

SpiroFlo and Biofilms

What is Biofilm?

Biofilm is bacterial slime that grows wherever there is water.

99% of all bacteria live inside of biofilm. Within the protective slime, the bacteria build communities to take apart and consume nutrients that no single bacteria could break down alone. One bacteria's expulsion becomes another's food. In addition, the biofilms concentrate nutrients with polymer webs in order to survive despite water purification tactics. This highly efficient combination makes the bacteria in the biofilm a near self-sufficient community.

In his illustrative article, "Slime City," Andy Coghlan describes the residue:

More properly known as biofilm, slime cities thrive wherever there is water—in the kitchen, on contact lenses, in the gut linings of animals. When the urban sprawl is extensive, biofilms can be seen with the naked eye, coating the inside of water pipes or dangling slippery and green from plumbing.

As with most bacteria, some have beneficial uses. In wastewater treatment plants, biofilms are (temporarily) left in place to remove contaminants from processed water. However, those same biofilms cause problems by clogging and corroding pipes in addition to contaminating the water they once took a step in purifying. Outside of wastewater treatment plants, the problems continue:

Biofilms develop when bacteria and other microorganisms form a protective environment that acts as a shield against attack. When in a biofilm, bacteria become highly resistant to antibiotics, high temperatures and host immune responses. This resiliency contributes to human health problems such as recurrent urinary tract infections, medical device related infections and tooth decay (from kanebiotech.com).

These "attacks" include chlorine treatment (the present industry standard), though the biofilm has evolved to become up to 150-3000 times more resistant to free chlorine and 2-100 times more resistant to monochloramine than free-floating bacteria (LeChavellier, Lowry, Lee, & Gibbon 1993). This treatment can reduce the protective slime shield, but the biofilm remains attached and the layer soon regenerates.

By evolving to nullify the current solutions, biofilms are, according to Jack Hoffbuhr, Executive Director of the American Water Works Association (AWWA), "one of the greatest problems facing water utilities today."



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How SpiroFlo helps

Referred to as a “tornado in a pipe,” the SpiroFlo system develops an organized vortex causing the water flow to spin. With liquid swirling around the pipe wall, other phases of the flow (air, contaminants, etc.) will separate and travel in the center of the spinning vortex.

Still maintained over long distances, this spinning flow acts as a scrubber that removes the biofilms from the boundary layer of the pipe. Traditional water flow leaves the biofilms undisturbed, or simply removes small portions of the biofilm that repopulate downstream. The SpiroFlo system removes the biofilms from the pipe wall forcing the slime along with the spinning vortex.

Once biofilms are detached from the security of the pipe wall, they need to be neutralized before they can re-adhere downstream. SpiroFlo has partnered with Hydrotech Ltd. to add an electro-coagulation system to eliminate the accumulated biofilms initially removed by the SpiroFlo device. Followed by a reverse osmosis system to clean and purify the water, it will be possible to deliver quality water without biofilms.

The application of our technology is already well established in the oil and gas market where the system is being used to remove the build-up of paraffin wax from flow lines. In some cases the problem, endemic to many oil and gas wells, is eliminated altogether.

Current prognosis:

- Biofilm uses polymer webs to concentrate nutrients and survive despite water purification.
- Regardless of material or lining, biofilms readily attach to all surfaces.
- Standard flushing techniques remove some of the protective layer, but the biofilm stays attached.
- Chlorine treatment is not as effective as it used to be and its value continues to diminish.

Current Conclusion:

Bacteria constitute a very successful life form. In their evolution, they have developed successful strategies for survival... where they behave very differently than free-floating bacteria. Their successful strategies make it difficult for us to control biofilm growth in automated watering systems (Dreeszen 2003).

Despite the futility of current methods, the water treatment industry continues to purify, flush, and keep materials crevice-free because minimizing biofilms is better than letting a potentially infinite sprawl of bacteria take place.

SpiroFlo's Solution:

In conjunction with strategic partnerships, SpiroFlo helps eliminate the problem. By scraping biofilms from the surface wall, the SpiroFlo technology returns the biofilms to the weak free-floating state they had to evolve from to survive. By eliminating biofilms, pipe corrosion and clogging is reduced, and clean drinking water is efficiently enhanced.

References

- Coughlan, A. "Slime City", *New Scientist* 15 (2045), pp 32-36 (August 31, 1996).
- Dreeszen, P.H. *Biofilm: The Key to Understanding and Controlling Bacterial Growth in Automated Drinking Water Systems (2nd edition)*, Edstrom Industries Inc. (June 2003).
- LeChevallier, M.W., Lowry, C.D., Lee, R.G., & Gibbon, D.L. "Examining the Relationship Between Iron Corrosion and the Distribution of Biofilm Bacteria", *Journal AWWA* 85, pp 111-123 (July 1993).
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How Does It Work?



In simple terms, the patented SpiroFlo device is a “tornado in a pipe.” The SpiroFlo device shapes turbulent liquid flow into a spiraling flow with very stable characteristics and operational efficiencies.

In single-phase liquid flow, pressure loss is reduced, thereby lowering energy requirements, drag, and line wear. In multi-phase flow, settling or drop-out is reduced and a homogenized mix can be anticipated. The system can also be used for continuous mixing of liquid with liquid and liquid with gases (thereby eliminating the need for tanks and other expensive storing apparatus). This is particularly beneficial where a liquid-liquid or liquid-gas mixture is difficult to maintain since the device will create a spinning (and mixing) vortex at the point of departure from the device.

As fluid flow is introduced to the SpiroFlo device, the flow is organized and undergoes a rotational shift of 90-degrees to the inlet.

Fluid traverses around a series of helical-shaped “turbines” which causes the fluid to spin and accelerate as it passes across the device. Any air particles present in the fluid are pulled toward the center of the tornado-like vortex (pictured right) as the flow becomes fully organized.

Liquids travel around the pipe in a 45-degree spiraling flow (pictured above), and the gases travel in a spinning rope-shaped flow in the middle of the vortex.



Removal of Biofilms:



The spiraling flow is effective in the area of biofilm removal from pipe walls (typical biofilm clogged pipe pictured left). Aligned with strategic technology partners, SpiroFlo is helping to greatly reduce the health dangers of biofilms to drinking water systems.

When sent through the SpiroFlo device, the liquid moves at a high velocity to scrape biofilms from the pipe wall. The SpiroFlo device continues to generate excitement for the liquids transportation industry in the removal of biofilm where no effective solution previously existed.

Biofilm Solutions

These before/after pictures show the effectiveness of SpiroFlo in removing biofilms from water lines, all while operating at very low pressures (2 psi) for a short processing time (~5 minutes).



Before SpiroFlo



After SpiroFlo

SpiroFlo and Oil and Gas:

With over 1,000 successful installations, the SpiroFlo technology is tried and proven in a myriad of applications. In the oil and gas industry, SpiroFlo helps keep paraffin prone oil and gas lines free from build-up. When left unchecked, gas production is strangled and the well production is lost. These before and after pictures show the effect of the SpiroFlo process against the damaging effects of paraffin accumulation.



Typical paraffin clogged pipe



Pipe after SpiroFlo

Summary

Biofilms (or bacterial slime) are one of the greatest problems facing the water industry today. SpiroFlo, in conjunction with strategic technology partners, is helping to eliminate biofilms in the same way it eliminates paraffin build-up in oil and gas lines. With high efficiency, low cost, and no maintenance, SpiroFlo is the solution.

For more information, visit our website at www.SpiroFlo.com.