Scaling Back Bacteria

Legionella **bacteria are the cause of Legionnaires' disease, a type of pneumonia first identified in 1976 in Philadelphia.**

By Jan de Baat Doelman

Scale prevention helps reduce risk of Legionnaires' disease

The *Legionella* bacterium, *Legionella pneumophila*—the fundamental agent of Legionnaires' disease—is a water-based organism that causes infection when inhaled in aerosol form. Legionnaires' disease acquired its name in 1976, when an outbreak of pneumonia occurred among attendees of a convention of the American Legion in Philadelphia. Later, the bacterium causing the illness was named *Legionella*.

Normally linked to cooling towers, evaporative condensers, mist machines, humidifiers, whirlpool spas and showers, *L. pneumophila* is most commonly associated with the disease outbreak (legionellosis) that is caused by the inhalation of contaminated water in the form of aerosol spray that is smaller than 5 µm. *Legionella* bacteria thrive in stagnating water, such as in tanks, reservoirs, dead legs in piping systems and poor-flow areas. They require temperatures between 68°F and 113°F (under 68°F, they survive, but over 140°F, they are killed) and a supply of nutrients found in algae, rust, sludge and scale.

Scaling and biofilm buildup in pipe and fixtures can create an ideal breeding ground for *Legionella*.

Disease Prevention

Health agencies continually draw attention to the risks and best practices for cooling water treatment for cooling towers and evaporative condensers. Conditions that affect the proliferation of *Legionella* include:

- The presence of scale deposits or algae growth in the water;
- Dead legs in the pipe or stagnation due to low use of outlets;
- Low temperature in potable hot water heaters and distribution systems;
- Stratification of water in heaters; and
- Inappropriate water treatment.

L. pneumophila may be able to colonize certain types of water fittings, pipe and materials used in the construction of water systems. The presence of such materials, and of large quantities of sediment, may provide nutrients for *Legionella* and can make eradication difficult. In practice, *L. pneumophila* is found in many recirculating hot- and cold-water systems, particularly in larger, complex systems such as those found in hospitals, hotels, offices and factories.

Managing the risks from *Legionella* in water systems requires a holistic approach and a suite of control measures underpinned by a suitable and sufficient risk assessment specific to the system in question. In areas with hard water, scale formation can be a problem unless properly managed, and can increase the likelihood of *Legionella* growth.

The Role of Scale

Scale, or limescale, is a hard, rock-like deposit of calcium or magnesium salts that forms in heat exchangers, cooling tower packing and other water-fed equipment as a result of heat and increased concentration factor. Scale formation impairs heat transfer, interferes with flow and cooling, and can be a breeding ground for *Legionella*.

The scaling tendency of a water supply depends on the hardness of the water; still, if not adequately treated, even relatively soft waters can become highly scaling when concentrated by evaporation. Poor scale control not only puts the cooling process at risk, but also can squander thousands of dollars in wasted energy, chemical and water charges.

Scale is a problem in both hot- and cold-water systems. Dripping taps can deposit scale in and around the tap, and with high ambient room temperatures provide an ideal growth medium for *L. pneumophila*. In hot water systems, scale can trap *Legionella* and biofilm, providing a perfect growth medium that disinfectants cannot penetrate.

Scale deposits colonized by *Legionella* can continuously re-contaminate a system even after disinfection. Biofilm is a source of nutrients for *L. pneumophila* and can lead to taste and odor problems from the products of the bacteria's metabolism.

Scale is a major cause of inefficiency in hot water systems. Scale on heat exchange surfaces dramatically reduces the heat transfer efficiency and promotes corrosion in the calorifiers and pipe. Descaling of a hot water system is time consuming and expensive. Water softeners can

reduce scale, but there is growing concern over the increase to sometimes high levels of sodium in the water.

Bacteria & Scale Reduction

Many air conditioning and refrigeration plant systems use water for cooling. The heat generated by cooling coils is removed by water, which is passed through a water-cooling tower. These are recirculating systems, which operate at temperatures ideal for bacterial and algal growth and have plentiful supplies of nutrients. They have been highlighted as a major possible source of Legionnaires' disease, mainly because of the large number of people that can be affected.

In a tower that is well designed and maintained, however, chances of problems with *L. pneumophila* are low. Most cases of outbreaks have occurred in towers that were badly designed and had little or no maintenance.

In cooling towers, temperature, hardness, pH, scale and corrosion are all factors that increase the chance of biofilm, algae and *Legionella* colonization. Many agents are used to control these factors, including scale and corrosion inhibitors, dispersants and biocides. Water softeners are sometimes used for hard water, which can cause a problem with foaming.

Limescale buildup from a cooling tower, one of the main culprits of Legionnaires' disease outbreaks

Biofilm is a major problem in cooling towers. Biofilm and scale can reduce the efficiency of a cooling system to the point that it no longer transfers heat. Health and safety officers recommend periodic chlorination and descaling of cooling towers. Chlorine, however, is not always compatible with other treatment chemicals such as corrosion inhibitors, is not effective in alkaline water, and can itself cause corrosion.

Some biocides are effective against *L. pneumophila* if used in sufficient concentration. Strains of *L. pneumophila* and other bacteria may become resistant to particular biocides, so dual or alternating biocides should be used.

Electronic Water Treatment

What is required in all water systems—cold, hot and process—is a method of continuously controlling scale deposition and a water treatment regime that prevents the growth of biofilm and bacteria, in particular, *L. pneumophila*. One method is electronic scale treatment, which couples scale deposition prevention with the chlorination of all water supplied to a building or factory, both hot and cold.

Electronic water treatment involves the fitting of electronic water descaling equipment at strategic points in the water system. Water treated by such systems prevents scale from forming in pipe and on heat transfer surfaces. The equipment also removes existing scale deposits over a period of time. There are many advantages to this non-intrusive engineering solution:

- Energy use is greatly reduced due to heat exchange surfaces remaining free of scale deposits (just ¼ in. of scale increases energy costs by about 40%).
- Corrosion caused by scale deposits is eliminated.
- Extensive downtime and labor costs involved in descaling systems are eliminated.
- A source of colonization for biofilm and *L. pneumophila* is removed.
- Water distribution efficiency and pressure are increased by removal of scale deposits that can reduce pipe diameters considerably. *wqp*

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