

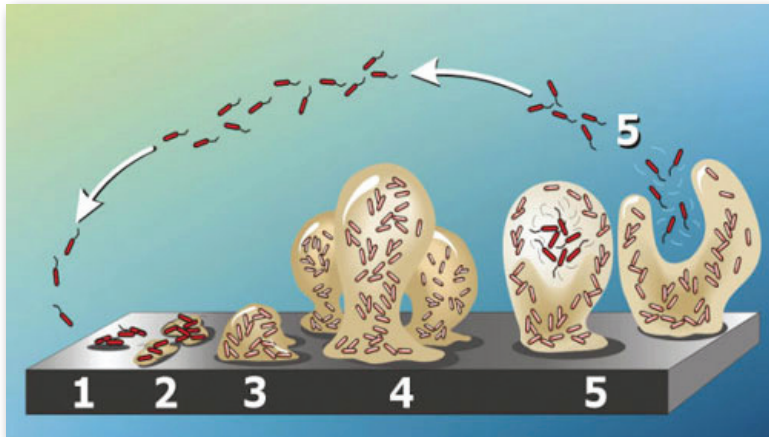
**Problem:**

# Biofilm

**Solution:**

The Hydrozonix water treatment system provides chemical free elimination of biofilm

A biofilm is a three dimensional structure composed of living, reproducing microorganisms; these structures can form on both living and non-living substances. Biofilms form when single cell microorganisms adhere to the surface of an object and begin to reproduce. The microorganisms attach to the surface and to each other and produce an extracellular polymeric substance (EPS). Bacteria in the biofilms are attached and held together by the extracellular polymers of the EPS. Once the biofilm architecture matures it releases single cells (planktonic bacteria), in this way the biofilm reproduces.



Biofilm Lifecycle

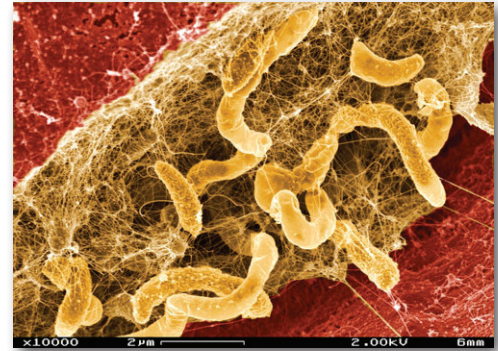
## Common Oilfield Scenario

1. Frac fluid is left in an impoundment or frac tanks for a few days or weeks
2. Bacteria begin to form biofilm on the bottom of the impoundment or tank walls
3. The fluid is batch treated and the planktonic bacteria (single cells) are killed, but the biofilm (held together by EPS) survives
4. Water transfer kicks on pumps, causes turbulence, and clumps of biofilm and bacteria colonies pass through the blender
5. Biocide mixed on the fly will likely not penetrate these bacteria colonies

As biofilms collect sediment and minerals found in frac water they begin to lay down scale, create rust and pitting. The anaerobic ability of SRB (sulfate-reducing bacteria) creates an acidic environment. Sulfuric acids produced by SRB wreak havoc on pipe, help donate energy, providing energy and fueling the formation of the bacteria. The free electron donation process perpetuates and continues to fuel the SRB formation by attaching to available sulfate compounds the favored food of the bacteria.

(For more information about biofilms visit [www.hypertextbookshop.com/biofilmbook/v004/r003/index.html](http://www.hypertextbookshop.com/biofilmbook/v004/r003/index.html))

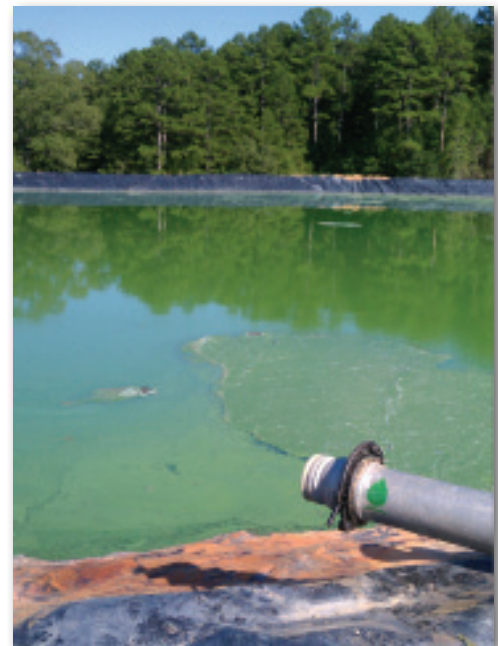
The **Hydrozonix** system will eliminate the biofilms through destruction of bacteria, penetrating cell walls, exposing and destroying cytoplasm, eliminating both the environment and the reproduction process for the formation of new biofilms/bacteria. Elimination or massive reductions in SRB's also help destroy production of harmful hydrogen sulfide (H<sub>2</sub>S). Hydrodynamic cavitation and acoustical features of the system eliminate the clumping mentioned earlier. This results in greater surface area exposure for greater destruction.



Sulfate-Reducing Bacteria (SRB) Biofilm

## Biofilm Lifecycle

1. Microorganisms adhere to a surface
2. EPS is produced and attachment becomes irreversible
3. Biofilm develops and matures
4. Further maturation
5. Single cells are released from the biofilm



Impoundment with biofilm formation