CASE STUDY 34 - HD Q-PAC

Zero Odor Complaints After Using HD Q-PAC in a Biotrickling Filter Saco, Maine WWTP

Howard Carter, Saco ME WWTP Chief Operator and Lantec Products

INTRODUCTION

After a discussion about Lantec HD (high density) Q-PAC with Howard Carter of the Saco, Maine waste-water treatment plant at the Lantec booth at the WEF trade show in the fall of 1998 it was decided to attempt to biologically treat hydrogen sulfide (H_2S) odors at several locations in the Saco treatment system with a strictly biological scrubber. This was an idea that Howard had been thinking about for some time but was looking for the right microbe support product to use to accomplish this cost saving treatment.

2 Stage 20" diameter scrubbers at Windy Point

HD Q-PAC offered the very high biofilm surfaces (up to 200 to 300 ft^2/ft^3 with a fully developed microbial bloom) that were necessary to get sufficient active microbes in contact with the high H_2S concentrations that always appeared in the hot summer months in Saco. Using Howard's Yankee ingenuity he was quickly able to fashion two scrubbers from materials readily available at the plant so that he was able to be on line with his first scrubber for treating fumes from his sludge tank by November 1, 1998 and shortly thereafter a scrubber for the Windy Point lift station.

1) Windy Point Pump Station

Using 20" diameter empty polyethylene drums and cutting out the bottom of one, then plastic welding them together, Howard built what was to turn out to be a very effective and inexpensive scrubber with a tiny footprint. The scrubber consists of: 4 feet of Lantec's polypropylene HD Q-PAC, a small hardware store recirculation pump, an under the sink carbon filter to remove chlorine from city water (his scrubbing liquor) and a Miracle Grow® container used to spread fertilizer though a garden hose.

Structured HD Q-PAC made from Polypropylene

The scrubber was outfitted with a 100 ACFM fan to suck the fumes out of the lift station sumps through the scrubber.

The malodorous fumes are drawn from the sump into the bottom of the homemade polyethylene scrubber and flow upward counter current to a very small stream of de-chlorinated city water at a 3-4 GPM total flow rate. The purpose of the water is to keep the layer of microbes (or biofilm) formed on the HD Q-PAC needle like surfaces moist. After a brief incubation period, an in situ biofilm formed on the HD Q-PAC surfaces which acclimated to the H_2S laden air and rapidly developed an appetite for this foul smelling compound with an odor threshold of only 0.4 ppb_v (parts per billion by volume).

The carbon filter for de-chlorination is replaced every 3-4 months as is the nutrient providing fertilizer can. The total cost of these consumables is less than $50.00, two times per year. Otherwise no hazardous and potentially dangerous industrial chemicals are needed. A simple sprinkler system timer is used twice per day to inject a few gallons of make up water containing a few parts per million of nutrients. The make up water is necessary to compensate for any evaporation and to replace a small amount of blow down that occurs simultaneously. The blow down prevents the pH of the recirculating water from falling too much. The pH decreases because the thiobacillius bacterium that is

dominant in the layer of microbes ingests hydrogen sulfide and excretes sulfuric acid that accumulates in the recirculating water. It has been found that at a pH of 4 and above thiobacillius is most active. The blowdown restores the pH close to the original acidity of the city water (pH of about 6.3). The system is fully automatic requiring no operator and just regular pump station maintenance monitoring every week or so.

Hydrogen sulfide concentrations at Windy Point range from about 5 ppm_v in the middle of the Maine winter to as high as 110 ppm_v in July and August. Because a very scenic residential neighborhood had grown up around the lift station, citizen complaints would start to come into the WWTP starting with the first warm days of April. In April complaints would average one every other day. In subsequent months the complaint frequency would accelerate until several complaints each day were coming in from angry neighbors.

During first full year of operation (1999) Maine experienced one of the warmest summers of the twentieth century. Despite the fact that the lift station is surrounded by single family homes (see photo, note neighboring house in background) that summer the waste water treatment plant received not one complaint! And not a complaint in 2000 or 2001 either! Without the use of any hazardous industrial chemicals and with insignificant costs for a very small quantity of liquid fertilizer available at any hardware store the Windy Point lift station has successfully eliminated H_2S odors and all complaints from the Windy Point neighborhood.

2) Main Plant Sludge Tanks

Howard Carter of the Saco, Maine WWTP, using his plastic welding kit and various materials around the plant, built a rectangular 4' x 4' scrubber for a covered sludge tank. Using a 200 ACFM blower he was able to draw the H_2S fumes out of the sludge tank headspace through the homemade scrubber packed with a 4 foot depth of Lantec's HD Q-PAC. No hazardous industrial chemicals are used to solubilize and destroy (oxidize) the foul smelling fumes. The appetite of the microbes is all that is required to destroy the H_2S! Similar to the operation at Windy Point about 6-7 GPM of process water (no chlorine to remove) is sprayed over the HD Q-PAC to maintain a moist biofilm. The process water provides sufficient nutrients so no hardware store fertilizer is required. The H_2S influent concentrations in the air coming off the sludge tanks is much higher than at the Windy Point lift station, often as high as 200 ppm_v or more in the summer.

Due the higher inlet concentrations of H_2S, the gas velocity in the biotrickling filter is slower, about 12-13 feet per minute, instead of the 45 FPM in the Windy Point scrubber. This allows the layer of microbes more contact time to ingest the totally reduced sulfur compounds that are present. Although only H_2S has been measured it can safely be assumed that other reduced sulfur compounds must also be present. No evidence of dimethyl disulfide, methyl sulfide or mercaptans has been evident in the scrubber emissions. These compounds have very low odor thresholds, similar to that of H_2S. Windy Point has achieved zero odor complaints since the installation of the biotrickling filters utilizing HD Q-PAC as the biofilm support media for in 1998. Two other biotrickling filters have also been operating with equal success in the main treatment plant treating malodorous air from the sludge dewatering tanks.

3) Augmented Performance of Windy Point Biotrickling Filter

To further improve upon the operation of the Windy Point scrubber, a second stage was built to take the air from the first stage and treat it further. Because the first was removing 98-100% of the H_2S the second stage microbes would not have much of an opportunity to thrive because the food supply would be depleted before the air reached the microbes. In order to alleviate this condition the air flow was reversed periodically to build up the layer of microbes in both vessels. Once a vigorous biofilm evolves in both stages the scrubbing system should be more resistant to sudden shock loading should such a condition occur. The operating data shown in the accompanying chart show the very high removal rates attained by this two stage system during the summer of 2001. The data is shown from July 12 to October 18. It is clear that most data points show 100% removal or very close to 100% removal. There is a gap in the data from 8/16 to 9/6 due to personnel vacations.

4) Comparison with Other Biotrickling Filter Media (Peat, Compost and Lava Rocks).

The HD Q-PAC design facilitates the formation and maintenance of an active and healthy aerobic layer of microbes. Competing microbes are controlled and limited due to the establishment of a stable equilibrium within the biotrickling filter. This design consists of a dense array of long slender needle like elements vertically oriented and suspended from a support grid that acts as a water distributor helping to maintain a uniform distribution of downward flowing water over the biofilm. This liquid distribution prevents drying out of portions of the layer of microbes and the resultant loss of H_2S destruction efficiency.

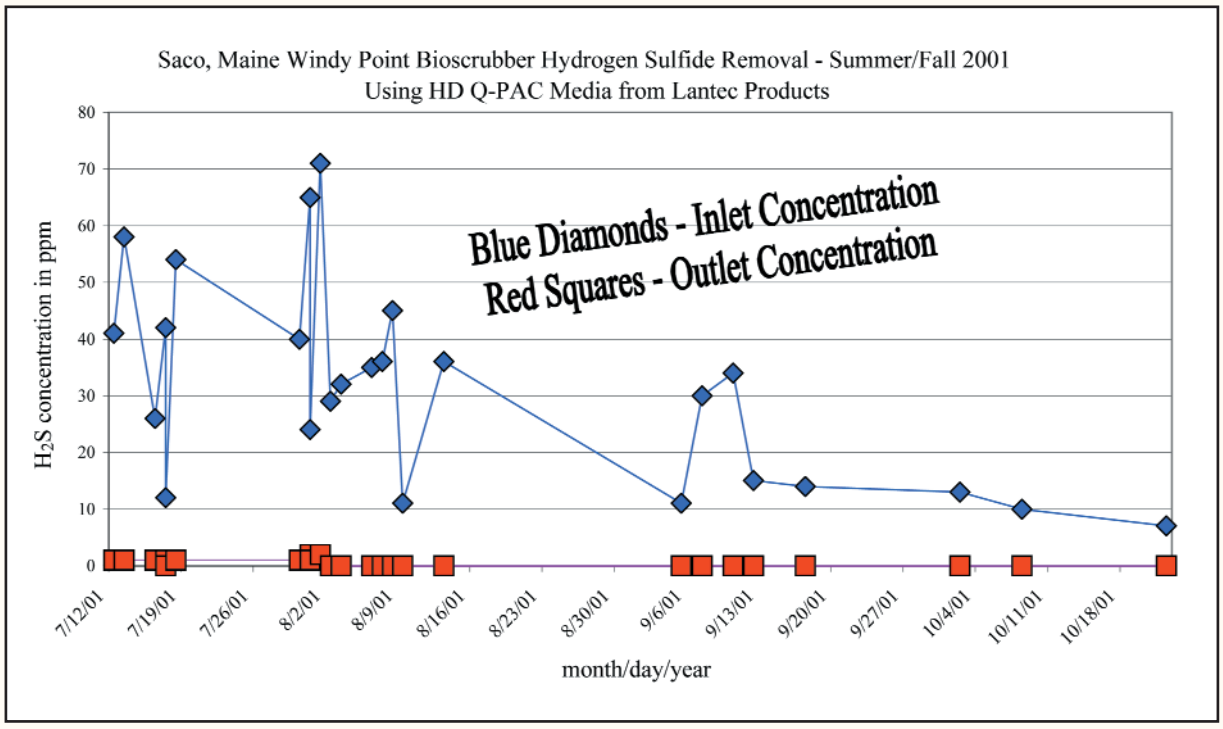
Another factor affecting the efficiency of the biotrickling filter is the rate the H_2S gas transfers from the upward flowing air stream into the wet layer of microbes. The plastic needle like design of HD Q-PAC assures that all the water contained within the biofilm is close to the exposed surface of the layer of microbes and in contact or very close proximity to the H_2S molecules in the air stream. Exposing a large surface of water to the laminar flowing layer of contaminated air facilitates a high mass transfer rate of H_2S gas into the water phase. This is the first step in to achieving biodegradation.

Porous media (lava rock is a good example) allows water to migrate deep into the pores of the media. Any microbial colony located within such a pore will be shielded from exposure to passing H_2S gas and hence useless to odor control.

Windy Point Pump Station with nearby house in background

In contrast, HD Q-PAC's narrow cylindrical elements support a thin layer of microbes. In such a layer the water contained within the biofilm is either at or very near the surface of the colony. Hence mass transfer of H_2S (gas phase), into the bacteria (liquid phase) is optimized when using HD Q-PAC to support microbial growth. Optimization of transfer of H_2S into the biofilm is a critical design criterion of any biotreatment system.

Other porous media, such as peat and compost, contain many pores and channels throughout its crossection. Some of these pores narrow down to 1 or 2 microns. This is small enough so that some microorganisms in the biofilm are too large to enter the pore. Also anaerobic activity results when small amounts of H_2S gas succeeds in diffusing into such a pore. The hydrophobic nature of HD Q-PAC's polypropylene prevents water from diffusing out of the layer of microbes into the structure of the media itself. This keeps all the moisture in the biofilm and also provides a strong stable structure to support active growth of the microbes. With HD Q-PAC there will be no weakening over time (as with wetted peat and compost) causing increased pressure drop and often media replacement. The vertically oriented round structure of the HD Q-PAC needles have a self cleaning feature. As the microbes multiply on its long thin cylindrical elements the surface area in contact with the gas phase grows geometrically as the thickness of the biofilm increases linearly. The resultant large effective surface can grow to two or three times the dry plastic surfaces of the media. Additionally as the biofilm gets thicker and heavier it reaches a point where some of the microbes will slough off under its own weight. This prevents the layer of microbes from getting too thick and limiting both oxygen and H_2S transfer into to the deeper microbes that are near the plastic surfaces. Unlike porous media which can harbor deep inaccessible caverns where no aerobic activity can take place the HD Q-PAC maintains relatively thin renewable films that maintain constant aerobic conditions.



5) The Future of Bioscrubbing

The highly successful biological scrubbers built by the Saco WWTP using Lantec HD Q-PAC biological growth media use no hazardous industrial chemicals. This completely eliminates the need for caustic soda, sodium hypochlorite, chlorine or other harsh chemicals. HD Q-PAC's unique patented design provides an extremely high effective surface up to as much as 300 square feet per cubic foot when fully loaded with biofilm. The state of the art design of HD Q-PAC prevents the layer of microbes from becoming too thick and thus preventing oxygen transport through into the biofilm to the microbes residing at the bottom of the biofilm at the plastic surface interface. This feature avoids anaerobic operation at these surfaces causing secondary generation of foul odors. Biological scrubbers utilizing HD Q-PAC to support a layer of microbes can be used as a primary scrubber as seen by the elimination of odor complaints at the Windy Point lift station or as a pre scrubbing system to remove most or all of the hydrogen sulfide prior to treatment in a conventional wet chemical scrubber to greatly minimize chemical consumption. In large municipal WWTP's this two stage bio and wet scrubbing strategy can save better than 95% of chemical usage and costs over an extended period of time using only naturally occurring microbes. There is no need to resort to genetically altered bacteria.