Real-time Monitoring of Legionella in Casthouse Water Cooling Systems

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Abstract

The Direct Chill (DC) casting process uses water to extract typically 95 % of the heat from the molten aluminium and control the solidification process. When the casthouse is equipped with an open recirculation system (i.e. cooling tower, lubricant separation unit, etc.), it represents a high risk for the growth of *Legionella spp* because the overall conditions are favourable. In addition, the cooling tower are prone to generate aerosol that will disperse and could transport the contaminated water. *Legionella spp* is a family of pathogenic bacteria that is responsible for Legionellosis. In Europe, Australia, and the USA there are about 10–15 cases detected per million population per year. The transmission is observed by inhalation of contaminated bioaerosols.

The owner of the casthouse may have legal obligation to manage and monitor the presence of *Legionella spp* in their water-cooling system. The detection must be addressed quickly with curative actions that will affect the water chemistry and related quality and stability. The water chemistry variation of the cooling water could also significantly influence the water quenching power and impact DC casting performances. Real-time monitoring allows a better control of the water chemistry (e.g. no shock treatment) and quenching power that reduces variation on the overall DC casting process.

This paper will present the advantages of real-time monitoring that can detect the presence of *Legionella* by measuring the concentration of a specific bacteria namely the *Legionella pneumophila*. The measurements can be done directly on site with results available within 4 hours compared to 14 days traditionally. This makes possible quicker corrective actions and eliminate the risk of outbreak. ,

Rio Tinto Aluminium was the first industry to demonstrate the feasibility to measure the presence of *Legionella*, using the BioAlert™ technology, in an industrial environment. The applicability of this technology to establish a control chart based on the daily results improved considerably the water stability and lowered the risk of *Legionella* exposure. In addition, it also contributed in better understand the bacteria metabolism, and its influencing factors, to improve operational practices and reduce the overall impact on production.

Keywords: Legionella, BioAlert™, Real-time monitoring, Quenching power DC casting, Water treatment system.

1. Introduction

It is a common misconception that water used to feed a process system is pure and safe. It is not sterile, though. Because waterborne bacteria like *Legionella* can spread and become dangerous for human health, water management program is essential.

Legionella bacteria are at the cause of Legionnaires' disease, a severe, acute lung infection with pneumonia-like symptoms, which can be fatal for immunodeficient individuals. The *Legionella* genus (*Legionellaceae* family) numbers 59 species and 70 serotypes, of which nearly half have been linked to human diseases [1]. *Legionella* is found in most natural and engineer water system such as cooling tower. They typically grow in humid conditions with temperatures between 25 and 45 degrees Celsius, which makes contaminated water cooling systems prevalent. The *Legionella pneumophila (Lp)* genus is associated with over 85 % of all infections. They belong to 15 different serotypes, and serotype 1 represents more than 61 % of reported cases [2]. In the United States, reported *Legionella* cases have increased ninefold since the year 2000 (Figure 1) [3].

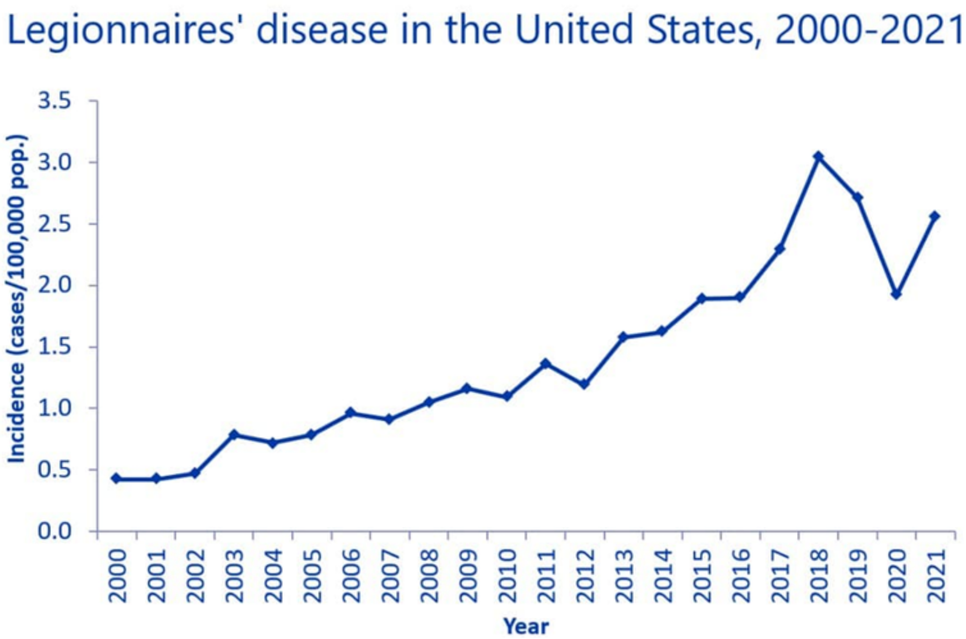

Figure 1. Increase in cases of Legionnaires' disease in the United States, 2000-2021.

In direct chill (DC) casting, the solidification phase requires process water in order to extract heat from the molten aluminium. Quenching power can be defined as the heat-extracting ability of the water [12]. Cooling tower is a recommended equipment for the casthouse water cooling system due to their overall performance within the operational temperature range (from 70 ºC down to 27 ºC). Aerosolized water can be released into the atmosphere by cooling towers. At Rio Tinto Aluminium Quebec, the majority of the water casthouse designs are open loop recirculation system (i.e. cooling tower, lubricant separation unit, etc.) as opposed to closed loop cooling system with heat exchangers and chillers that separate cooling and process water (Figure 2). The same procedures for operation and maintenance apply to both kinds of loop circuits. Closed-circuit cooling towers, on the other hand, prevent atmospheric exposure of the DC process cooling water. Open recirculating system represents a higher risk for the growth of *Legionella* because the overall conditions are favourable (same casting process water circulating through the cooling tower, more complex chemistry water due to a diversity of contaminants, complexity of the chemical treatment strategy, biofilm easily developing in the cooling tower, etc.). In addition, the cooling towers are prone to aerosol generation, which can disperse and transport the contaminated water with *Legionella*.. They have the potential to expose a large number of people to contaminated aerosols over long distances (up to 10 km) [4, 5].

to confirm where the highest levels of *Legionella* detection are in the system to better identify the root cause of detection.

Validating various on-line monitoring systems in complex water systems will presents a significant challenge, but it is an undeniable necessity to improve operations and guarantee a consistent and stable quenching water for aluminium casting production. This will drive the exploration of alternative chemistries and the adoption of innovative equipment that can greatly enhance performance and production compared to traditional water treatment strategies, all while taking into consideration environmental and human health perspectives.

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