Air Quality in Livestock Production Buildings: Developing a Sampling Strategy for Measuring Concentrations of CO_2 and Dust in a Commercial Swine Farrowing Building

Kelci R. Knight, TR Anthony, TM Peters, R Altmaier, JL Gibbs, A Ramirez, MW Nonnenmann

Department of Occupational and Environmental Health, The College of Public Health, The University of Iowa

Background

During cold outdoor temperatures, swine confinement buildings are designed to have minimal ventilation with outdoor air.

Inhalation of dust (*e.g.,* inhalable and respirable) and CO_2 result adverse respiratory health effects among swine production workers.

Understanding the spatial distribution of dust and CO_2 concentrations in swine farrowing rooms during minimal ventilation conditions is needed to inform the installation of an engineering control filtration system designed to reduce worker exposure.

Objectives

1. Evaluate the spatial distribution of dust and CO_2 concentrations in a swine farrowing building.
2. Compare concentrations of dust and CO_2 measured using a mobile sampling cart and fixed area basket.

Methods

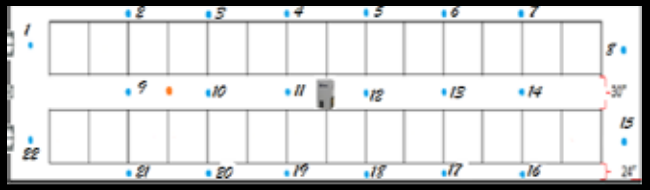

Figure 1. Schematic diagram of a swine farrowing room and sampling locations

Area measurements in a 28-crate farrowing room
- Single fixed area station:
  - Center aisle
  - Between mid-room and exhaust wall (orange dot)
- Mobile monitoring for mapping:
  - 22 positions, 5 minutes at each (blue dots)
  - Computed room average to compare to single station
- Sampling conditions:
  - 5 random days, 2.5 hr / test
  - Outdoor temperatures < 4ºC

Instrumentation, 1.5 meters from floor
- Direct reading:
  - DustTrak II (dust)
  - ToxiRAE Pro (CO_2)
- Integrated samplers:
  - Inhalable dust: IOM, 2.0 LPM
  - Respirable dust: Cyclone GK 2.69, 4.2 LPM, d_{50} = 4.04 µm

Results

Objective 1

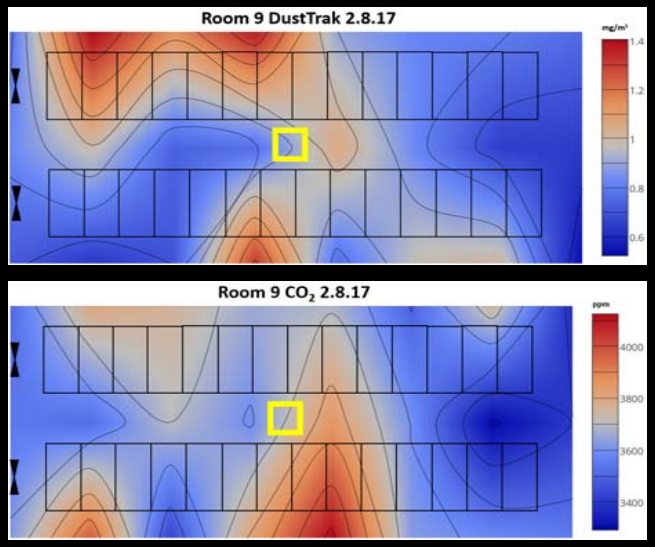

Figure 2. Spatial distribution of contaminant concentrations for respirable dust (mg/m³) and CO_2 (ppm) in a 28-sow swine farrowing room. The yellow box indicates the location of the gas-fired heater

Objective 2

Table 1. Arithmetic mean contaminant concentrations measured using a fixed area basket and a mobile sampling cart in a swine farrowing room.

	Mobile Cart	Fixed Area Basket		
	Arithmetic Mean (SD)	Arithmetic Mean (SD)	Sample Size	Paired t-test, p
DustTrak (mg/m³)	0.989 (0.300)	1.17 (0.360)	6	*0.019*
Inhalable dust (mg/m³)	3.71 (1.40)	3.96 (1.57)	10	0.532
Respirable dust (mg/m³)	0.535 (0.875)	0.246 (0.139)	10	0.343
CO_2 (ppm)	2694 (791)	2657 (674)	10	0.698

Table 2. Inhalable dust, respirable dust and CO_2 occupational exposure limits and industry guidelines

Contaminant	OSHA PEL	ACGIH TLV	Industry Guideline*
Total Dust	15 mg/m³	10 mg/m³	2.5 mg/m³
Respirable Dust	5 mg/m³	3 mg/m³	0.23 mg/m³
CO_2	5000 ppm	5000 ppm	1540 ppm

*Donham et al., 1989

Conclusions

There was no statistically significant difference between fixed area basket and the mobile sampling cart for gravimetric dust or CO_2 concentrations.

A statistically significant difference was observed between area basket and mobile cart when using a direct reading instrument (*i.e.,* DustTrak) to measure dust concentrations (p = 0.019).

Inhalable dust, respirable dust and CO_2 concentrations were below the OSHA PEL and TLV recommendations but exceeded the industry guidelines.

Future Research

Our findings will inform future sampling strategies for measuring contaminant concentrations of dust and CO_2 swine farrowing rooms.

These data will allow the optimization of an intervention assessment of controls to reduce dust, CO_2 and bioaerosol concentrations to reduce worker and animal exposures.

Acknowledgements

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