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Biofilters

By: R. D. von Bernuth

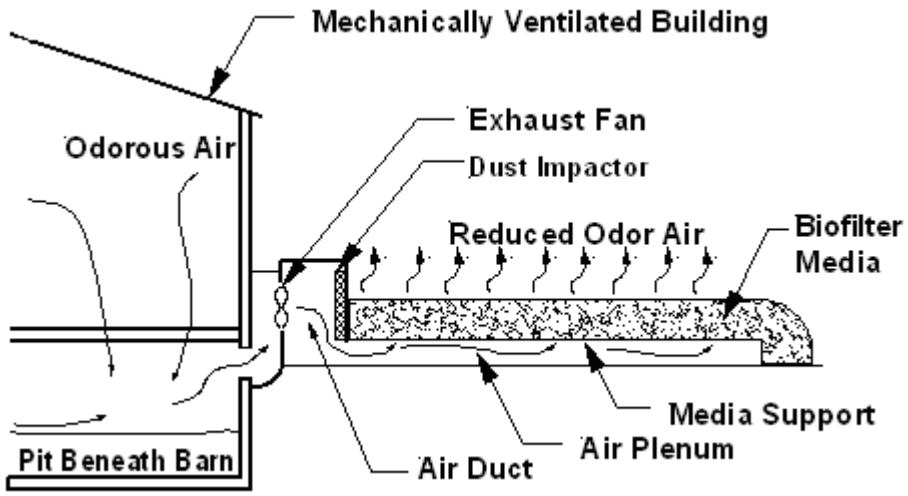
Introduction

Odor control is often a concern for swine operations, and one of the methods proven to reduce odor is the use of a biofilter. A biofilter is a bed of organic material through which odorous air is passed. The material filters dust from the air and serves as a host for microbes that convert odorous gases into non-odorous gases, principally carbon dioxide and water. The effectiveness of the biofilter depends upon the air remaining in contact with the filter long enough for the odorous gases to be trapped on the medium microbes to break the gases down. Two gases typically found in air from swine facilities are hydrogen sulfide and ammonia, and properly operating biofilters can remove 80 to 95% of those gases.

Installation

Figure 1 below shows a typical installation.

Figure 1. Typical biofilter installation (from Nicolai, Janni, and Schmidt; Frequently asked Questions about Biofilters; University of Minnesota)



Construction of a biofilter involves building a plenum where air from the fan is distributed beneath the media (usually a mixture of wood chips and compost, from 50 to 70% wood chips) placed upon a slatted floor. It has been found that used shipping pallets work very well as the media support if wire mesh is added on top to prevent the media from falling through the spaces in the pallets.

Biofilters can be installed on just the pit fans or on all the ventilation fans. Typically, the filter must be designed to handle the maximum air flow rate, and summer ventilation rates for swine facilities vary from 120 cfm per animal space (8 ft2 per animal) to 500 cfm per animal space for farrowing.

Costs

Researchers at the University of Minnesota have found that installation costs run from $100 to $150 per 1000 cfm of air to be treated. Operation and management costs run about $3.00 per 1000 cfm per year. Total costs for a 1,000 head finishing barn with all the ventilation air moving

through the biofilter, a five-year life on the medium, and three turns per year are summarized below.

Installation (Fixed cost):	Approximately $15,000
Annual operating costs:	Approximately $360.
Fixed cost per pig:	$15,000/15,000 pigs = $1.00 per pig
Operating cost per pig:	$360/3000 = $0.12 per pig
Total cost per pig:	$1.12 per pig

Design

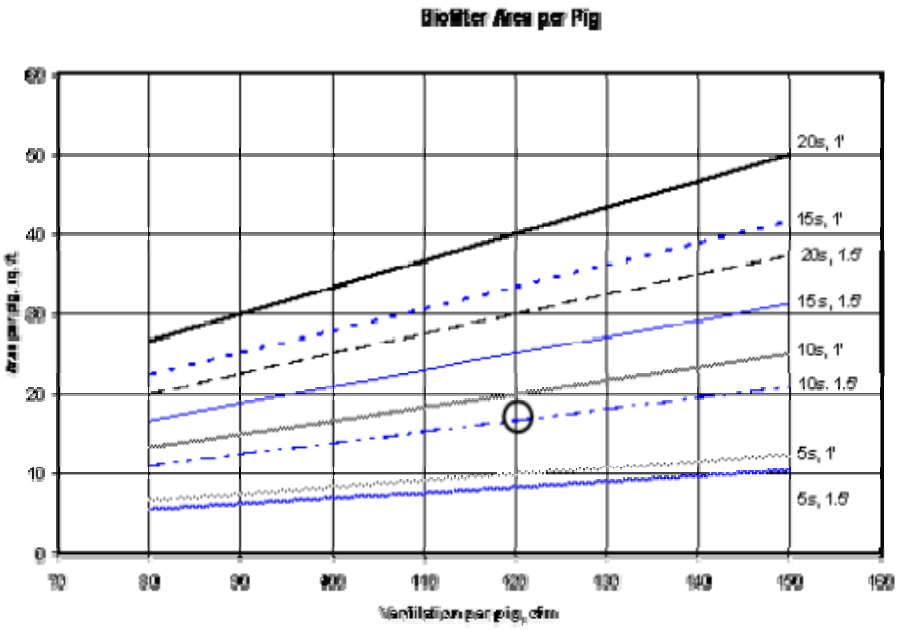
Biofilter design requires the use of mechanical ventilation. An alternative to forcing all of the ventilation air through the biofilter is to run just the pit ventilation air through the biofilter. This will substantially reduce the cost and will reduce odor about 50%.

Typically the exhaust fans in a barn will not develop sufficient pressure to push the air through the biofilter and will have to be replaced. However, if the barn is designed with a biofilter from the beginning, the additional cost is minimal.

In the summer it is important to keep the media moist so that an ideal environment exists for the microbes. In the winter additional moisture isn't necessary, and the warm air from the building will melt any snow that falls on the media.

The design of a biofilter is a tradeoff between cost and effectiveness. Thicker or deeper biofilters are generally more effective but they require more power to push the air through. Biofilter thicknesses of one to 1.5 feet are usually most economical, and the contact time required to remove most of the odorous gases should be between five seconds and 15 seconds. The University of Minnesota guideline (Janni, et. al., 1999) recommends 5 seconds. Experience at Michigan State University (von Bernuth, et.al., 1999) would suggest 10 seconds is a better choice. A larger biofilter takes less power but more space and involves somewhat higher installation costs. Figure 2 shows the tradeoff between ventilation and contact time as it impacts the biofilter area per pig. The circled spot on the chart is for 10 seconds of contact time and a 1.5 foot deep filter with a ventilation rate of 120 cfm per pig. This requires 16.7 square feet of biofilter per pig making the biofilter roughly twice the occupied floor area of the finishing barn. If the contact time is reduced to five seconds, the area can be roughly the same as the occupied floor area of the barn if the filter is 1.2 feet thick. I would not recommend contact times less than five seconds. Nicolai, et. al., 2002, give design details. Further information can be found in Richard, 2000.

Figure 2. Biofilter Area per Pig as Influenced by Contact Time and Filter Thickness. (Lines are



larger view (excel)
denoted by contact time and thickness, e.g., [20s, 1'])

Conclusions
Biofilters can be an effective means of reducing odor from swine operations, and have been accepted by Michigan Department of Agriculture as an odor mitigation technique. Their design requires consideration of fan capacity, size and depth of the biofilter, and type of material used in the media. Construction is relatively simple, with the most significant addition being a means of transmitting the odorous air through the filter. The is usually accomplished with a plenum and a series of used shipping pallets covered with wire mesh.

References

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