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Copper and Silver Water Treatment

Copper and Silver Ionisation effect on other bacteria

Copper and Silver Ionisation effect on pathogens other than legionella

HTM04-01 recommendations

Following the publication of the new updated version of the HTM04-01 last year, duty holders now must ensure the safety of all water used by patients, residents, staff and visitors to healthcare facilities so as to minimise the risk of infection associated with all waterborne pathogens. This therefore applies to other waterborne pathogens, not just Legionella, including Pseudomonas aeruginosa, Stenotrophomonas maltophilia and Mycobacteria.

S. maltophilia is considered an emerging multidrug-resistant opportunistic pathogen, and the increasing incidence of nosocomial and community-acquired infections is of particular concern for immune-compromised individuals as this pathogen is associated with a significant fatality/case ratio (Brooke 2012).

S. maltophilia, previously known as Pseudomonas maltophilia and later Xanthomonas maltophilia is commonly found in a free-living state, mainly in soil and water but also in animals and foods. It is associated with wet surfaces and aqueous solutions and its cells have the ability to survive with minimal nutrients, e.g. in drinking water, ultrapure water, treated water and dialysate effluent.

S. maltophilia has become an important pathogen as it can acquire genes from other bacteria species including those involved in antibiotic resistance (Brooke 2012). It can also transfer antibiotic resistance to other bacteria (Babalova et al. 1995).

The HTM04-01 and Stenotrophomonas

The HTM04-01 states that "There are at least 14 species of Stenotrophomonas; the most important waterborne pathogen is S. maltophilia. This is an emerging opportunistic environmental pathogen that causes healthcare-associated infections and is found in aqueous habitats including water sources. S. maltophilia is an organism with various molecular mechanisms for colonisation and infection, and can be recovered most notably from the respiratory tract of cystic fibrosis patients with P. aeruginosa. Its habits within the healthcare environment are very similar to P. aeruginosa; however, it is more heat-sensitive and will not grow above 40°C. Good temperature management should reduce the risk of colonisation. It has been associated with the colonisation of taps/tap water, sinks/sink traps, showers, hydrotherapy pools, ice-makers, disinfectant solutions, haemodialysers, nebuliser chambers, humidifier reservoirs, bronchoscopes and ventilator circuits. S. maltophilia isolated from tap water has been shown to be responsible for the colonisation/infection of five neonates in a neonatal intensive-care unit. Where clinical results indicate water may be a vector in the transmission of Stenotrophomonas spp., then water sampling should be carried out as per P. Aeruginosa." (See page 20 of HTM04-01 linked in references list below)

S. maltophilia control in water systems

Tolerance is a problem when trying to control microorganisms, and S. maltophilia is of particular concern because of its resistance to some biocides. Brooke (2012) presented a comprehensive review of studies on S. maltophilia which includes its biocide tolerance. The study showed that:

- S. maltophilia was recovered in large numbers (5.1 x 105 – 4.8 x 106) in sputum suction tubing after exposure to 0.1% sodium hypochlorite for 2 h.

- Resistance to Triclosan (2,4,4'-trichloro-2'-hydroxydiphenylether) and sodium dodecyl sulphate (SDS) was also demonstrated, with clinical isolate X26332 surviving and persisting in a 0.02% solution of SDS for 14 days at 30 C.

- Silver nitrate, at the recommended dose of 100 µg/L, did not significantly prevent biofilms formation in drinking water, and that only when concentration of silver nitrate reached around 10,000 µg/L was it able to inhibit biofilm formation.

Brooke's study also discussed metal resistance in clinical and environmental settings. It showed that S. maltophilia cells have gene clusters used for the import, storage and efflux of metals.

How copper and silver ionisation control pathogens

Chaudri et al. (1999) showed that toxicity to microorganisms due to zinc in soil was due to free Zn2+, its ionic form. Metals applied in a compound as a biocide are bound to other atoms, for example as nitrate in silver nitrate, and hence may not be bio-available. For metals to show toxicity to microorganisms they must be present in their ionic, and hence bio-available, state.

Copper and silver ionisation involves the generation of copper and silver ions in water. This happens when water flows through the turbine of a flow sensor sending a signal to the system control unit, which then passes a low DC current between two copper and two silver electrodes located in an electrode chamber. The current causes the release of copper and silver ions into the flowing water. Being electrically charged the copper and silver ions seek opposite polarity and find this in the negatively charged sites on the cell wall of Legionella bacteria. The ions distort and weaken the cell wall and then bind at specific sites to DNA, RNA, cellular protein and respiratory enzymes denying all life support systems to the cell, causing death. Therefore, biocide tolerance in S. maltophilia is unlikely to occur when using copper and silver ionisation to control pathogens in water systems.

Copper and silver ionisation control of S. maltophilia and other pathogens in water systems

As stated in HTM04-01, S. maltophilia is heat-sensitive and will not grow above 40°C. Good temperature management should, therefore, reduce the risk of colonisation. Use of the word 'should', however, implies that control is not guaranteed.

It has been demonstrated that copper and silver ionisation is effective against Legionella, P. aeruginosa and Mycobacteria as well as S. maltophilia (Liu et al. 1994, Miuetzner et al. 1997, Liu et al. 1998, Stout et al. 1998, Biurrun et al. 1999, Rohr et al. 1999, Kusnetsov et al. 2001, Stout and Yu 2003, Chen et al. 2008, Lin et al. 2011, Bedford 2012, Barbosa & Thompson 2016). This is most probably because the copper and silver are in their ionic state which is the form that is able to kill microbial cells, hence their success in controlling pathogens in water systems.

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