Biofilm

Introduction
This is the final in a series of articles on how to optimize water medication. Previous articles dealt with the requirements for water quality and the drinking water system and the chemical characteristics that will make a product suitable for water medication: solubility and stability. In this article we will discuss biofilm, one of the major challenges in drinking water medication.

What is biofilm
Biofilm is a slimy substance (like tooth plaque) produced by bacteria. It is a full biological system, a "city of microbes", that helps bacteria to survive by sharing nutrients and shelter them from harmful factors in the environment.
Biofilms have a lifecycle (Figure 1) that starts with attachment of bacteria to the wall of the system. Rough surfaces will of course make this easier. When they grow the shape becomes more like mushrooms. Finally parts or individual bacteria are detached and become free floating in the water again to start formation of biofilm elsewhere.

Impact of biofilm
The major problem with biofilm is that it can block nipples and even pipes. This can lead to reduced water and feed intake by the animals and in the end lower growth rates. Blockage of nipples can also interfere with water medication as it will lead to underdosing in the animals that have limited water supply.
Also biofilm can be a reservoir of pathogens (Salmonella can survive for weeks in biofilm) and resistant bacteria.
Finally some of the bacteria in biofilms might produce enzymes that degrade certain antibiotics causing the treatment to fail.

Check
A first check to find out if biofilm is present in a water system is simply power flushing water from the end of the system into a white bucket. Biofilm will appear as light green or yellowish slimy chunks (Figure 2). A laboratory test for bacterial count is more scientific but not always a good indicator because most bacteria are in the biofilm and not in the water (Figure 1). Using swabs instead of drip samples gives a more accurate picture of bacterial contamination (Figure 3). Finally you can use on site water tests that measure the level of ATP in the water as an indicator of microbial growth.

Risk factors for biofilm
Risk factors that stimulate bacterial growth are related to water quality, the drinking water system and products added to the water.

Water quality
High levels of bacterial contamination in the water source of course should be avoided, as well as minerals that can roughen the inner surface of the system (calcium, magnesium, iron, manganese).

Drinking water system
A poorly designed or constructed water system often also plays a significant role.
An open system with float tanks gets contaminated easily by bacteria in the dust.
Any part of the system where the water is slow moving or turbulent increases the risk of biofilm:

- -inappropriate or variable diameter of the pipes
- -excessive bends in the design
- -dead ends or circular piping
- -too much glue on the inside at couplings

The pipes should be as smooth as possible and made from the right material. PVC is preferred over iron (oxidation) and stainless steel (interaction with manganese). Sometimes poly-ethylene (PE) pipes are used but NH_3 in the air in the barn can penetrate these pipes, acting as a source of nitrogen for bacteria and stimulating the formation of biofilm.
Finally a relatively high water temperature will facilitate bacterial growth. This can occur when the pipes are too close to any heating equipment or directly exposed to the sun.

Water additives
Many farms supply various products to the animals via the drinking water: vitamins, electrolytes, milk replacer, probiotics or organic acids. All of these should be considered potential food for micro-organisms that will promote the growth of biofilm.
Also the lactose that is present in many water medication products is a source of energy for bacteria and other micro-organisms.

Treatment of biofilm
Once a biofilm is established it is very difficult to remove completely, also because often risk factors cannot be changed easily.
The most effective treatment is using a product that is based on hydrogen peroxide (H_2O_2). These products have an effervescent action that detaches the biofilm from the inner surface of the system. To prevent massive blocking of nipples by detached biofilm it is recommended to start with a low dose (0.005% =50 ml/1000 L of water) and increase every 48 hours by 50 ml to 250 ml/1000L (0.025%) In the presence of animals this is the maximum concentration that will not create abnormal taste. Because this concentration does not kill bacteria it is advised to use a disinfectant (sodiumhypochlorite) afterwards. In the right concentration this can be done while the animals are in the barn.
When the barn is empty higher concentrations of H_2O_2 can be used. Above 2% hydrogen peroxide also has a disinfecting effect, so sodiumhypochlorite might not be necessary.

Prevention of biofilm
To prevent problems you first have to have a critical look at the quality of the water and the drinking water system to minimize the risk of biofilm. Only use water medication products without lactose.
It is useful to develop a routine protocol for cleaning and disinfection of the system for example after each addition or at fixed time points. Several products with different active ingredients are available on the market for cleaning and disinfection. Always consult the product supplier for optimal use and correct dosage.

Summary
Biofilm is one of the major challenges in drinking water medication. It is a slimy substance produced by bacteria on the inner surface of the system. It can block nipples creating a risk of underdosing and is a potential reservoir for pathogens.
Risk factors that stimulate bacterial growth are related to water quality, the drinking water system and products added to the water. The use of water medication products with lactose should be avoided as lactose is a source of energy for bacteria.
Biofilms can best be treated using a product that is based on hydrogen peroxide (H_2O_2). To

minimize the risk of biofilm developing it is useful to implement a routine protocol for cleaning and disinfection of the system.

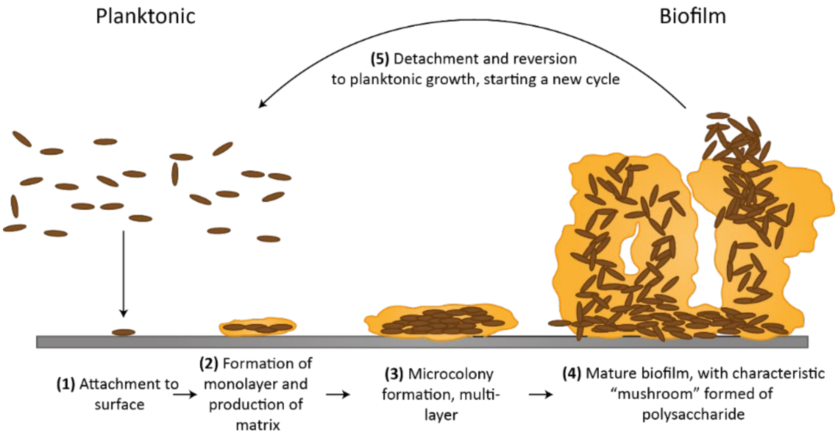

Figure 1 Lifecycle of biofilms

Figure 2 Biofilm

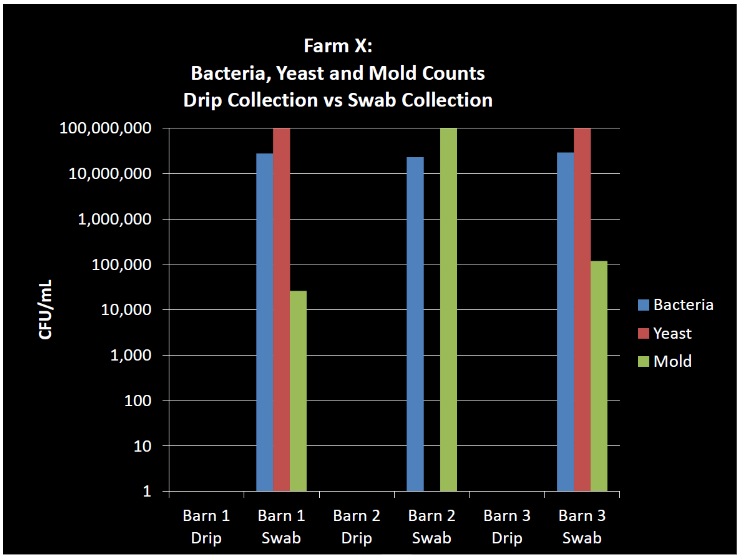

Figure 3 Differences in microbial counts between drip and swab samples