TESTING OF A NEW MEDIA IN BIO-TRICKLING FILTER AT THE HYPERION TREATMENT PLANT

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ABSTRACT

To treat odors associated with two of the City's largest interceptor sewer systems the City of Los Angeles has been testing various odor control strategies for several years in order to develop the most cost-effective approach. The Air Treatment Facilities (ATF's) for the interceptors are located in the public right-of-way and therefore safety concerns played a major role in process selection. After careful evaluation of alternatives, Bio-trickling filters (BTF) were selected as they do not require the use of chemicals.

Initial testing at the test facility located at the Hyperion Treatment Plant was conducted on a full-scale, single stage bio-trickling filter followed in series by a bench-scale polishing stage consisting of either a Biofilter or carbon adsorption unit. These test results indicated that at the selected ATF locations the odor levels remaining after first stage treatment were too high for direct atmospheric release and that a polishing stage was required. Furthermore, air modeling indicated that only the use of activated carbon as the polishing stage would reduce odor levels to targeted goals.

Based on the information gained from these initial tests, a 2-stage odor control system employing bio-trickling filter technology followed by carbon absorption was selected for the City's ATF's. In an effort to improve the BTF performances, a new media manufactured by Taiwan-based Matala Water Technology has been tested. .

Under a joint effort between Envirogen Technologies, Inc. and the City of Los Angeles, Matala media was placed inside a BTF manufactured by Envirogen Technology. The installation of this unit, located at the Hyperion Treatment Plant, was completed at the end of May 2008. Testing was performed over the following seven (7) month period. This paper will present the test results of those tests.

KEYWORDS

Bio-trickling filter, biofilter, odor control, H_2S removal, collection system, Matala media.

INTRODUCTION

The City of Los Angeles has adopted a maximum odor level standard of 100 Dilutions to Threshold (D/T) for the discharge of the ATF's for the two large interceptor sewers. Initial pilot tests conducted earlier to select a uniform ATF technology indicated that a multi stage odor control system is needed to reduce the odor at the stack below 100D/T.

The selected location for the ATF's is in the public right-of-way. Because of concerns about safety, a BTF, which does not use chemicals, was selected as the first stage to provide Hydrogen Sulfide (H_2S) removal, while carbon adsorption was chosen as the second stage to remove residual Volatile Organic Compounds (VOCs) and other odorous compounds. The design foul air inlet odor conditions were characterized by a source with a H_2S concentration of 150 parts per million (ppmv).

The vendor for the BTF was originally sole-sourced to provide a unity on the equipments used in collection system. However dependence on a single, proprietary bio-trickling filter and media can present certain risks. Therefore in an effort to diversity options and mitigate these risks, the City identified and tested a new media manufactured by Taiwan-based Matala Water Technology.

The main test objectives were to (a) verify that the selected media could provide consistent H_2S reduction and (b) verify that the pressure drop across the media would not substantially increase and remain within the original design consumptions.

The 6 ft. diameter by 17 ft high test unit (Figure 1) was constructed out of fiber glass. This BTF utilizes two separate gas/liquid contacting zones, each 4 feet in height.

Figure 1. Envirogen Test Unit at Hyperion Treatment Plan

Matala FSM 460 media was used for the upper level and Matala FSM 365, for the lower level. While the details of the manufacturing process have not been disclosed by the manufacturer, Matala media appears as a non-woven, random structure, polypropylene monofilament that has some of the individual fibers welded or bonded together at junctures. Figure 2 shows the upper and lower media installed inside the vessel at Hyperion Treatment Plant.

Figure 2. Upper and Lower Media Inside the Vessel

Each contacting zone uses a single spray nozzle for irrigating the media. An empirically determined flow rate of 15 gallons per minutes (gpm) was shown to evenly distribute the flow over the surface of the media.

A water line with two timers (time ON; time OFF) for flow control supplies make up water to the sump. To simulate field conditions at the ATF's potable water was used for make-up water. A separate pump supplied by a 100 gallon nutrient tank, also using the two-timer method of flow control, injects nutrient solution irrigation line upstream of the zone split. To make the nutrient mix twenty-five (25) pounds of powder purchased from a local fertilizing vendor was added to a 100 gallon tank which was then filled with water. An external pump connected to the sump at the base of the BTF recirculates the scrubber liquor back up to the spray nozzles. An irrigation control panel installed next to the BTF houses the make-up water and nutrient dosing timers.

This BTF was installed on the top of the effluent channel receiving foul air from the primary system. To avoid the accidental discharge of odor during the experiments, the treated air was discharged back to the primary channel at a downstream location. Excess water in the sump was discharged through an over flow drain into the same channel. The performance of a BTF is optimized when the overflow drain water has a pH at or slightly less than 2 A pH below 2 is not a problem at the Hyperion test facility but at the actual interceptor field locations neutralization may be required prior to discharge if the pH is lower than 2. The drainage water is expected to have a pH of approximately 2

TEST METHODOLOGY

The following BTF operational parameters were measured and recorded daily.

- Make-up water flow rate (gallons per minute)
- Nutrient dosing cycle frequency and duration settings
- Nutrient usage (gallons per day)
- Overflow drain water outlet pH (pH meter)
- Inlet, middle bed, and outlet H_2S (Interscan meter; sensitivity 0.1 ppmv)

VOC samples were collected every two to four weeks from inlet and outlet air stream. The air samples were analyzed for 39 VOC compounds at the Hyperion Treatment Plant laboratory using method TO-14A. Odor samples were collected several times from inlet, middle bed and outlet air stream in Tedlar bags and shipped overnight to St. Croix Sensory, Inc. for analysis of Dilutions to Threshold (D/T) and Recognition Threshold (R/T).

SYSTEM START-UP

Start-up began at the end of May of 2008. To promote the growth of bacteria the airflow was incrementally increased and the media was seeded during start-up. The initial airflow to the BTF was 710 cfm which represents a 19 second Empty Bed Resident Time (EBRT). After 2 weeks of operation the airflow was increased to 900cfm (15 Seconds EBRT).

On July 18th the airflow was increased to 1,350cfm (10 seconds EBRT). On October 31st the final airflow adjustment with the control damper fully open was made. This maximum airflow was 2,200 cfm (6 Seconds EBRT) was continued for duration of this test.

RESULTS

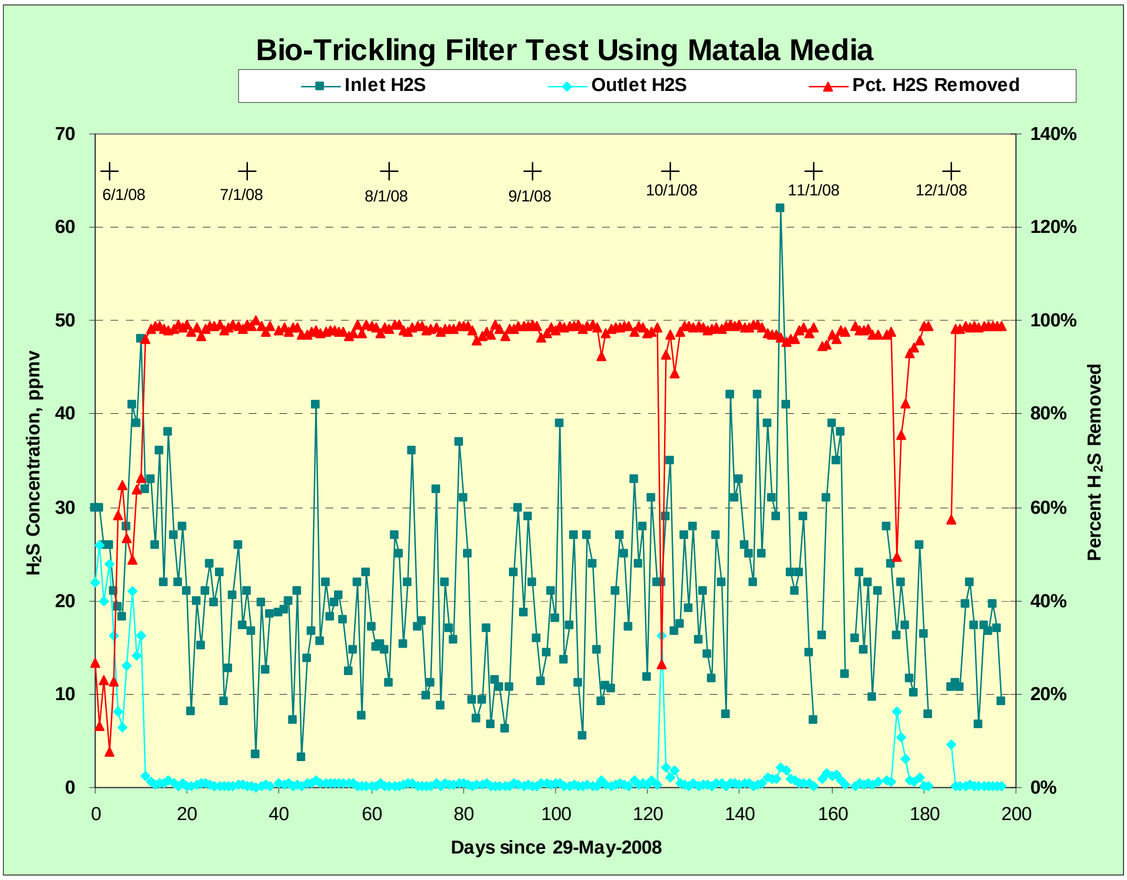
H_2S Removal

After a short start-up period the BTF generally maintained excellent H_2S removal efficiency through the seven months testing period as shown in Figure 3.

During this test campaign there were three significant drops in H_2S removal. The first two events (beginning of October and November 20th) were attributed to an electric power failure in the area. During the power outage both the fan and nutrient feed system were shut down and stopped for a short period of time. In both of these incidents the power was restored within 24 Hours and the operating system immediately restarted. The removal efficiency during these events showed a sharp decline but after a short period of time the optimum performances were regained.

On November 26 (3rd event), the total system was intentionally shut down for a period of four (4) days to simulate an emergency shut down. The unit was re-started on December 1st to evaluate the ability of the system to recover. As shown on Figure 3, optimum performance was regained after a short period of time.

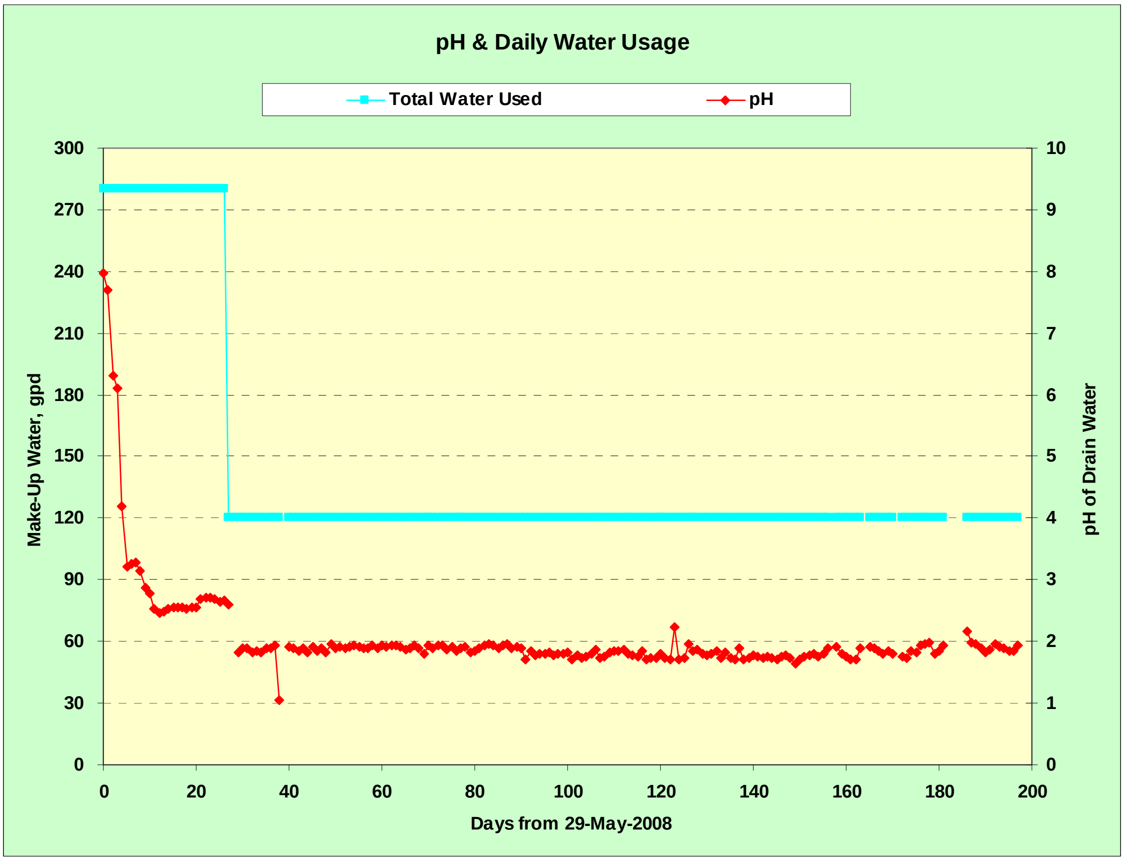
Figure 3 - H_2S treatment in the biological stage



pH of Drain Water

Drain water pH was recorded daily during the seven (7) month campaign. After a short start-up the pH of drain water was reduced to approximately 2 and maintained at this level throughout the seven months test period. Figure 4 shows the relation of pH and make-up water during this test period.

Figure 4 – pH vs. daily water usage



Odor Removal

One result from this test campaign, although not totally unexpected, was that while H_2S removal by the BTF was very effective, the BTF outlet odor concentration was relatively high. BTF inlet odor levels ranged from 8,000 to 21,000 Dilution to Threshold (D/T,) while odor from middle bed ranged from 2,200 to 8,800 D/T and outlet odor ranged from 2,200 D/T to 5,000 D/T. The highest outlet odor reading of 5,000 D/T was associated with the inlet odor level of 13,000 D/T, but odor removal efficiency increased at higher inlet odors, so the magnitude of outlet odor was dampened. For inlet odor values of 21,000 D/T, outlet odor level was around 4,000 D/T for removal efficiency of 81 percent. For inlet odor value of 8,000 D/T, outlet odor level was 2,200 D/T for removal efficiency of 73 percent.

No correlation between inlet H_2S and odor was observed, due to the influence of other odorous compounds beside H_2S. For example, an inlet H_2S concentration of 22 ppm had an odor value of 21,000 D/T while an inlet H_2S concentration of 14.8 ppm had an odor value of 8,000 D/T. Therefore a large portion of the odor can be attributed to odorous compounds other than H_2S.

VOC Removal

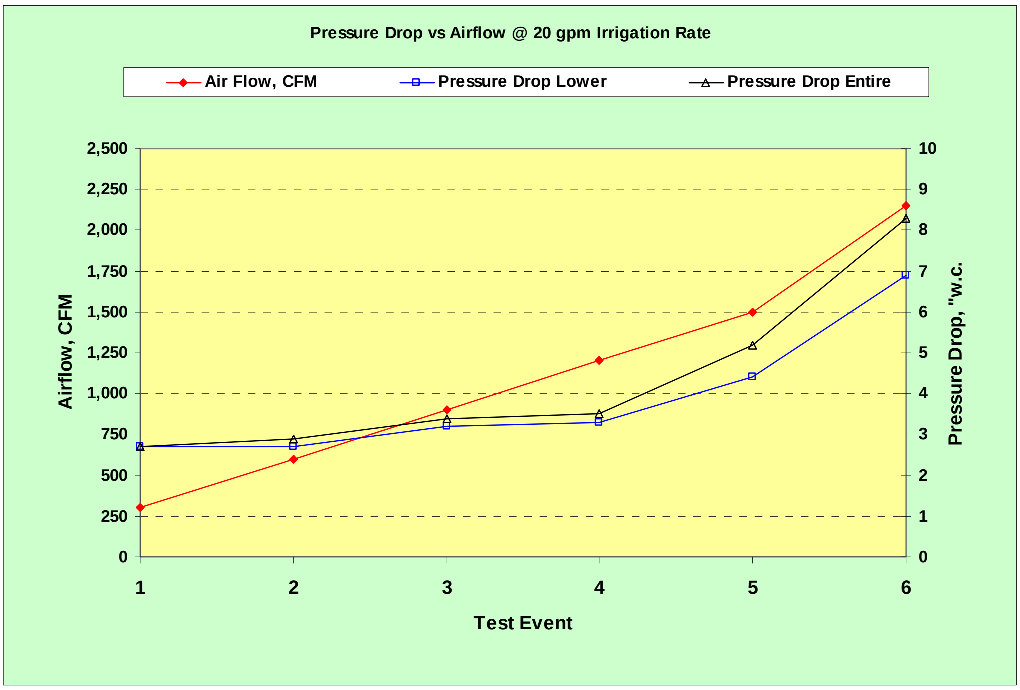
Because the irrigation of both media levels used the low pH water in the recirculation system, the BTF unit did not provide any significant reduction of volatile organic compounds (VOC's). However it should be noted this BTF was operated and tested for H_2S removal and was not optimized for VOC removal. The BTF system could achieve higher VOC removal if upper irrigation was connected to a once through flow of nutrient mixed with fresh water. This configuration will be tested on the next test event.

Pressure Drop

The other objective of this test was to identify the pressure drop in different operating modes. Initially the pressure drop was about 0.5 inch of Water Column (W.C.). However as the airflow was increased the pressure drop also increased. At maximum airflow of 2,200cfm the pressure drop was recorded to be as high as 8.5 inches of W.C.

To identify the media plugging problem a series of pressure test was conducted on December of 2008. During this test event the pressure drop was measured at different irrigation rate and airflow. Figure 5 shows the increase in pressure drop when airflow was increased, but irrigation rate remained at 20 gpm.

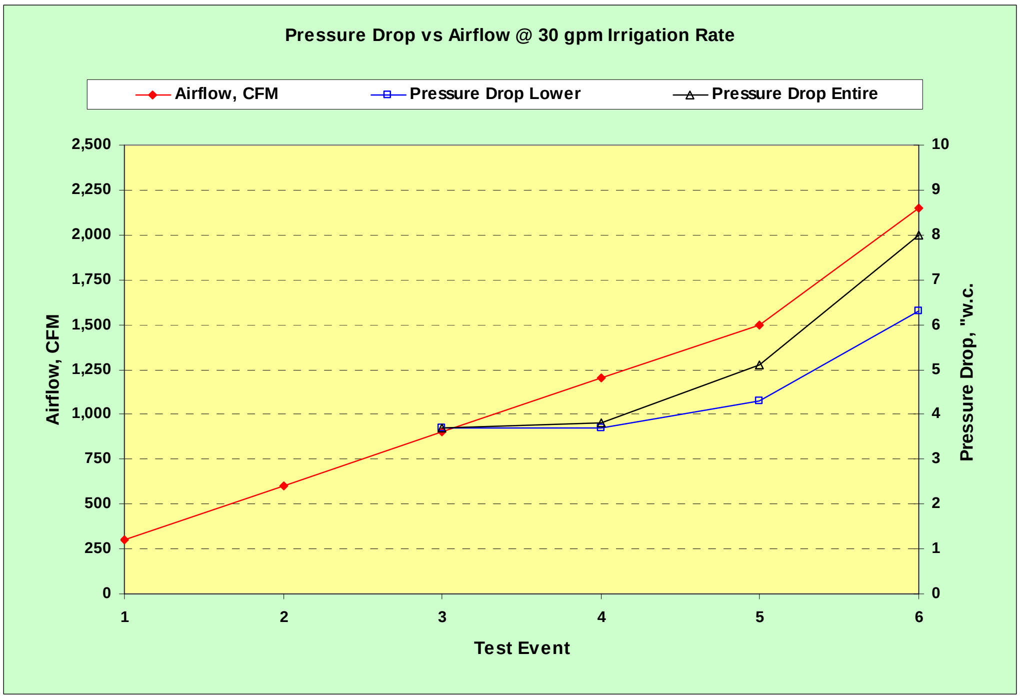
Figure 5 – Pressure Drop vs. Airflow at 20 gpm Irrigation Rate



As shown in this graph, the pressure drop across both media layers was just below 2 inch of W.C. at around 500cfm airflow, and as airflow was increased to a final level of 2,200cfm the pressure drop was recorded to be about 7.5 inches of W.C.

During the next test, the pressure drop was measured at different airflow when irrigation rate remained at 30 gpm. Figure 6 shows the result of this test.

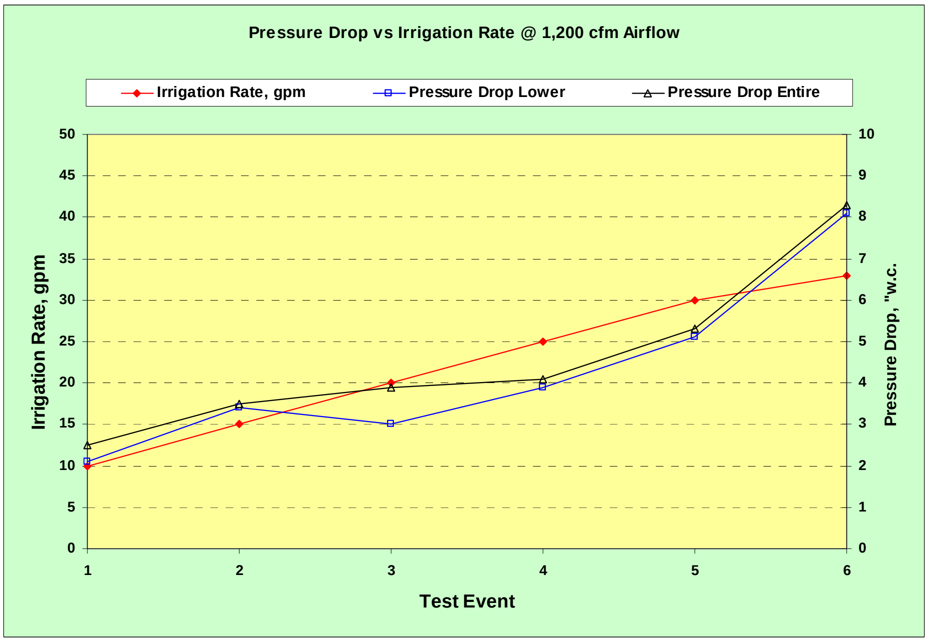
Figure 6 – Pressure Drop vs. Airflow at 30 gpm Irrigation Rate



During the next test pressure drop was recorded at different irrigation rates when airflow remained at 1200 cfm. Figure 7 shows the result of this test.

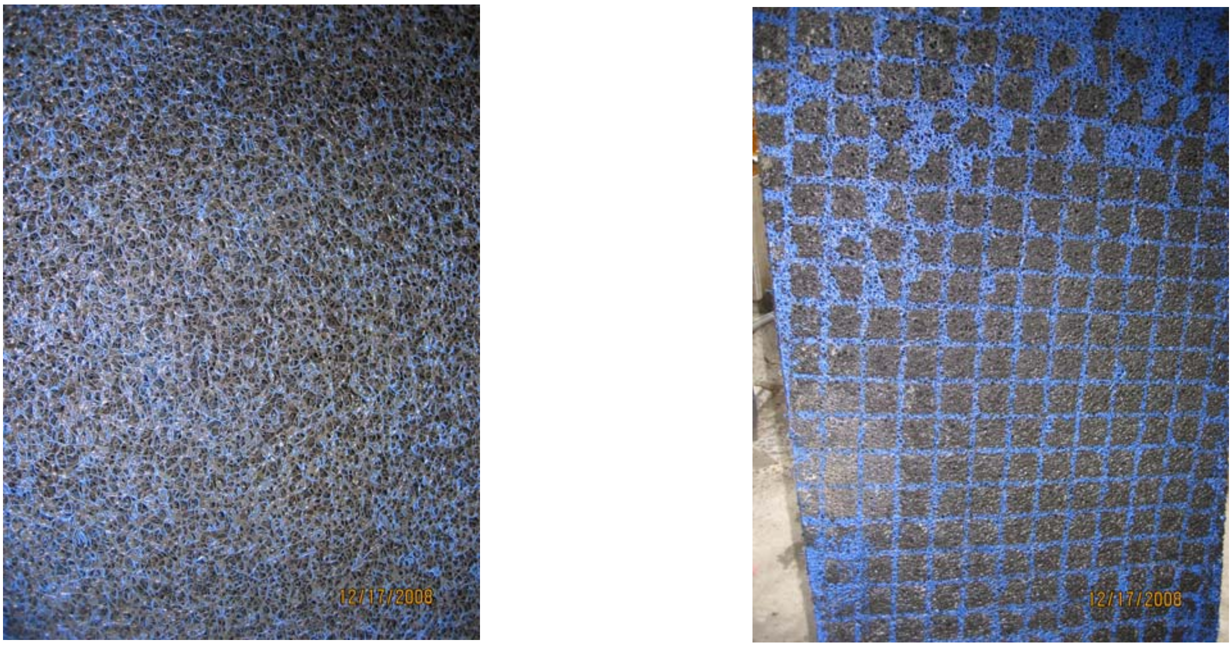
NOTE: The “Pressure Drop Lower” is the pressure drop across the lower media. The “Pressure Drop Entire” across both sections of the media (lower and upper media levels). When the air flow is low and the irrigation rate is at its lowest rate, the pressure drop for the lower media and entire media are approximately the same

Figure 7 – Pressure Drop vs. Irrigation Rate 1,200 cfm Airflow



On December 18th 2008, the operation of this unit was halted to physically inspect the media for plugging. During this time the lower media was taken out of the vessel for inspection. As shown in Figure 8 there was a large grease build up on the bottom layers of lower media.

Figure 8 – Pressure Drop Caused by Grease at Lower Media



The grease which came from foul air penetrated approximately 1.5 feet into the lower media. The majority of the increase in pressure drop during this campaign can be attributed the grease. The installation of a grease trap filter should eliminate this problem. There was also evidence of grease buildup on the blade of the inlet fan suggesting that the grease trap needs to be installed upstream. Failure to do this on a system intended for long time use could adversely on-line availability.

DISCUSSION

During startup the biological system provided excellent H_2S removal efficiency achieving 98% at an airflow of 710 cfm (19 Seconds EBRT). However, H_2S removal efficiency decreased at higher concentrations. Based on the data taken from the middle bed, most of the H_2S was removed at the lower media. Upon reaching steady-state operation, the system provided effective H_2S treatment at flows as high as 2200 cfm. Therefore it can be concluded that the media continued to perform even at very low residence times (6 seconds EBRT).

Even though the test BTF’s produced low outlet H_2S concentrations, the outlet odor remained relatively high with an overall average of about 3,500 D/T. Therefore a polishing stage to remove the remaining odorous compound is necessary to comply with air quality, VOC regulations and odor control criteria. Because the air coming out of a BTF is totally saturated (100% Relative Humidity), a dehumidification or reheat section may be required if activated carbon is chosen as the polishing stage.

Relative to odor reduction, vendor technical experts are considering changing the irrigation process so that the upper media receives the once-through fresh water irrigation. Also since most of H_2S removal taking place at the lower media, the concept of replacing the upper media with a dehumidification layers and then carbon is being considered for testing in the same test unit.

The vendor also stated that this system was tested under lower inlet H_2S concentration and better results could be obtained at higher inlet concentration. It should be recognized that the Hyperion test is a single example of a wastewater influent source at a large city. Gas stream characteristics for smaller systems and different sources would be expected to be different. The knowledge base would be significantly expanded if the vendor is able to obtain odor data from other installations operating with a variety of inlet conditions.

Except for toluene the BTF provided poor removal of the VOCs measured. The cause may be that inlet VOC concentrations are too low to support the biological growth necessary for removal of those compounds or that the low pH environment is unsuitable for the removal chemistry. The VOC removal of this BTF will be closely monitored during the next phase of this test when upper media irrigation is converted to once-through fresh water irrigation.

CONCLUSIONS

Based on the testing at the Hyperion plant, we have established that the Matala media provides effective and consistent H_2S removal. Grease in the inlet air stream seems to be the reason behind the high pressure drop. With the proper grease trap installed, a pressure drop of approximately 1.5 "w.c. at a 10 Seconds EBRT is anticipated. . The system tested was operator friendly. The only time the system exhibited a loss of performance that lasted several days was after a loss of power that lasted for more than 24 hours.

For the Hyperion influent source, the BTF outlet odor averaged about 3,500 D/T. Under the air quality rules mandated by California, the addition of an effective activated carbon filter is required for odor control. To avoid loading up the carbon with water vapor, a system to reduce the Relative Humidity may be required. Except for toluene, the BTF provided no significant VOC reduction. Testing at Hyperion will continue to more fully investigate this system under various operating conditions with different types of media. Additional data will be collected to better define the makeup of the outlet odor.

The issues regarding Non-Methane Hydrocarbon will also be studied and investigated in future tests.

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