Belt Conveyor Manure Separation System: Impact on Odour and Gas Emissions

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SUMMARY

A new housing system for grower-finisher pigs that incorporates a belt conveyor (BC) system to separate feces from the urine at the pen level was developed. Comparative tests showed that the performance and well-being of the animals were not adversely affected by the use of the BC pen design. The system was effective in isolating most of the phosphorus in a low mass solid phase. The overall trends in gas emission rates showed that the BC pen design concept can help reduce the emission rate of carbon dioxide. No significant impact was observed for ammonia and odour emissions.

INTRODUCTION

Environmental concerns from handling large volumes of manure from livestock operations have led to exploration of new and innovative strategies to be able to manage manure in an economical and environment-friendly manner. In this research project, a new pen design concept for swine barns in which the slatted portion of the pen was replaced with a tilted belt conveyor (BC) to separate the feces and urine at the pen level was investigated. This project was implemented in two phases: Phase 1 conducted at the IRDA facilities in Québec involved the development of the BC pen design concept and assessment of efficiency of separation of the solid and liquid components. The main goal of Phase 2 trials conducted at PSCI was to compare the odour and gaseous emissions from a chamber with the BC system (Figure 1) with those from another chamber with a conventional (slats and under floor gutter) manure handling system.

"The new pen design concept showed potential to isolate up to 80% of the phosphorus in the solid phase."

RESULTS AND DISCUSSION

Results of four trials conducted at IRDA showed that the BC system has been very effective in isolating most of the phosphorus in a low mass solid phase; 76 to 81% of the phosphorus excreted by the pigs in the BC room was isolated within the solid phase of excreta. Results also showed that 39 to 48% of total nitrogen were retained in the urine while feces contained almost the same nitrogen concentration (40 to 45% of total nitrogen). The total ammonia nitrogen (TAN) content of the urine ranged from 75 to 79%, which was the level expected because TAN originates mainly from urea degradation produced in urine. From a phosphorus management perspective, the new pen design concept thus showed the potential to isolate approximately 80% of the phosphorus in a solid phase representing 20% of the total manure mass.

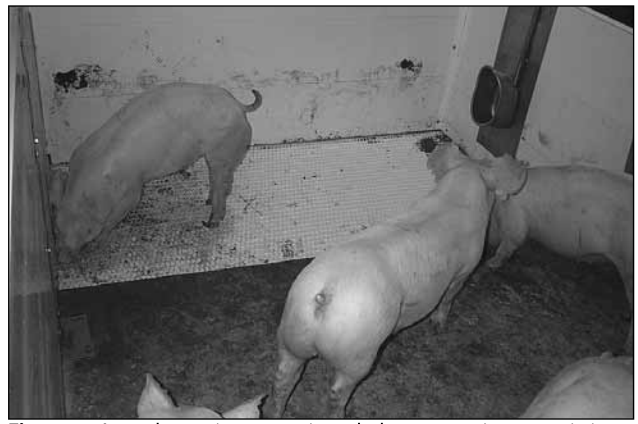

Figure 1. A pen layout incorporating a belt conveyor into an existing pen design

Pigs housed in the pen equipped with the BC system were more frequently observed lying down in the resting area than pigs housed in the conventional (control) pen. They also tended to use the dunging zone less frequently for lying than pigs in the control pen, suggesting that the BC system may possibly promote pen cleanliness. The frequency of feeding and drinking episodes was unaffected by the BC system, which is in agreement with the feed intake and feed conversion data.

The overall trends in gas concentration levels (e.g., ammonia (NH_3) and carbon dioxide (CO_2)) observed in trials conducted at PSCI and IRDA indicated that the BC pen design tended to reduce the levels of these gases. The odour concentration values for samples taken from the conventional and BC rooms were highly variable, thus statistical comparison of the odour values from the two chambers showed no significant difference ($p>0.05$). In terms of gas emissions, the BC pen design concept can help reduce the emission rate of specific gases (e.g., CO_2) compared to the conventional room (Table 1). No statistically significant impact of the system was observed for emissions of other gases (e.g., NH_3) and odour.

CONCLUSION

1. The BC pen design concept proved effective in separating the urine and solid manure components on a continuous basis, thereby allowing more effective management and handling of the nutrients (particularly phosphorus and nitrogen) in the separated components.
2. The performance and well-being of the animals were not adversely affected by the use of the BC pen design.

3. The overall trends in gas (ammonia and carbon dioxide) concentration levels observed indicated that the BC pen design contributed to the reduction in the levels of these gases.
4. The odour concentration values for the samples taken from the conventional and BC rooms were highly variable, thus statistical comparison of the odour values from the two chambers showed no significant difference.
5. The overall trends in gas emission rates showed that the BC pen design concept can help reduce the emission rate of carbon dioxide compared to the conventional room design. However, the BC system had no significant impact on ammonia and odour emissions. Further work to better assess the technology can be made with enhanced control of inlet air contaminant levels and improved techniques for measuring odour.

The experiments with the BC pen design concept also revealed potential areas for further work to optimize the system and to realize significant benefits from the use of such a system in addition to those already identified. By separating the manure into two streams, the BC system can help mitigate the hazard from H_2S exposure in swine barns. An optimized BC pen design can be potentially incorporated into a deep-pit barn construction with separate in-barn long-term storage for the separated components, without the typical hazards from high H_2S levels associated with conventional deep-pit barns.

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Table 1. Gas Concentrations and Emissions Measured in the Two Chambers

Trial #	Week #	Start Day	Mean NH_3 Concentration (ppm)			Mean CO_2 Concentration (ppm)			Mean NH_3 Emission ((mg/h-kg_{pig})		Mean CO_2 Emission ((mg/h-kg_{pig})	
			Inlet	Conv.	BC	Inlet	Conv.	BC	Conv.	BC	Conv.	BC
1	1	08-Jun	6.6	8.0	88.1	420	536	536	2.6	2.3	552	451
	2	15-Jun	6.9	7.9	8.1	412	523	510	1.6	1.9	489	434
	3	22-Jun	7.3	9.4	8.6	435	552	516	3.0	1.8	476	342
	4	29-Jun	9.6	11.9	11.4	454	549	527	4.0	3.7	454	370
2	1	12-Jul	7.6	8.2	8.4	462	511	501	2.4	4.2	211	203
	2	19-Jul	9.9	11.1	11.3	479	535	530	4.4	5.2	217	195
	3	26-Jul	8.5	10.1	9.9	455	520	507	4.7	4.5	199	176
	4	2-Aug	8.0	10.3	9.8	481	569	551	5.7	4.7	211	182
3	1	01-Sep	8.2	10.3	9.7	455	540	530	5.8	5.1	541	487
	2	08-Sep	13.4	16.0	15.6	461	547	531	4.5	4.8	519	499
	3	15-Sep	8.6	10.9	11.0	445	553	550	4.0	3.1	497	384
	4	22-Sep	6.5	9.3	9.1	453	594	581	2.8	1.9	403	313
4	1	06-Oct	7.6	8.6	8.9	479	550	551	3.6	3.6	516	423
	2	13-Oct	8.9	10.7	10.6	476	561	538	4.3	4.1	491	358
	3	20-Oct	6.2	8.4	8.4	504	603	582	5.1	3.2	521	322
	4	27-Oct	4.3	7.4	6.1	512	635	584	4.2	2.0	467	245