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Legionella

ASI Technical Document #201

Introduction

Legionella are aerobic, non-spore forming, typically flagellated, Gram-negative bacteria. The genus was named after a severe epidemic of pneumonia at an American Legion convention in 1976, which led to the isolation and characterization of *L. pneumophila*. Since then, more than 50 species and 70 serogroups of *Legionella* have been identified.

In humans, *Legionella* spp. can cause Legionnaires' disease and Pontiac Fever. Legionnaires' disease is difficult to diagnose as it produces symptoms very similar to a number of other pneumonias. Symptoms may include dry coughing, high fever, chills, diarrhea, shortness of breath, chest pains, headaches, excessive sweating, nausea, vomiting, and abdominal pain. It can be fatal, particularly if the onset of treatment is delayed. Pontiac fever is a nonfatal, nonpneumonic, influenza-like syndrome typified by headache, fever, and myalgia. The Centers for Disease Control (CDC) estimates between 10,000 and 25,000 cases of Legionnaires' disease occur annually in the United States.

Habitats

Legionella bacteria occur naturally in aquatic habitats and have been recovered from some municipal water supplies in the United States[1]. Low levels of *Legionella* in municipal water may seed industrial potable water systems and cooling water networks. *Legionella* may then colonize and amplify in hot water tanks, humidifiers, water spray irrigation systems, cooling towers, ice machines, dead-legs in distribution systems, and other areas where bioflora are able to flourish.

Correlations between the presence of scale and sediment in distribution systems and the presence of *Legionella* have been noted in the literature[1,2,3].

Legionella has been shown to have some resistance to low levels of chlorine, and survives in municipal distribution systems because typical chlorine residuals may be insufficient to kill it[4]. Large distribution systems and building water systems may provide near optimal conditions for *Legionella* growth, including warm water temperatures and abundant nutrients contributed by sediments and biofilms. In addition, the presence of amoebae and protozoa, which

have been shown to harbor *Legionella*, may create a shielding effect, further reducing the effect of biocides[2].

Monitoring

The primary route of *Legionella* infection in humans is inhalation of aerosolized bacteria. Therefore, showers, faucets, evaporative condensers, respiratory therapy machines, cooling towers, vegetable misters and other aerosolizing agents are of paramount concern[5,6].

While *Legionella* have been found in potable water distribution systems, the concentration at which they are found is usually insufficient to be of public health concern. In cold water *Legionella* may be outcompeted by other organisms, while in hot water systems *Legionella* proliferate. Regular monitoring of municipal supplies can determine the concentration of organisms present. This information can be used to assess if any additional flushing or disinfection should be undertaken and can also be extremely useful if a *Legionella* outbreak should occur in the general area. Demonstrably low *Legionella* counts within the municipal system indicate that infection is extremely unlikely to have occurred as a result of *Legionella* growing in the municipal system.

Building water systems, particularly those with susceptible populations, should also be monitored to ensure that system operation and disinfection procedures are adequate to prevent *Legionella* colonization and amplification. In addition to disinfectant residual and standard bacterial parameters, periodic *Legionella* monitoring is recommended.

OSHA suggests prompt remedial action be implemented when concentrations of *Legionella* in water samples are >10 CFU/mL (potable water) or >100 CFU/mL (cooling tower water)[10]. Ta, et.al. have suggested that for swabs, a *Legionella* action trigger of >1,000 CFU/swab may be appropriate for hospital potable water systems[7]. However, a recently published World Health Organization document shows that in Europe, the action levels are much lower (up to three orders of magnitude lower).

Nosocomial (hospital acquired) Legionnaires' disease is of particular concern due to the presence of immunocompromised individuals. The Allegheny County (PA) Health Department and the Association for Professionals in Infection Control and Epidemiology (APIC) developed guidelines for the prevention and control of *Legionella* infection in health care facilities. These guidelines involve routine monitoring for *Legionella*, including a minimum of one annual survey with at least ten distal sites (faucets, showerheads, etc.) sampled[8,11]. International experience indicates the OSHA guidelines should not apply to these healthcare facilities and that more conservative action limits would be prudent.

A comprehensive cooling tower monitoring program includes swab and bulk water samples collected from the incoming or make-up water, the header tank, tower pond, and the water returning from the circulation system (at the point of entry to the tower). Swab or scraping samples should be collected of representative sludge, slimes and sediments in the header tank or tower pond. Our experience indicates monthly monitoring of cooling towers and systems for *Legionella* during the cooling season is appropriate.

Water samples should be collected in sterile, one-liter (1L) plastic bottles, using sodium thiosulfate for chlorine neutralization. Swab samples should be collected using swabs formulated with transport media to prevent desiccation. Samples should be shipped, unrefrigerated, to the laboratory in an insulated cooler by overnight delivery. Samples are analyzed within 96 hours of collection.

Analytical Techniques

Although a variety of *Legionella* methods exist (including direct and indirect fluorescent antibody tests, polymerase chain reaction, etc.) the standard procedure is a traditional culture method, based on the CDC procedure, which uses Buffered Charcoal Yeast Extract media with additives. After initial incubation (7 days), colonies with morphologies similar to *Legionella* are patch-plated to distinguish non-*Legionella*

isolates. At the end of this 48 hour incubation, isolates meeting *Legionella* criteria are referred to as "Presumptive Positives." ASI provides *Legionella* confirmation, if requested, by confirming the *Legionella* Serogroup of representative isolates. This latex agglutination procedure differentiates *L. pneumophila* Serogroup 1(which may account for up to 80% of legionellosis cases) from Serogroups 2-14 and other *Legionella* species.

ASI is a member in good standing in the U.S. Centers for Disease Control (CDC) Environmental *Legionella* Isolation Techniques Evaluation (ELITE) Program.

Disinfection Techniques

Several disinfection techniques have been used to treat contaminated systems, including hyperchlorination, ultraviolet (UV) light, ozone, thermal eradication, instantaneous superheating systems, copper-silver ionization and other techniques. For these or other methods to be successful, *Legionella* in the water column, inside commensal microbes and in biofilms must all be killed. The effectiveness and costs of these treatments can vary in practice.[4, 9] ASI can provide assistance in determining the most appropriate treatment for your application and monitor treatment efficacy.

Summary

ASI can help water system managers by developing and interpreting *Legionella* occurrence data and assessing system operation. This approach instills confidence regarding the microbial quality of the system and the manager's ability to provide appropriate responses, particularly when litigation is threatened.

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