Introduction

Keeping up with legislation can be tough for many businesses with new regulations and practices seemingly every year. In this technical note, Pi aims to address one aspect of the L8 ACOP legislation, to help you and your tower manager (internal or contracted) to decide your company’s best practice for dealing with biofilm.

What is biofilm?

Biofilm is simply a deposit consisting of bacteria, fungi and various proteins secreted by these micro-organisms. The secreted proteins are collectively termed extracellular polymeric substance (EPS) or slime1.

Why is biofilm problematic?

HSE HSG274 Legionnaires’ disease: Technical guidance Part 1, 2013, Pg. 31 – Biofilm can impair heat transfer efficiency, cause severe localised corrosion and the growth of legionella and should be considered a high risk contamination.

The growth of biofilm is a response by a micro-organism to environmental pressures that are usually in the form of reduced nutrients, the presence of disinfectants etc. Different disinfectants affect biofilms in varying degrees of efficacy, and the presence of biofilms can increase the micro-organisms’ resistance to antimicrobial agents by 10-1000 times2. The most common disinfectant, chlorine, has been shown to penetrate less than 20% of a biofilm in a laboratory study2,3.

When shielded from disinfectants, biofilms allow already present legionella bacteria to multiply to potentially dangerous levels. In its advanced stages, biofilms release packages of bacteria into the bulk water, spreading pathogens into your water supply4,5.

As the biofilm develops and takes hold, they become more established, and therefore even more difficult to get rid of. Microbially induced corrosion can begin to occur on surfaces where biofilm is attached, creating pits. These pits will remain even after biofilm has been removed, and will facilitate further corrosion6. Biofilm growth can also impair heat transfer efficiency by clogging up surfaces with slime7.

How do we get rid of biofilm?

Even chlorine dioxide (ClO₂) which is seen by many as the most effective for biofilms has been shown to only penetrate 0.1 millimetre of biofilm with a 25ppm solution8. A major biofilm contamination will require shock treatment using high concentrations9,10 (with a considerable environmental impact, see pg.38 of HSE HSG274 Legionnaires’ disease: Technical guidance Part 1) and a full cleaning, all of which cost time and money.

HSE HSG274 Legionnaires’ disease: Technical guidance Part 1, 2013, Pg. 32 – If the contaminating material appears to be microbial i.e. biofilm, irrespective of thickness, the pack should be cleaned.
If getting rid of biofilm is difficult, the key to a successful management is prevention.

**HSE HSG274 Legionnaires’ disease: Technical guidance Part 1, 2013, Pg. 15 – Preventive maintenance is an important measure to assure reliable and safe operation of the cooling system.**

**How do I prevent biofilm from forming?**

The triangle opposite represents the relationship between biofilm, disinfectant and corrosion. By covering one corner of the triangle, we can predict the outcome for a water system. If we don’t disinfect, we get corrosion and biofilm. If we use too much disinfectant in order to completely eliminate all chances of biofilm, we get corrosion. If we use corrosion inhibitors, we feed the biofilm and reduce the efficacy of the disinfectant. Striking a balance between these three factors is the challenge all cooling tower managers face.

**HSE HSG274 Legionnaires’ disease: Technical guidance Part 1, 2013, Pg. 9 – The cooling water treatment programme should be capable of controlling not only legionella and other microbial activity, but also corrosion, scale formation and fouling to maintain the system’s cleanliness.**

**How can Process Instruments help me?**

Currently, L8 legislation recommends that a residual level of disinfectant is maintained (this level is different depending on the chemical used) and suggests a minimum of weekly level checks to ensure this. Many dutyholders have recognised that weekly checks are not enough to cope with changes in temperature, oxidant demand, pump speeds, valve failures and all the other variables that go into maintaining a disinfectant residual. This has led to the implementation of many continuous online measurement systems, often using amperometric sensors and automatic dosing. (This is something Pi can provide with our world class sensors and cutting edge controllers [http://www.processinstruments.co.uk/products/]).

**HSE HSG274 Legionnaires’ disease: Technical guidance Part 1, 2013 , Pg. 20 – The dosage and control of the biocide regime should be automated to ensure the correct quantity of biocide is applied at the required frequency. The dosage of oxidising biocides, such as bromine and chlorine, can be controlled by a redox or amperometric control system, which automatically adjusts the dosage in response to the oxidant demand of the water to maintain the desired biocide residual level.**

Whilst a properly maintained residual can go a long way towards ensuring your water system’s security against pathogens, we know that it does not give us a complete picture. Traditionally dip slides are used to assess the microbial activity of a water system, however, in a similar way to weekly disinfectant residual checks, these measurements are not enough to cope with changes in temperature, oxidant demand, nutrient levels, sunlight exposure and the additional complexities of an organic system. In the same way that dutyholders have turned to continuous, online sensors to provide a more stable oxidant residual, BioSense, a continuous online biofilm monitor, tells those same dutyholders when a biofilm forms in their system.

**BioSense**

**BioSense** is a biofilm monitor which applies a potential between electrodes which encourages micro-organisms to grow on the surface of the probe before they would settle on the surfaces of a pipe or a vessel. The biological activity of the biofilm creates a signal which a BioSense controller can use to trigger dosing or alarms. On selected models, the BioSense is able to email or send an SMS text message to your phone, alerting you to biofilm activity.

**Why do I need a BioSense?**

**HSE HSG274 Legionnaires’ disease: Technical guidance Part 1, 2013, Pg. 20 -- The treatment programme should be capable of coping with variations in the operating conditions, make-up water analysis and microbial loading.**
In order to fulfil this requirement, dutyholders must know the current state of their water system, and have the capability to react quickly to changes. Using dip slides does not give us either of these abilities, as they only give us information after a 2 day incubation. Dip slides also give a count of free floating planktonic bacteria and not sessile biofilm. When coupled with the fact that legionella does not grow on dip slides, this means that dip slides are a useful but not complete solution to biofilm (and ultimately legionella) control.

**HSE HSG274 Legionnaires' disease: Technical guidance Part 1, 2013, Pg. 40 – Dip slides are commercially available plastic slides which are coated with sterile nutrient agar – a medium on which many micro-organisms will grow, but not legionella.**

**Conclusion**

The managers of cooling towers have a challenging responsibility. The HSE ACOP calls for all that is reasonably practicable to prevent a legionella outbreak. It is only with the correct tools that operators can ensure:

- A residual disinfectant is maintained, even with variations in operating conditions
- The disinfectant remains effective, even against resistant biofilms
- A clean and safe environment, even between checks and cleans

With Process Instruments this is more than practicable, it’s easy!

To discuss your application further, call 01282 422835 or email sales@processinstruments.co.uk

**References**


