THE WATER MANAGEMENT SOCIETY

TOOLBOX TALKS

BIOFILM

Biofilm an introduction - what is Biofilm?

A biofilm is a complex mix of microorganisms, mucus and nutrients; it is the natural habitat of many bacteria that are able to grow in water systems and will develop on any permanently wetted surface. In many cases biofilms in engineered water systems are microscopically thin and cannot be seen or felt but they can become substantial and recognisable as slime, often around the waterline where there is a high concentration of oxygen.

Within biofilms there will be a variety of living and dead microorganisms which might include bacteria, algae, fungi, protozoa and complex organisms such as nematodes.

The binding mucus will incorporate minute particles such as rust, scale and organic materials as well as microorganisms and will be "grazed" by bacteria, amoebae, nematodes and even by larger organisms such as molluscs or fish where they are present.

The microorganisms in biofilms are described as "sessile" and those in the body of the water as "planktonic", however normally sessile microorganisms might release planktonic spores or even break away as part of their life cycle, transported on the water current or swimming to colonise other places. The biofilm will continuously grow and dwindle, fragment and settle and should be regarded as a permanent but dynamic feature.

Microorganisms, such as bacteria and fungi, also grow at the surface of water if it is undisturbed and can form a floating biofilm which can develop into a film or scum but is often not visible.

Why biofilms cause problems within water systems

Biofilms create an environment where microorganisms live, breed and multiply; they also provide some protection against shear (surface disruption) from water currents and biocides in the water. The mucus component of biofilms is a polysaccharide (sugar) and lipid (fat) gel comprised mostly of water and which is highly insulating, so it reduces the efficiency of heat exchange. Biofilms also cause drag, which impedes (slows) water flow and increases pumping demand.

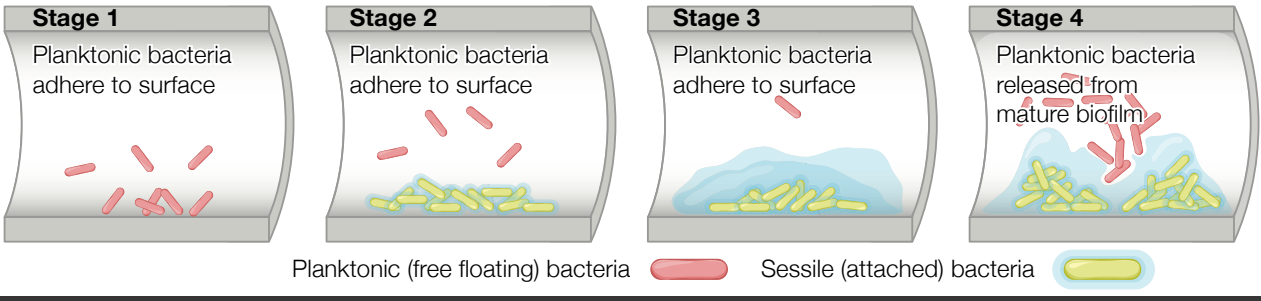
The coating of surfaces with biofilm acts as a barrier which can create corrosion cells directly and, as it impedes the diffusion of oxygen, reducing conditions can develop which favour nitrite-reducing bacteria (NRBs) or sulphate-reducing bacteria (SRBs). NRBs degrade nitritebased corrosion inhibitors and SRBs generate hydrogen sulphide (H2S), which causes under-deposit acid corrosion and a foul smell like bad eggs. If not limited by the supply of nutrients or otherwise controlled, the biofilm might become so well established as to cause blockages in drains, strainers or even pipework.

The effects of biofilms on systems varies widely from insignificant (their universal presence is often not realised e.g. plaque on teeth) to critical, such as when blockages prevent systems working or when they render the water unfit for purpose. This can be particularly significant in clean or ultraclean water systems or conventional systems used by people highly susceptible to infection.

Controlling Biofilms

Systems operating with suitably treated water, such as the mains supply, process systems dosed with biocides and domestic hot water systems, can usually be maintained largely free of significant biofilm, but other systems and any areas of treated systems where the biocide or temperature is not maintained are likely to develop biofilms. The rate of development will vary according to conditions such as the availability of nutrients and oxygen, temperature and exposure to light.

Once a biofilm is established, treating with disinfectant alone might not be effective in removing it, so additional techniques such as abrasion or the addition of biodispersants might be required.



Biofilm formation diagram