

Bio●Reaction, Industries and Sierra Pine's Design, Construction and Start-Up of an Engineered Biofilter Pilot System

SierraPine, a wood products manufacturer, with experience in both thermal oxidizer and biofiltration technologies for control of VOC and HAP emissions from wood products plants, determined that in order to meet the upcoming MACT standards, additional controls might be necessary at several of its mills. The company's experience with biofiltration, combined with the timely expansion and development of new product designs by Bio●Reaction Industries, LLC, provided a unique opportunity for a partnership. Discussions during late winter 2001 lead to an agreement to conduct a multi-unit pilot study on press vent emissions at SierraPine's Springfield, Oregon particleboard mill. Several designs were developed by Bio●Reaction to address suspended particulate, airflow, and HAP concentrations from the press vents. Fabrication and installation of four uniquely designed 10,000 acfm Bio●Reactors™ was completed, with start-up on September 17, 2001. All airflow from one press vent, with the highest HAP and particulate emissions, was divided equally to the four pilot units. Each of the pilot Bio●Reactors™ has been independently adjusted for a number of parameters to determine the best design for optimum removal efficiency and cost effectiveness. Expectation is that HAP removal efficiency will continue to meet or exceed the MACT standard; and that with lower initial capital and no additional fuel costs, one or more of the prototype Bio●Reactors™ units will be scaled up for use in this and other wood product applications.

Installation began with minor additions and modifications at the mill. These included: enclosure of the #2 press vent exhaust, ductwork to the biofilter locations, water and electrical connections, and reinforced concrete pads for each unit along the west wall of the building (outside), adjacent to the press. The biofilter bases were set in place in late August with assembly and all connections completed by September 12, 2001 (Figure 1). Inspections and evaluations occurred for the next several days with start-up on September 17, 2001.

In order to provide the greatest amount of information regarding unit sizing, internal design and humidification/scrubber systems, each of the 4 units was built with a different configuration of the various components. Unit 1 is the "simplest" configuration consisting of an internal humidification/scrubber system with x-flow plastic media followed by a single bed of patented, balled mulch-based media with overhead spray nozzles for 'scrubbing', recirculation and moisture control (Figure 2). Unit 2 consists of an external humidification/scrubber with two separate beds with split airflow to each. Unit 3 (2nd in placement) has an internal humidification/scrubber system with three separate media beds and a similarly divided airflow. Unit 4 has an external humidification/scrubber; three separate beds and divided airflows with a variable frequency drive. All units operate as induced draft systems at approximately $16,150 \pm 1,275 \text{ m}^3/\text{h}$ ($9,500 \pm 750 \text{ acfm}$). These units are designed for operating temperatures between 15° and 35°C. Press vent emissions are usually in the 30° to 40°C range so adequate heat for near optimum operation existed in the emissions. However, a 'flash tank' was installed to utilize the condensate return from the steam-heated press for additional heat if necessary. The overall objective was to evaluate the specific performance of each unit (configuration) to arrive at the most cost-effective design for this application.

The four pilot units have now operated continuously since start-up with only short interruptions from cessations in production, flow restrictions from particulate accumulation, and minor adjustments. At start-up odors of formaldehyde were noticeable from the biofilter stacks, but by the end of the first day of operation they were no longer discernable. Initial samples, collected and analyzed for formaldehyde after only a few days of operation, revealed over 90% removal.

After the first 3-weeks, inlet and outlet formaldehyde and methanol samples were collected using activated carbon and silica gel tubes with elution and gas chromatography analysis in the laboratory. These data showed removal efficiencies (Dre) for formaldehyde and methanol in excess of 90%, the requirement in the USEPA draft MACT document for the Wood Products Panel Board Industry.

The activated carbon and silica gel collection and analysis provide a rapid and easy to use method of assessment of the efficiency of operation and target compound removal by the biofilter pilot units. In addition to these methods, monthly samples are collected and analyzed using the NCASI (National Council for Air and Stream Improvement) Impinger Method (accepted by USEPA) for corroboration of the formaldehyde and methanol data generated from the activated carbon and silica gel tubes. In addition third party stack sampling and analysis will be performed to further validate the sampling and analysis being done by the manufacturer.

All data combined show a range of formaldehyde inlet concentrations between 13 and 17 ppmv with biofilter outlet emissions from <0.1 to 0.2 ppmv. Each set of inlet-to-outlet data revealed a Dre of greater than 90%, many exceeding 95%. Similar removal efficiencies of (Dre >90%) methanol has been observed, but with greater variability in both inlet and outlet concentrations. Inlets concentrations have ranged from 100.6 ppmv to 10.5 ppmv while biofilter outlets ranged from 2.2 ppmv to <0.5 ppmv.

The particulate load to each unit (based on previous stack tests) is approximately 0.34kg/hr (0.75lbs/hr). Current operation calls for weekly blowdown of approximately 757 l (200gal) from each unit to eliminate accumulated particulate in the x-flow media. The blowdown has a BOD of from 200 – 800ppm and a pH in the range of 4.5 to 7.5, posing no problem for acceptance by a POTW at a rate of 15,000 to 23,000 l/month (4,000 to 6,000gal/month). This volume of wastewater is based on a nominal size of 136,000m³/h (80,000cfm) for a complete press application.

All four pilot units are currently performing at or near the calculated design criteria, with all exceeding the 90% Dre for both HAP constituents. The relatively small footprint of the Bio●Reactor™, when compared to the much larger footprint of conventional, ‘flat-bed’ biofilters, allows for placement of these units in close proximity to the emission source eliminating long, costly duct runs. The patented Bio●Matrix™ media system and other design innovations make this smaller, more compact size possible. This pilot operation has been essential in order to develop an optimal design and operating regime that allows continuous operation for many years with adequate removal efficiency to meet and exceed the MACT standards, and for determination of optimum design-to-cost considerations for future applications.

Figure 1

Installed Biofilters at Sierra Pine



Figure 2

Biofilter Design, Engineering for Press Vent Emissions



Cross-Flow Media

- Airflow
- VOC & HAP Concentrations
- Particulates



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