Using Ultrasonic to Control Algae & Biofilm Costs

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Implementing ultrasound, a new "green" technology, is helping municipalities improve water quality and decreasing operational costs by controlling algae growth in ponds, lakes, and reservoirs and by preventing biofilm growth on equipment inside the plant.

AlgaeControl.US Vice President, George Hutchinson stated, "Our municipality and industrial clients are experiencing two very significant benefits from implementing ultrasound. Water quality is improved by controlling algae growth in lakes and reservoirs; and chemical dosages are lowered by eliminating biofilm growth on the plant facilities, such as a waste clarifier or on sedimentation basin walls."

Understanding Biofilm Growth

Biofilm is made up of bacterial layers, the most important of which is the thin bottom layer created by anaerobic bacteria. These bacteria are only oxygen tolerant for a short migratory period as a freely moving colony forming unit (CFU). On finding a suitable surface, they attach themselves by secreting polysaccharide glue from small pili filaments. They then begin to multiply, something they cannot do in the CFU stage, and rapidly begin to cover the surface. To shield themselves from the oxygen they send a chemical signal often referred to as quorum sensing that attracts aerobic and aerophillic bacteria to their colony. The aerobic bacteria secrete exopolymers that cover and attach them to the anaerobic layer. This exopolymer mass makes up about 80% of the mass and is that slick and slimy material one associates with biofilm.

This biofilm mass attracts algae and higher order life forms that feed upon and attach themselves into this increasingly complex matrix of life. It is estimated that of all the bacteria on earth, 99% live in biofilm. So control of biofilm growth on plant equipment surfaces not only eliminates the environment where algae attach and thrive, but it limits the habitat where new bacteria accumulate and reproduce.

How Ultrasound Controls Biofilm Formation

Anaerobic bacteria can form an irreversible attachment in seconds of finding a suitable surface. When using ultrasound to limit biofilm growth, it is important to mechanically or chemically clean the surface and restart the process with ultrasound present. Although ultrasound can help limit further biofilm growth when it is already present, it does not have the power to reverse existing anaerobic attachment.

The phenomenon of preventing biofilm growth on cleaned surfaces occurs when ultrasonic intensity level is sufficient to provide a sensation of turbulence to anaerobic bacteria. This is important because in nature, anaerobic bacteria avoid colonizing turbulent water zones where the shearing forces make attachment difficult not only for them but even more so for the aerobic bacteria they depend on for an oxygen shield coating. The ultrasound thus suspends the anaerobic colonization and without an existing anaerobic colony the aerobic bacteria have no compulsion to attach to the surface. The most powerful device offered by LG Sonic, the XXL, can control the biofilm growth out to about 200 feet from the sound projector.

While it is possible to kill bacteria with the LG Sonic ultrasound device given enough time, it is not the reason that bacterial counts are reduced in a potable water process. For example, USDA Aquaculture studies have concluded that up to 60% of bacteria are killed by the LG Sonic ultrasonic device in a four day period. The bacteria killed included coccoid types as well as rod shaped Escherichia coli (e. coli) and Flavobacterium. While this may be helpful, most potable water plants have a much shorter residence time (hours) in the process so this action while useful, is limited. The major benefit is by preventing the biofilm colony formation where new bacteria are being generated.

For potable water plants, the bottom line savings are due to reduced disinfection chemical dosing requirements such as sodium permanganate or chlorine, longer filter run times, and longer equipment run times due to reduced plugging and fouling with algae and biofilm. Further savings and better tasting water can result from water entering the process at the start having fewer algae and the flavors they can put in the water.

Controlling Algae in the Feed Reservoir

When you control algae propagation in the body of water that you draw from, whether a lake or reservoir, fewer algae are then brought into your plant at the intake. The LG Sonic unit controls algae growth by matching the resonance frequency of the algae cells with just enough power behind it to influence the cell structures in the following manner:

The vast majority of blue-green algae (cyanobacteria) have a gas vesicle system (hundreds to thousands of these tiny organelles per cell) that is easily broken by the ultrasonic sound waves resulting in:

1) loss of their ability to control their buoyancy (they sink),
2) disruption of their life cycle processes as light is diminished, and
3) weakening of their ability to guard against bacterial attack.

The roaming types (green, brown, black, filamentous, etc.) do not have the gas vesicles and the unit affects their inner membrane called the plasmalemma causing it to separate from the outer sheath. Once the separation is done, the cell can no longer get nutrients, control its internal pressure, or get rid of waste products through its contractile vacuole.

Case Study (Potable Water System):

The City of Union pumps water seven miles from the Broad River into their potable water plant in South Carolina. They process from 3.2 mgd to 5.4 mgd depending on the season. Due to the US Federal Regulation to reduce THM's (Trihalomethane disinfection by-products) in potable water, the City of Union stopped chlorinating at the intake from the river in the summer of 2006. This allowed the city to reduce their usage of sodium hypochlorite by 50%.

No Ultrasound / No Chlorine– December 2006

However, by eliminating the chlorination at the intake, bacteria and algae quickly began to adhere to the sedimentation basins walls and v-notch weirs forming biofilm. The city was concerned they would soon start experiencing taste and odor issues from the algae growing inside the plant. Arnold Franklin, lead plant operator stated, "Instead of cleaning the basins once every six weeks, I had no choice but to begin an every other week schedule for cleaning the basin walls and v-notch weirs. The biofilm and algae made the task difficult and increased our maintenance costs. Keeping the plant compliant had turned into a maintenance nightmare."

In November 2006 city personnel decided to implement a test with two LG Sonic units; one in a sedimentation basin and another aimed at their v-notch weirs. The basins and weirs were first cleaned thoroughly prior to installation of the LG Sonic units. From the start they saw that the bio-film and algae was not forming in the basins or weirs which were under the influence of the ultrasound waves. Without the biofilm present, the algae did not have an environment in which to adhere and propagate. When the basins and weirs underwent their next scheduled cleaning process, the process took a shorter time because the colony of biofilm did not exist.

With LG Sonic– No Chlorine August 2007

The city budgeted for a plant wide roll-out of the LG Sonics devices and as of November 2008 the City of Union has continued to maintain their reduced THM and HAAS levels. They reverted their cleaning cycle back to their original schedule – once every six weeks. This reduction in schedule fortunately took place during the height of the South Carolina summer heat when temperatures averaged 90 degrees and when the 2007 drought conditions necessitated a more reasonable and reduced cleaning cycle. Their November 2007 THM levels measured 34.4 ppb, well under the specified regulated threshold of 80 ppb. In January 2008, the THM levels dropped again to an outstanding 18 ppb. The HAAS level in November 2007 was 22 ppb, compared to the 60 ppb maximum level; and dropped again to 12ppb in January 2008.

Donnie Johnson, Waste Water Supervisor for the City of Union is so pleased with the results at the water plant, he has now budgeted for ultrasound to be installed in their waste water clarifiers. The project objective for the ultrasound is the same as at the water plant; to eliminate biofilm formation which in turn will reduce their weekly maintenance cycle to once a month.

Case Study (Waste Water Clarifier System):

The City of Lebanon, Virginia Waste Water Treatment Plant is like many others around the country in that their clarifier maintenance is a weekly chore; typically predicated on the algae and biofilm growth that has grown on the equipment. One day after cleaning a clarifier can appear as follows:

In July 2007 Chris Dye, lead operator at the Lebanon Waste Treatment Plant, installed the ultrasound device to reduce the number of hours between cleaning cycles. Due to the turbidity in the clarifier, an LG Sonic XXL was implemented to produce as strong a signal as possible across the unit.

The installation involved placing a rigid conduit on the inside sidewall of the clarifier and the LG Sonic mounted to the rear of the skimmer trough underneath the path of the rotating arm. The rotating skimmer easily passes over the conduit due to a rubber scraper at the end of the skimmer arm.

Chris typically cleaned his 3 clarifiers each week which took one man an entire 8 hour day. He now cleans all three clarifiers once a month and is finished with all three prior to lunch hour. A visual notation of the improved water clarity inside the clarifier resulted in a slight reduction in their chlorine demand before discharging into the creek.

In the year that followed the LG Sonic installation, the City of Lebanon has saved over 200 man hours in maintenance, a 50% reduction for this one process, and realized additional savings from the reduction in chlorine over time.

When your potable water or waste water plant needs to improve plant efficiencies or reduce overhead; when you need to reduce THM levels, reduce TSS, or preserve water due to drought conditions; or when you need to eliminate the taste and odor issues derived from algae, then the ultrasound waves and the LG Sonic devices are a natural and cost effective answer that's easy to implement. The AlgaeControl.US offers an affordable algae analysis program and site planning assistance through their authorized dealer network. For more information contact www.algaecontrol.us or find a local authorised dealer at the Dealer Directory button on our homepage.