Use of Nanoparticles to Control Gaseous Emissions from Swine Manure Slurry

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SUMMARY

A series of tests using commercially-available nanoparticles was conducted to evaluate their impact on ammonia (NH_3), hydrogen sulphide (H_2S), carbon dioxide (CO_2), and gas mixture emitted from swine manure slurry. A number of nanoparticles tested reduced NH_3 at initial concentration of 50 ppm by 78 to 86%, while a few were able to reduce 25-ppm H_2S to below detection level (<1 ppm).

INTRODUCTION

Nanoparticles are highly reactive powder materials with unique properties due to its nanoscale dimensions. The goal of this work is to take advantage of advances in nanotechnology to control odour and gaseous emissions from swine operations. Specifically, various types of nanoparticles and deployment techniques for reducing swine barn gaseous contaminants were assessed in laboratory-scale tests.

RESULTS AND DISCUSSION

Nanoparticles were selected using a set of criteria based on physical and chemical properties, previous use in remediation applications, availability, and cost. Six types of nanoparticles were chosen and obtained from a commercial supplier; these include: magnesium oxide (MgO), magnesium oxide plus (MgO+, a proprietary name for the same material derived using a different process), aluminum oxide (Al_2O_3), aluminum oxide plus (Al_2O_3+), zinc oxide (ZnO), and titanium dioxide (TiO_2).

Figure 1 shows the normalized concentrations of each target gas after being passed through a filter cassette assembly filled with different types of nanoparticles and powder materials. Normalized concentration values equal to 1.0 indicate no effect of the treatment; values close to zero indicate effective removal of target gases. For NH_3, the top three materials were Al_2O_3, TiO_2 and ZnO, which correspond to a reduction of 85.6%, 85.2%, and 78%, respectively, from an initial 50-ppm NH_3 concentration. However, the gas filtered with MgO+ showed a possible reaction between the material and the gas analyzer sensor, thus showing a substantial increase in NH_3 concentration.

Using MgO, MgO+ and ZnO nanoparticles, H_2S gas at initial concentration of 25 ppm was reduced to levels below detection limit of the H_2S monitor used (<1.0 ppm). On the other hand, Al_2O_3 and TiO_2, which were effective for NH_3, reduced the concentration of H_2S by 57% and 13%, respectively. A decrease in CO_2 concentration by 73% and 78% was achieved using MgO and MgO+, respectively.

Commonly available powders (talcum powder and sodium bicarbonate) were also tested and showed results comparable to the least effective nanoparticles. However, when compared with the blank filter assembly, the observed results from talcum powder and sodium bicarbonate (and the least effective nanoparticles) indicate that the reduction in the target gas concentration could be mainly attributed to the filtration effect.

"Nanoparticle technology has the potential to significantly reduce Ammonia and Hydrogen Sulphide levels."

CONCLUSIONS

Nanoparticles were found effective in reducing levels of specific gaseous contaminants emitted from swine manure slurry. Additional tests are being conducted to investigate potential techniques for practical implementation of this technology in commercial swine barns.

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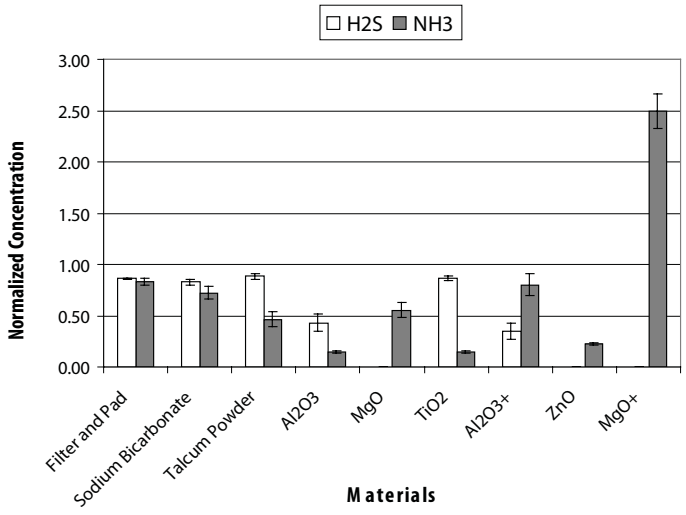

Figure 1. Average normalized concentrations of target gases passed through various powder materials. Each value is the average of three replicates and the error bars represent standard error of the mean.