Application of a Biological Treatment Approach to Control Gaseous Emissions from Swine Operations

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SUMMARY

This study demonstrated that adaptation of measures developed in another industry with similar environmental concerns (i.e., oil industry) could lead to successful control of gas emissions generated from swine operations. Use of metabolic inhibitors such as nitrite and molybdate when added to swine manure slurry significantly decreased the level of hydrogen sulphide (H_2S). Room-scale tests will be conducted to evaluate the impact of the treatment process on overall gaseous and odour emissions from swine production rooms.

INTRODUCTION

Swine barn workers may be exposed to potentially hazardous levels of gases, especially H_2S, generated during in-barn manure handling tasks. A biological treatment method developed in the oilfields was evaluated for possible adoption to address similar concerns in the swine industry. This treatment process relied on two different mechanisms which are utilized simultaneously. First, the activity of microbial species which are responsible for generation of undesirable gases and odour precursor compounds in the manure are diminished using a balanced mixture of specific inhibitors, namely nitrite (NO_2) and molybdate (Mo). The second mechanism involved stimulation of the catalytic activity of sulphide-oxidizing bacteria that are either indigenous in the raw swine manure or those which are isolated and enriched from the manure in the laboratory and subsequently added to raw swine manure as a treatment.

RESULTS AND DISCUSSION

Laboratory test results showed that addition of NO_2 at gradually increasing concentrations led to corresponding incremental reduction in H_2S levels over the first few days after application of the treatment, then the residual effect of the treatment was diminished over time (Figure 1). Addition of molybdate (Mo) even at the lowest concentration tested (0.25 millimole Mo) led to a sharp decrease in concentration of H_2S from an initial value of about 1450 ppm (Figure 2). Similar to the trends observed for NO_2, the residual effect on H_2S levels was dependent on the quantity of Mo added. However, at high Mo concentrations, the resulting levels of H_2S remained low over the duration of the tests (>40 days). Simultaneous addition of NO_2 and Mo initially led to a sharp decrease in concentration of H_2S in the headspace gas (Figure 3). With combined application of nitrite and molybdate at higher amounts, a low H_2S concentration in the range of 200 to 300 ppm was maintained over a period of 45 days. It must be noted that the test conditions were designed intentionally to create high levels of H_2S, thus, the treatment can be deemed effective if it was able to reduce these extremely high values and maintain low H_2S levels.

"Lab-scale studies have been successful in significantly reducing Hydrogen Sulphide levels, with technologies adopted from other industries."

The combination of treatments using metabolic inhibitors that reduced the concentration of H_2S in the headspace gas of the small serum bottles to less than 20 ppm H_2S were assessed in 4-L bottles. All combinations tested were effective and decreased the concentration of H_2S to a range between 0 to 25 ppm H_2S, which was maintained throughout the tests.

In initial laboratory-scale tests, a microbial culture of sulphide-oxidizing bacteria was isolated from swine manure and enriched. The use of the isolated culture to treat 30 mL of swine manure slurry in serum bottle tests did not result in a

Figure 1. Profiles of H_2S concentration in the headspace gas of the serum bottles containing fresh manure, treated with varying levels of nitrite.

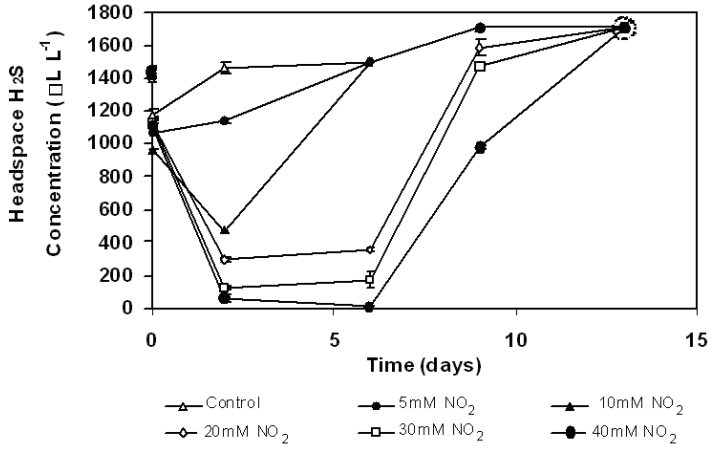


Figure 2. Profiles of H_2S concentration in the headspace gas of the serum bottles containing fresh manure, treated with varying levels of molybdate.

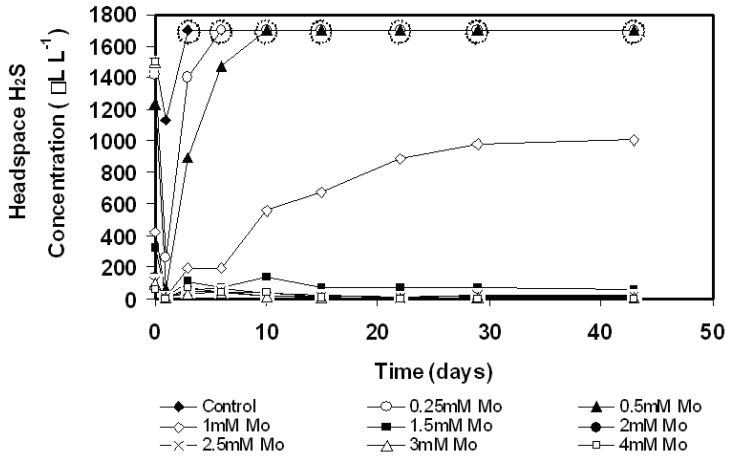
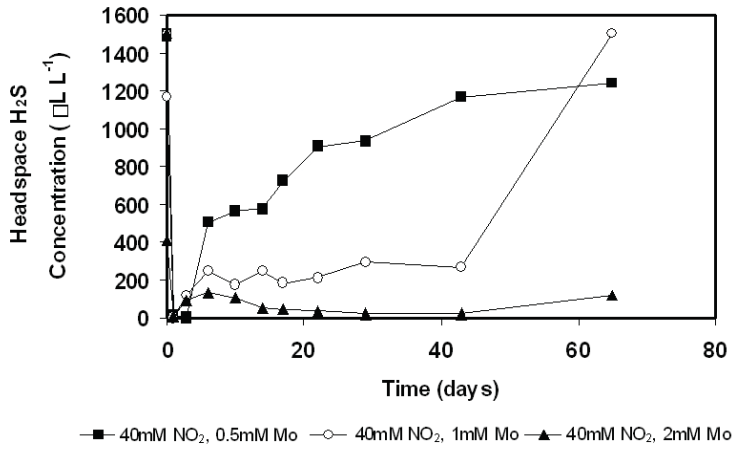


Figure 3. Profiles of H_2S concentration in the headspace gas of the serum bottles containing fresh manure, treated with various combinations of nitrite and molybdate added simultaneously.



significant decrease in sulphide concentration, possibly due to a small inoculation size, or the low concentration of biomass in the inoculant liquids. However, these preliminary results indicate the potential for isolation and enrichment of indigenous sulphide-oxidising bacteria present in the manure. A more detailed study is being conducted to verify the possibility of enriching a sulphide-oxidizing culture from the manure and to assess the activity of the enriched culture in reducing the emission of sulphide from manure slurries.

CONCLUSION

A biological treatment approach developed for the containment of hydrogen sulphide (H_2S) in oil reservoirs has been shown to reduce the emission of H_2S from swine manure. Isolation and enrichment of sulphide-oxidizing bacteria from manure is currently underway to examine various factors affecting the microbial culture aspects of this treatment approach. In this on-going study, the treatment method will be evaluated in room-scale tests to fully assess its impact on the overall odour and gaseous emissions. The effect of this treatment on manure nutrient properties will also be examined to determine the possible environmental impact of subsequent land application of the treated manure. This information will form the basis of practical guidelines for pork producers seeking new cost-effective ways to reduce H_2S in the barn.

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