. These practices can further prevent the possibility of Legionnaires' disease originating from evaporative coolers.

Legionnaires' disease characteristics

It is important to discuss the causes of this disease and to understand how it is contracted. There are three conditions that must be satisfied before Legionnaires' disease can be contracted:

- The water must contain viable Legionella bacteria in high levels;
- Fine mists of a specific droplet size of the contaminated water must be inhaled deeply into the lungs; and
- The person inhaling the contaminated fine mists must be susceptible (or have a suppressed immune system).

Legionnaires' disease is an illness characterized primarily by pneumonia and is caused by a bacteria known as Legionella pneumophila. The only known entry into the human body is through the lungs. The bacteria has never been isolated from air, yet ail evidence seems to point to the fact that they may become airborne via water droplets.

It has been shown repeatedly that the Legionella pneumophila bacteria is present in many water supplies including potable water, yet its presence in water is not known to create a problem. The bacteria must be transmitted as an aerosol in sufficient bacterial densities to be potentially infectious.

Stress conditions often related to Legionnaires' disease are: males over 40 years old; smokers; alcoholics; persons having previous respiratory ailments; and persons having suppressed immune systems.

Disease amplification

Legionella growth is relative to the temperature of the water (see Figure 3). It is active at a temperature range of 20° to 45°C (68° to 113°F), with optimum growth occurring at about 37° to 41°C (98° to 105°F). The bacteria is found to be dormant at temperatures of less than 20°C (68°F) and is retarded at temperatures above 50°C (120°F). It does not survive at temperatures above 60'C (140°F) or more.

Evaporative coolers most often operate with water temperatures less than 24'C (75°F), or slightly above the wet bulb temperature and quite often below 20°C (68°F) where the Legionella bacteria are not active.

As with all microbiological organisms, Legionella bacteria require nutrients and optimum water quality to proliferate. While water temperature is an important factor in bacteria growth, other conditions must exist. These include the presence of nutrients, sediment and other micro-organisms (particularly protozoa amoeba and/or algae) in the water. These so-called "dirty" systems often provide favourable growth conditions of all types of bacteria, including Legionella..

Disease transmission

The Legionella bacteria enters the lungs via extremely small water droplets (aerosols) of 1 to 5 microns in size. They become seated in the deep recesses of the lungs where, after an apparent incubation period of three to 10 days, the disease usually bursts forth into "full bloom".

The bacteria are rod shaped, 1 x 3 microns in size, and can be transported by aerosols large enough to hold them. However, only those aerosols between 1 and 5 microns in size can be inhaled deeply into the lungs.

Rigid media-type evaporative coolers release water mainly as a vapour. However, this vapour is too small to transport the bacteria.

Slingers (another type of evaporative cooler) normally release droplets that are too heavy and too large to inhale into the lungs (see Figure 4). As the water evaporates from these droplets, they can become smaller and somewhat more suspect. Misting devices create small water droplets that may be in the 1 to 5 micron range. Increased care should be taken when using either of these types of evaporative coolers or humidifiers. Any spray-type

washers must have acceptable, well maintained mist eliminators to avoid becoming suspect (see Figure 5).

Equipment maintenance

Whereas no cases of Legionnaires' disease have been attributed to evaporative coolers, there can be no room for complacency. With the much greater longevity of some of the newer rigid media, combined with year-round use of evaporative cooling for industrial and commercial applications, preventative measures must be addressed.

The following simple maintenance procedures for water systems will also improve cooler performance, reduce musty odours and prolong the life of the equipment:

- Maintain system bleedoff consistent with make up water quality.
- Cooler sumps must be dumped when de-energized and filled with air fresh water when energized. during the operating season. A complete emptying of the sump will help to remove sediment and microbial growth that accumulates at the bottom. These accumulations are not normally removed by conventional bleedoff.

- Allow the evaporative media and sump to dry completely every 24 hours. Most species of biological organisms are easily killed or retarded by drying. When the system is shut down, allow the fan to operate long enough to completely dry out the media.
- Maintain system cleanliness. Deposits from calcium carbonate, minerals and nutrients may contribute to the growth of molds slime and other generators that are annoying to building occupants.
- Develop a maintenance checklist and follow it on a regular basis.
- Refer to the system or media manufacturer for more detailed assistance in water system maintenance.

System design

Media type evaporative coolers.

Design these evaporative coolers to eliminate fine water droplets (larger than 1 micron) downstream of the evaporative cooler. This eliminates water droplets capable of carrying Legionella bacteria and reduces the possibility of moisture in ducts downstream.

For rigid media, a 500 to 600 fpm (2.5 to 3 m/s) face velocity limit combined with a water distribution of 1.5 to 2 gpm/ft² (1.0 to 1.4 I/s/m²) of top surface will yield desired results. The water distribution header will require the regular use of flush valves or cleanouts at the ends.

Assure that drains are located in a position that enables complete dumping of the sump. Sediment usually accumulates in areas where there is little movement, such as corners and depressions in the sump or piping.

Provide an automated drain assembly or flush system at the lowest point in the sump to automatically dump and drain the system.

Design systems that are accessible for maintenance and inspection. Refer to media manufacturer's or system manufacturer's instructions for proper installation and operation.

Spray type evaporative coolers.

The potential to transmit Legionella bacteria is prevalent in spray type air washers, foggers, misters and slingers. Water temperatures in these evaporative coolers are low and not conducive to Legionella bacteria growth, but they can produce respirable aerosols.

When these systems are utilized for evaporative cooling or humidification, the following guidelines should be followed:

- Install mist eliminators that will remove droplets larger than 1 micron
- If a mist eliminator is not installed, only use once-through water. A re-circulation system could amplify bacteria. Use clean water from a reliable source with proper backflow prevention.
- This type of equipment should be designed to automatically drain when the system shuts off. Otherwise, the water in the lines may incubate Legionella bacteria. Dead legs and stagnant zones in the piping system must be avoided.

Microbial control
There may be certain applications where a biocide program is used to control microbial growth and subsequent musty or fishy odours in the air stream. These odours are not in themselves an indication of the presence of Legionella bacteria. However, they may be objectionable to building occupants.
Table 1 lists some common biocides and their effectiveness in controlling algae and bacteria. However, some may not be effective for Legionella bacteria.
Comments on biocides. Bleach, chlorine, bromine and ozone are strong oxidants that not only can cause skin irritation and eye damage but also may damage evaporative cooler components. All biocides should be safely handled and applied as instructed on the label or Material Safety Data Sheet (MSDS).

Some other considerations regarding biocides are as follows:

- The quantity required and frequency of addition is dependent upon a number of factors such as the water capacity of the system, concentration of active ingredients the quantity of biological material, etc.
- Household bleach is a 3% to 5% chlorine releasing liquid.
- Chlorine tablets are slow dissolving, 30% to 50% dry chlorine releasing product.
- Bromine tablets are slow dissolving, 30% to 50% dry bromine releasing product.
- Quats are organic quaternary ammonium compounds often used for disinfections and sanitizing. They are available generally as liquids with 1% to 20% active components. These products often cause foaming.
- Ozone must be generated on site, and it is extremely corrosive to most metals, papers, plastics and rubbers. It is also more toxic than chlorine and bromine.

It should be noted that most biocides used in cooling towers do not have EPA approval for use in evaporative coolers. Some can be used for cleaning and disinfecting purposes in evaporative coolers. Chlorine, bromine and other harsh chemicals result in softening of cooling pads and corrosion of bare metal parts.

Always follow the chemical manufacturer's label. Do not use any chemical that does not list its ingredients on the label.

Preventative measure
The following preventative measures are recommended for overall system cleanliness:

- Run fans after turning off water until the media is completely dry.
- Thoroughly clean and flush the entire cooling water loop on a regular basis (minimum monthly). Include disinfection before and after cleaning.
- Obtain and maintain best available mist elimination technology.
- Do not locate the inlet of an evaporative cooler near the outlet of a cooling

tower.

Summary

Legionnaires' disease is contracted by inhaling an aerosol laden with a sufficient Legionella bacteria into the lower respiratory system. Evaporative coolers do not provide suitable growth conditions, and generally do not release an aerosol. A good maintenance program eliminates potential microbial problems and reduces the concern for disease transmittal.

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