3.2 Development of Trickle-Bed Air Biofilter

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Abstract

The 1990 Amendments to the Clean Air Act have stimulated strong interest in the use of air biofilters for the control of volatile organic compounds (VOCs) in effluent air streams. Biofilters are specially suited for the treatment of gas streams contaminated with low to moderate concentrations of VOCs. The effectiveness of three biofilter media was compared; a peat mixture, a channelized medium, and a pelletized medium. Toluene was used as the model VOC. The performance of the peat biofilter was found to be very sensitive to air temperature, and feed toluene concentration, while the channelized medium biofilter suffered from short circuiting induced by uneven biomass accumulation. Furthermore, biomass removal from this medium was not practical. The pelletized medium appeared to be the medium of choice. It provided for a resilient and effective trickle bed air biofilter (TBAB) that combined efficient treatment at high organic loads and ease of biomass control.

3.2.1 Introduction

Since enactment of the 1990 amendments to the Clean Air Act, the control and removal of volatile organic compounds (VOCs) from contaminated air streams has become a major public concern (Lee, 1991). Consequently, considerable interest has evolved in developing more economical technologies for cleaning contaminated air streams, especially dilute air streams. Biofiltration has emerged as a practical air pollution control (APC) technology for VOC removal. In fact, biofiltration can be a cost-effective alternative to the more traditional technologies, such as carbon adsorption and incineration, for removal of low levels of VOCs in large air streams (Ottengraf, 1986). Such cost effectiveness is the consequence of a combination of low energy requirements and microbial oxidation of the VOCs at ambient conditions.

Preliminary investigations (Sorial et al., 1993) were performed on three media: a proprietary peat mixture; a synthetic, monolithic, straight-channeled (channelized) medium; and a synthetic, randomly packed, pelletized medium. These media were selected to offer a wide range of microbial environments and attachment surfaces and different air/water contacting geometries. The results of this preliminary work demonstrated that 95+1% VOC removal efficiency could be sustained by all three media at a toluene loading of 0.725 kg COD/m³-d, but at different empty bed contact
times (EBCTs). For the pelleted medium, this performance could be achieved at an EBCT of 1 min., for the channelized medium at 4 min., and for the compost medium at 8 min. Both synthetic media developed headloss over time, with the pelleted medium showing a pressure drop in excess of several feet of water after sustained, continuous operation. These results left open the question of which medium could provide the optimum combination of high VOC elimination efficiency at high loading with minimum pressure drop.

### 3.2.2 Experimental Apparatus

The biofilter apparatus used in this study consists of three independent parallel biofilter trains, each containing 4 ft. of attachment medium: Biofilters A, B, and C. A detailed schematic of the experimental apparatus is given in Fig. 1, while a detailed description of the system and the operating procedure is given elsewhere (Sorial et al., 1993). Biofilter A was filled with a proprietary compost mixture, B with a Corning Celcor® channelized medium, and C with a Manville Celite® pelleted medium. Biofilters A and B were square and have an inner side length of 5.75 in., and biofilter C was round, with an inside diameter of 5.75 in. The air supplied to each biofilter was highly purified for complete removal of oil, water, CO₂, VOCs, and particulates. After purification, the air flow for each biofilter was split off, the VOCs were injected into it, and then it was humidified and fed to the biofilters. The air feed was mass flow controlled, and the

![Fig. 1. Schematic of the experimental setup](image-url)