RESEARCH ABSTRACT

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ENVIRONMENT

Title: The Development of a Biofilter System for Ammonia and VOCRemoval from Swine Operations **– NPB #01-086**

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ABSTRACT:
Biofilters have been used to degrade a wide range of air pollutants including odorous compounds such as H_2S and ammonia. Design procedures for biofilters in agricultural processes have been developed, but lack critical eliminates, such as the kinetics of oxidation required for accurate reactor sizing. Reaction kinetics is critical to accurately cost and size biofilters for the desired outlet concentration. Thus, a mobile, skid mounted biofilter was designed and built to determine the kinetics of ammonia oxidation at a modern 2400 sow farrow-to-wean unit. The biofilter system consisted of a variable speed blower, packed bed humidifier, and two reactors (4 ft x 4 ft with a packing volume of 12.5 ft^3 per reactor) configured in parallel. Prescreened, composted yard waste was used since compost contains a large number of active microorganisms, is relatively inexpensive, and easily available. Ammonia emissions (0-12 ppmv) from the swine facility (and 0-25 ppmv in simulated stream) were transported downward across packing in the reactors and spray nozzles at the top each reactor were used to add moisture to the packing. Ammonia conversion ranged between 25 to 95 % depending on the residence time and inlet NH_3 concentration. Using first order kinetics, the measured ammonia degradation rate ranged from 0.06 to 0.8 (mg NH_3/m^3/sec) for volumetric loading rates ranging from 0.05 to 0.25 mg/m^3/sec. Residence time distribution (RTD) analysis was also performed to determine the effect of scale-up on axial dispersion and deviation from plug flow. RTD analyses suggest that non-ideal reactor design equations may be required to predict reactor size for desired ammonia conversions. A reactor design method (i.e., sizing calculation) has been presented based on the kinetics of ammonia oxidation (i.e., how fast the reactor removes ammonia). For example, assuming a volumetric flowrate of 13 m^3/s, NH_3 conversion of 95% (C_{NH3in}=25 ppmV), and a first order rate constant of 0.08 1/s, a reactor volume of 487 m^3 and residence time of 37.5 sec is required. The size of the reactor will change, depending on the characteristics of the swine facility. Pressure drops across the bed should be 0.25 in H_2O or less in order to utilize in-house fans. This will probably limit the height of the reactor to 1 m or less. The mass of compost required can be estimated from its bulk density. Moisture content must be maintained between 40-60% in the biofilter to maintain biological activity. Additional research is required to develop inexpensive methods of emission humidification, online moisture analysis, and water addition.