DISINFECTION DIGEST
...FOCUSED ON SCIENCE

Biofilms

Abstract

Biofilms are nothing new to our world. They can be found in any environment that has a flow of water and a contact surface. Biofilms can be deleterious or beneficial depending on where they are found and which organisms they are comprised of. As a society, however, we most commonly associate the issue of biofilms with their related infections. Examples of these are otitis media and bacterial endocarditis, which are caused by bacteria entering a fluid filled part of the body. Most news worthy however, are the healthcare related infections where biofilms can develop on medical device surfaces such as catheters, medical implants or wound dressings. Accelerated Hydrogen Peroxide® (AHP®) is relatively new yet proven technology that has gained a reputation as being one of the most effective yet safe technologies on the market. In fact, two studies have been conducted using AHP highlighting its ability to kill and remove biofilms.

This document will help you and decision makers to better understand what Biofilms are and the relevance of using a disinfectant capable of killing and removing them.

Background

The literal meaning of Biofilm is "life-slime". The scientific definition of Biofilm is "the film or thin layer composed of cells of microorganisms such as bacteria, fungi, yeasts, protozoa and other microorganisms that are attached to a surface". When the bacteria or fungi adhere to surfaces they begin to excrete a slimy, glue-like substance (technically called extracellular polysaccharide) that helps them stick to all kinds of surfaces such as metals, plastics, rocks, implanted medical devices and even tissue. This slime layer also provides a protective environment in which to live. In fact the general structure of a biofilm consists of 85 percent polysaccharide and 15 percent microorganisms.

The bacteria & slime layer can now trap other materials such as clay, organic materials, dead cells or any other particle that floats over of the biofilm, which adds to the size and diversity of the biofilm colony. This growing biofilm now serves as a focus for attachment and growth of new organisms, which continues to increase its diversity.

It is interesting to note, that more than 99 percent of all bacteria exist as part of a biofilm community, however, traditionally microbiologists have only studied free-floating (planktonic) bacteria. This may not seem entirely significant, but research has shown that once a microorganism attaches to the surface of a biofilm it "turns on" a previously unused set of genes. This effectively makes it a significantly different organism to deal with. Studies conducted to date have shown that the antibiotic dose that kills free-floating bacteria need to be increased as much as 1000 times to kill a biofilm colony.

Herein lies the problem. A biofilm colony provides a number of advantages for microorganisms; it provides environmental protection from adverse elements like UV light, drying and antimicrobials. If you have an antibacterial agent, the rule of thumb is that for every unit it takes to kill a planktonic organism, it will take 1000 times as much to kill a biofilm organism. It also acts to attract nutrients based upon its negative charge. Many nutrients (particularly cations) are attracted to the biofilm surface. This provides bacteria cells within the biofilm with nutrients greater than compared to being in the surrounding water.

The Risks:

Biofilms are a growing concern especially with the use of whirlpool tubs, hydrotherapy tubs or foot spa baths. In North America there is a large number of tubs in use in various healthcare, educational and hospitality facilities not to mention the number of such tubs used in the Spa industry. Many of these tubs have been designed to allow water to accumulate and pool in the pump and other piping providing the conditions that are ideal for biofilm growth.

The risk of biofilm to bather is the number of colony forming units (CFU) that are shed and present in the water they are bathing in. Sores or breaks in the skin may become infected as a result of this exposure. What many are not aware of might actually be a greater risk to patients and staff. When a tub's jets system is turned on small segments of biofilm can break free and become aerosolized. The result is that inhaling biofilm from whirlpools could do a significant amount of pulmonary damage. Continuing to use or work around a hot tub could be a downward spiral to possible incapacitation. People feel poorly and try to make themselves feel better by staying longer in the hot tub. Then they feel worse.

Monitoring the presence of a biofilm and its relative size can be difficult. A biofilm will shed planktonic cells at various rates. Shearing forces (mechanical or hydrodynamic) applied to the biofilm will literally "shave off" slices or shards of potentially infectious material. If stress is applied to the location of the biofilm, suddenly a shower of bacterial shards is dislodged from the biofilm. If you happen to be taking a water sample just after disinfection of the tub, it is likely you will find a higher than acceptable bacterial CFU count because the biofilm has been traumatized by the disinfectant. If you take repeated samples over the course of a month your results might

Biofilms

display a strange pattern of high counts and low counts. This variation can be a result of a number of factors such as time of day the sample was taken, the length of time the tub was run prior to taking the sample, and when the tub was last disinfected. This variation can identify there is a problem and a biofilm is present but it does not identify what the actual size or level of biofilm contamination exists. This can only be done by taking an actual sample (scraping) from the surface of the biofilm.

How to Deal with a Biofilm:

The good news is that biofilms can be removed or destroyed by chemical and physical treatments. Chemical treatments using oxidizing chemistries such as chlorine or hydrogen peroxide have been recognized as being efficacious in both removing & destroying biofilms while quaternary ammonium compounds (QAC) are not. Depending on the level of contamination, physical treatments such as heat or mechanical removing (good old fashioned scrubbing) can also be used to help remove the biofilm and dislodge it from the surface. Either way, the consensus is proper disinfection of the pump, water lines and jets cannot be overemphasized. Consistent cleaning and disinfecting procedures must be adhered to. Remember, it only takes a very short time for a biofilm to re-establish itself and then you are starting the battle all over again. Therefore, continued maintenance of the tub is essential to prohibit biofilms from growing. The tubs should be disinfectant between patients. Tubs not in frequent use should be disinfected on a daily basis for maintenance purposes.

How could AHP be used to Treat Biofilm Contamination:

Accelerated Hydrogen Peroxide can be used as the cleaning technology (lifts and removes soil load and pathogens) as it is a proven excellent cleaner (CGSB 2:16-87 and ASTM 4488-89,5343) while also being a fast acting bactericide. In fact two studies have been conducted using AHP and studying its ability to kill and remove biofilms. In 2000, a study titled “Hydrotherapy tub usage (Infection risks – cleaning and disinfecting)” was published in the Canadian Nursing Home journal. This collaborative study between Public Health and Infection Control reviewed an outbreak of *Pseudomonas aeruginosa* that was attributed to hydrotherapy tubs. The study reviewed three disinfectant chemistries (Quats, Chlorine and AHP) and found AHP to have more advantages for use over the other two chemistries with respect to contact time, effectiveness and occupational health and safety advantages.

The second study was conducted by MBEC Biofilms Technologies Ltd of Calgary Alberta. Dr. Howard Ceri is a biofilm research scientist who compared AHP to a QAC product and evaluated both products on their ability to kill biofilms in dental water lines consisting of several different bacteria. AHP was proven to be effective against all biofilms tested and significantly outperformed the QAC product used in the study.

Implications for AHP

AHP Disinfectants are One-Step Disinfectant Cleaners

- AHP has proven cleaning efficiency resulting in lower costs and faster results as well as added confidence that disinfection can occur
- AHP has proven effective against biofilms

AHP Disinfectants provide the perfect balance between safety and efficacy

- AHP is designed to be easier on employees and occupants resulting in protocol compliance
- AHP provides a HMIS rating of "0", meaning it has been proven to be non-toxic, non-irritating to eyes and skin and non-skin sensitizing and does not require the use of personal protective equipment to handle

AHP Disinfectants are environmentally sustainable

- AHP's active ingredient, hydrogen peroxide, breaks down into water and oxygen leaving no active residues
- AHP is formulated to ensure that it will not negatively impact indoor air quality and has been approved as an asthma-safe product

AHP Disinfectants have realistic contact times

- Short contact times ensure surfaces remain wet for the required contact time, providing comfort and confidence that disinfection has occurred
- AHP has been proven through peer reviewed studies to reduce HAIs

AHP Disinfectants are compatible

- AHP formulations are tested to ensure compatibility that preserve your investments in equipment, furniture and building surfaces by reducing corrosion and wear

References:

Stewart P. Mechanisms of Biofilm Resistance to Antimicrobial Agents. Center for Biofilm Engineering. Montana State University. www.erc.montana.edu/CBEssentials-SW/research/Antimicrobials/default.htm

Biofilms

The Biofilm Institute. What is a Biofilm? www.biofilm.org/whatis_biofilm.htm.

Stoodley P. American Society for Microbiology Biofilms Project. Center for Biofilm Engineering. www.rit.edu/~jadsbi/asmbiofilm/pseudomonas.html

Gilbert P, McBain A. Biofilms:Their impact on health and their recalcitrance toward biocides. AJIC 2001;29:252-255.

Bierman S. Biofilm: Secret Refuge of the Microbial World. ICT. 2005;9(9):12 – 14.

Dreeszen P. Biofilm. Edstrom Industries Inc. June 2003

Thompson B, Budgell S. Hydrotherapy tub usage (Infection risks – cleaning and disinfecting). Canadian Nursing Home. 2000;11(4):4 – 10.

Ceri H. Final Report MBEC Protocol #VT-03-01. MBEC Biofilms Technologies Ltd. June 2003.