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Copper and Silver Water Treatment

Copper and Silver Ionisation effect on Legionella

Legionella

Legionella pneumophila is a disease-causing microorganism well known for causing Legionellosis (Legionnaires' disease and Pontiac fever). It is particularly dangerous for hospital patients that have a compromised immune system. L. pneumophila can survive in water temperatures from 0°C to 63°C (Nguyen et al. 1991), with an optimum growth range between 38°C and 46°C. It thrives and multiples rapidly in untreated or ineffectively treated water, and finds its way into a human system when it is inhaled as aerosols emitted by showers, taps cooling towers and fountains.

Cases of Legionnaires' disease have quadrupled between 2000 and 2014 in the USA and are still on the rise (Figure 1), hence the importance of not only being aware of it but also having a robust system in place to control Legionella. More cases occur in the summer than in other times of the year because Legionella thrives in warmer water temperatures commonly seen in summer months.

The number of reported cases of Legionnaires' disease in England and Wales between 1 January and 31 December 2016 was 496 (PHE 2016).

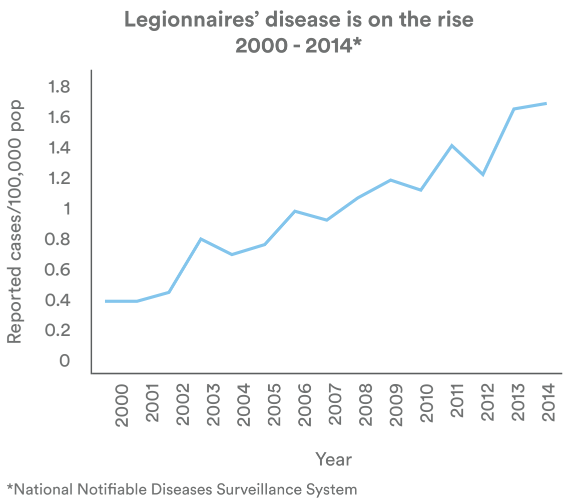

Figure 1: Reported cases of Legionnaires' disease per 100,000 population (NNDSS)

Temperature control has been the traditionally applied method for the control of Legionella in water distribution systems. This entails obtaining 50°C and above after running any hot water tap for 1 minute and 20°C and below after running any cold water tap for 2 minutes (HTM04-01 2016). However, only 13% of the results of tests carried out by the UK Building Services Research and Information Association (BSRIA) in 1996 using temperature control were free of Legionella.

Intermittent shock injection of chlorine into the water, to achieve 20 to 50 mg/L of chlorine throughout the system, can be effective in the short term. Bacterial re-colonisation often occurs, however, after the disinfectant levels decrease (Lin et al. 1998). Unfortunately, protozoan cysts of species such as amoeba that harbour Legionella survive free chlorine levels of 50mg/L (Kilvington & Price 1990). Chlorine also reacts with organic materials and accelerates the production of trihalomethanes (THMs), carcinogens which are the only regulated disinfection by-product in the UK. It is required by law that the sum of four THMs does not exceed 100 µg/L (Bougeard et al. 2010).

Chlorine Dioxide: The UK Drinking Water Inspectorate have prescribed that a level of 0.5mg/L of chlorine dioxide should not be exceeded. Studies on models indicate that concentrations of between 0.3 and 0.5mg/L can control Legionella, but maintaining this level in hospital water systems difficult as the chlorine dioxide will decompose to chlorite and chlorate, and decays over distance and at elevated temperatures (Sidari et al. 2004). Chlorite and chlorate are not only toxic but also less active than chlorine dioxide against Legionella, and are inactive against protozoa and biofilm.

There are health hazards to humans and environmental concerns associated with chlorine dioxide, and to this effect the UK Health Protection Agency has produced a guide on how to deal with chlorine dioxide incidents.

Copper and silver ionisation is a relatively new modality for the control of Legionella, Pseudomonas and other pathogens in water systems. The use of copper and silver ionisation was first recorded in the USA in 1990 (Lin et al. 2011), although it was pioneered by NASA in the 1960s (Albright et al. 1967). The ProEconomy copper and silver ionisation system is known by its trade name Orca.

Effective Legionella control using copper and silver ionisation

ProEconomy have been analysing water since 1993 and have built up a substantial databank. Their results show that when silver ion concentrations at outlets are maintained between 0.02 and 0.08 mg/L and copper ion concentrations between 0.2 and 0.4 mg/L, Legionella contamination is avoided.

Much more research proving the efficacy of the Orca system is available and Dr Birgitta Bedford, a founder member of ProEconomy and who has a PhD in Legionella control from Cranfield University, has compiled a list of references of over 40 scientific papers that support copper and silver water ionisation. Some of them are listed at the end of this Fact Sheet.

Data sets from hospitals using the Orca system demonstrate excellent control of Legionella and an example is given in Figure 2 (Barbosa & Thompson 2016). The graph records results for a large hospital on the outskirts of London and show 100% control for the last 15 months.

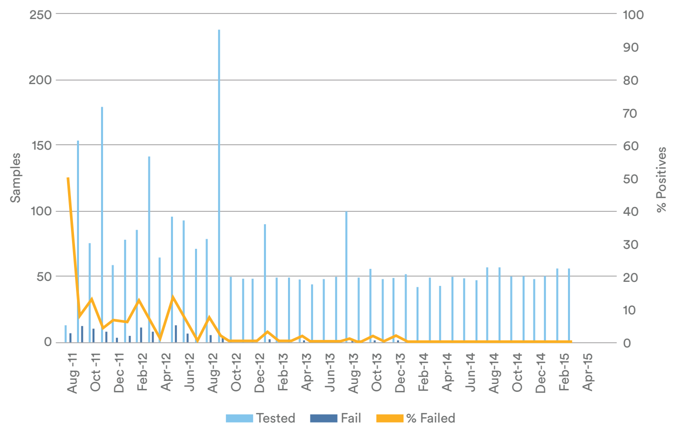

Fig 2: Legionella results pre- and post-Orca installation at large 900-bed hospital outside London (2011-2015)

Further evidence from published papers

Conclusions from a study carried out by the University of Pittsburgh, USA (Lin et al. 1998) stated that for Legionella control, copper and silver ionisation outperformed conventional treatment techniques such as hyperchlorination, chlorine dioxide, superheating and flush and UV light systems due to the following advantages:

1. Installation and maintenance are easy.
2. Efficacy is not affected by high water temperatures, unlike chlorine dioxide and UV light systems.
3. Residual disinfectant protection occurs throughout the system, unlike UV light.
4. Recolonisation is delayed as the copper and silver ions kill rather than suppress Legionella bacteria.

A study into the long-term (5 to 11 years) efficacy of copper and silver ionisation for Legionella control in 16 hospital water systems concluded that it reduced the incidence of hospital-acquired Legionnaires' disease, and furthermore was the only modality to have fulfilled all evaluation criteria that the USA recommend be applied to Legionella control approaches (Stout and Yu 2003).

Residual Effect of Copper and Silver

A 1994 study on copper and silver ionisation of a hospital water distribution system found complete inactivation of Legionella pneumophila and L. bozemanii when exposed to 0.4 mg/L copper and 0.04 mg/L silver, and continued residual inactivation two months after the copper and silver water ionisation unit was switched off (Liu et al. 1994).

Another study by Liu et al. (1998) evaluated copper-silver ionisation systems installed onto the hot water recirculation lines of two hospital buildings colonised with L. pneumophila, compared with a control also colonised with L. pneumophila. Four weeks after activation of the system, distal site positivity for Legionella in the first test building dropped to zero. After operating for 16 weeks the system was disconnected and installed onto the second test building. Twelve weeks of disinfection reduced the distal site positivity for Legionella in the second test building to zero. Legionella recolonisation did not occur in the first test building for 6-12 weeks and in the second test building for 8-12 weeks after inactivation of the system. A significantly higher copper concentration was found in the biofilm taken from a sampling device than in than that from water, and this was taken to be the reason the copper-silver ionisation system had a residual effect and prevented early recolonisation.

Copper and silver ionisation complements temperature

Results of tests carried out during a research project completed in 1996 by BSRIA in the UK showed that copper and silver ionisation was effective against Legionella bacteria in both cold and hot water systems with water temperatures as low as 35°C. Therefore, when temperature is lower than the recommended by the authorities, having copper and silver as a secondary Legionella control modality will ensure the water system is still protected.

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