Manure Scraper System Reduces Hydrogen Sulphide Levels in Swine Barns

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Summary

The effectiveness of a manure scraper system for reducing the risk of barn worker and animal exposure to hydrogen sulphide (H2S) was evaluated by comparing gas levels in two identical grow-finish rooms, one with manure scraper system installed (Scraper) and the other was a typical swine room (Control) with conventional manure pit-plug system. The H2S concentrations in the Scraper room were significantly lower by 90% compared to the Control room ($p<0.05$). Ammonia emission was not significantly affected by the manure removal system, but tended to increase over the 4-5 monitored weeks during each trial. Given the highly variable nature of H2S production and movement within a room, care should always be taken when emptying manure pits.

Introduction

A previous PSCI study found swine barn workers can be at risk of H2S exposure while performing manure management tasks, such as pulling pit-drain plugs to clear manure out of swine production rooms. Occupational regulations stipulate that worker exposure to H2S should not exceed an 8-h time-weighted average (TWA) of 10 ppm, or a 15-min short-term exposure limit (STEL) of 15 ppm. Out of 119 plug-pulling events monitored in different sections of various barns, 29% generated peak H2S values higher than 100 ppm, and 48% generated 15-min TWA values higher than the 15 ppm STEL value at the worker level. Because extended manure storage times can contribute to anaerobic degradation processes that give rise to H2S gas, an in-barn manure handling system that allows more frequent and complete removal of manure from production rooms has the potential to reduce H2S production. Hence, the goal of this study was to evaluate the effectiveness of a manure scraper system to reduce the risk of exposure of swine barn workers and animals to H2S gas.

Figure 1. Scraper system used to remove manure produced on a daily basis

Experimental Procedures

Two identical grower-finisher rooms at PSCI were used for this experiment. A total of 70 pigs per room were used at a starting weight of about 21.5 kg and remained in the rooms for 12 weeks for each trial. A manure scraper system (Fig. 1) was installed in one room (Scraper). The other room (Control) was operated normally, i.e., manure was allowed to accumulate in the pits, and was drained on a predetermined schedule by pulling the pit-drain plugs.

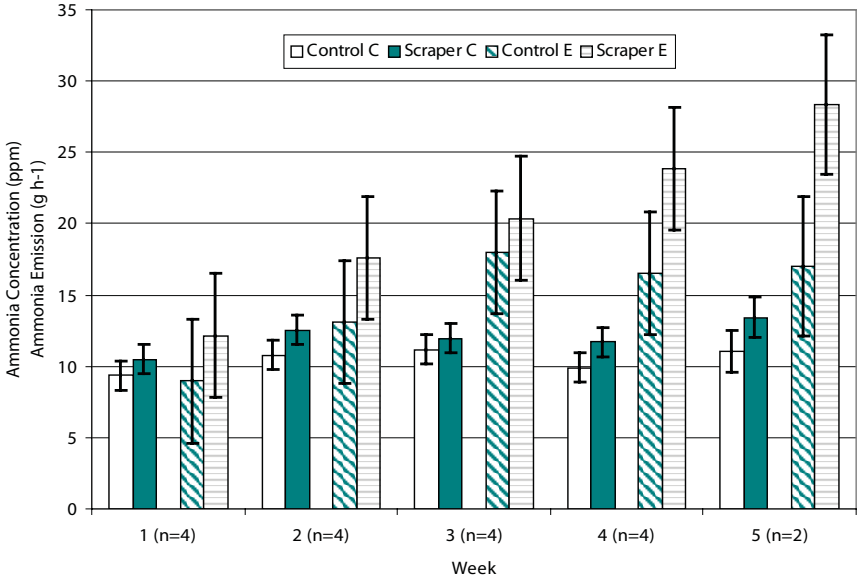

Figure 2. Weekly least square mean (LSM) ammonia concentrations (C) and emission rates (E) for the Scraper and Control rooms. Error bars represent SE, and n is the number of values used in the LSM.

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Table 1. Summary of peak H2S concentrations (ppm) measured at two locations in the Control and Scraper rooms on days that pit-plugs were pulled in the Control room.

Trial No.	Date	Control		Scraper	
		Over plug	Middle pen	Over plug	Middle pen
Trial 1	10-Mar-04	4	2	0	0
	24-Mar-04	0	0	0	0
	07-Apr-04	9	0	11	7
	21-Apr-04	12	4	0	0
Trial 2	30-Jun-04	12	2	0	0
	21-Jul-04	95	n/a	6	n/a
	11-Aug-04	40	30	2	0
	25-Aug-04	30	10	1	2
Trial 3	13-Oct-04	0	0	0	0
	27-Oct-04	48	4	0	0
	10-Nov-04	55	0	0	0
	24-Nov-04	18	11	0	0
	15-Dec-04	18	7	0	0
Trial 4	09-Feb-05	7	3	19	0
	23-Feb-05	0	0	0	0
	09-Mar-05	0	0	0	0
	23-Mar-05	52	4	0	0
	06-Apr-05	23	5	0	3
Lest-Square Mean		23.4[a]	5.6[b]	2.0[b,c]	0.8[c]
Standard Error		4.5	4.6	4.5	4.6

n/a – data not available, instrument malfunction

[a,b,c] Letters accompanying LSM values indicate significant differences (α=0.05) determined using transformed data.

The room air quality and H2S concentrations in both rooms were monitored over four production cycles (trials). Two H2S monitors (Model Pac III, with XS EC 1000 ppm H2S sensor, Draeger, Lübeck, Germany) were installed in each room: one over the middle of the pit (middle pen) and another directly above the plug, both at about 1 m off the floor. Ammonia concentrations were measured at the inlet and outlet of both rooms using an ammonia analyzer (Model Chillgard RT, MSA Canada, Edmonton, AB).

Results and Discussion

Based on the average readings from both measuring locations, the Scraper room had significantly lower peak H2S concentration levels than the Control room ($p<0.05$), equivalent to an average reduction of 90% (Table 1). Similarly, the scraper system significantly lowered the TWA H2S concentrations ($p<0.05$) by an average of about 96%.

More frequent manure removal using the scraper system did not affect the ammonia concentration measured at the outlet of the rooms ($p>0.10$) (Fig. 2). On average, 35.6% more ammonia was emitted from the Scraper room compared to the Control room, indicating that the manure removal system tended to increase room emission ($p<0.10$). Weekly average ammonia emissions also increased significantly ($p<0.001$) as each trial progressed, mainly due to increased manure production and ventilation rates required to account for increased heat and moisture production.

Conclusions

Overall, the results demonstrated the effectiveness of the scraper system in reducing H2S exposure of swine barn workers, with marginal impact on ammonia production. Based on the installation and operating costs associated with this study, the estimated cost to construct and operate a similar scraper system in a new or existing facility is about $2 to $3 per pig sold, respectively. However, this cost does not take into account the benefits of improved worker safety.

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