Coupled Physical/Chemical Pretreatment and Biofiltration Technologies to Reduce Air Emissions from Forest Product Industries

Improved Biofiltration System Will Control Emissions of VOCs and HAPs from Manufacturing Processes

Biofiltration systems are an emerging, option for controlling VOC emissions from industrial processes. The large fluctuations in the influent air volume and pollutant emissions related to these processes, however, reduce the biofiltration systems’ ability to degrade the pollutants in the air stream. Frequently, existing biofiltration technology is not capable of efficiently handling the emissions. The most serious problem is periodic “spikes” of very high concentrations of VOCs and HAPs, which can be toxic to the microbes within the biofilter. This research will develop a biofiltration system which can be used by the forest products industry to safely and reliably attain minimal emissions of VOCs at a reasonable operating cost.

Researchers at Michigan Tech University’s Institute of Wood Research used both laboratory and industrial on-site research to better understand biofiltration processes and optimize their performance. Initial laboratory studies helped develop advanced laboratory systems, and a pilot-scale system. The pilot-scale system includes an adsorption/desorption unit, on-line GC-FID analysis, and a modular biofiltration design. On-site work with operating industrial biofilters has been used to augment both laboratory and pilot-scale results. In addition, on-site industrial work has served as a conduit for technology transfer of information gained during this project to interested parties in the Forest Products Industry.

Benefits for Our Industry and Our Nation

- Coupled pretreatment/biofiltration system
- Limit fluctuations to diminish the pollutant degradation rates or kill the microbes in the biofilter
- Treats higher concentrations of VOCs (2,000-2,500 ppmv) than in existing biofilter units (less than 500 ppmv)
- Smaller-sized biofiltration units, with significant savings in equipment and maintenance costs, and in space requirements
- Extend life of biofiltration media resulting is significant operational cost savings

Applications in Our Nation’s Industry

By decreasing the variation in the influent streams, this technology can make biofiltration a more attractive technology to industries that experience frequent and often longer down times.
**Project Description**

**Goal:** To develop an efficient, cost-effective, and easily implemented method for controlling emissions of volatile organic compounds (VOCs), including hazardous air pollutants (HAPs), from forest products industries. Specifically, to determine the feasibility of using physical/chemical methods to adsorb and then desorb analytes in order to convert a dilute, high volume air stream to a more concentrated low volume air stream.

Researchers coupled a physical/chemical pretreatment unit with a second-generation biofilter for the removal of VOCs/HAPs. The pretreatment unit first concentrated the normally dilute concentrations of VOCs in the air stream by passing the air stream through a solid adsorbent media. Two model VOC compounds were used (alpha-pinene and methanol) and studies were conducted to characterize the effect of moisture, temperature, residence time, effects of the microorganisms on the solid support, and concentration on the retention of the VOCs in the adsorbent media.

The process of desorption was regulated by adjustments to the flow rates, the air temperatures, and the moisture content within the solid, VOC-saturated adsorbent. An adsorption-desorption isotherm and longevity estimate were developed for each adsorbent media.

Different microorganisms were tested in a second-generation biofilter that is capable of degrading relatively high concentrations of VOCs. The best-performing microorganisms were then used in the biofilter in the final year pilot studies. Pilot testing was conducted on the effectiveness of the coupled system in removing emissions generated at an operation forest products industry partner site.

**Results**

Coupled systems were shown to be able to efficiently concentrate dilute streams, and the coupled biofilters were able to remove 90%+ of the VOCs from the adsorption/desorption unit. The increased efficiency of the technology would allow for smaller units to be built, saving space and capital investment. These systems would also provide for better overall destruction and removal of problematic compounds such as terpenes.

**Project Partners**

- Michigan Technological University
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- Mississippi State University
  Mississippi State, MS
- USDA, Forest Products Laboratory
  Madison, WI

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