Evaluation of Heaters on Air Quality in a Swine Farrowing Building

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Background

During the winter months, Midwestern swine barns are minimally ventilated leading to an increase of carbon dioxide (CO_2) and dust concentrations.

Workers exposed to combinations of these contaminants are at increased risk of developing respiratory illnesses.

CO_2 sources include exhaled breath and heaters.

Dust sources include feed, animal dander, and potentially heaters.

Understanding relative contribution of heater-generated contaminants is important to improving air quality in these buildings.

Objective

Determine whether a heater that vents combustion gases can improve dust and CO_2 concentration in a farrowing barn.

Methods

Sampling Plan:

- 13 days from 12/9/15 - 3/1/16
- Four rooms in an educational swine farrowing building (Cedar Rapids, IA)
- Area monitoring: sampler inlets at breathing zone height (1.5 m)
- Five-minute sampling at each location, random start position selected each test day

Heater Characteristics by Room:

- Farrowing 1 (FR1): Two new vented heaters (Effinity93, Modine Manufacturing Co.)
- Farrowing 2 (FR2) and Nursery: Unvented heaters (Guardian 60, L.B. White Co.)
- Hallway: Previously used a Guardian 60, but was decommissioned; no heater in this room throughout the study period

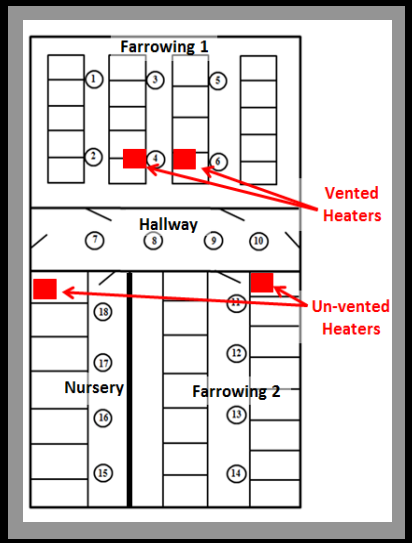

Figure 1: Facility layout and sampling locations

Methods, continued

Air Quality Monitors:

- ToxiRae Pro (RAE Systems): CO_2
- DustTrak 8530 (TSI, Inc.): respirable dust mass concentration
- CPC 3007 (TSI, Inc.): ultrafine particle count concentration

Additional Data Recorded:

- Inside temperature, ventilation factors
- Number of sows and piglets, by crate
- Local metrological data (CID Airport)

Data Analysis:

- Room-average concentrations, computed by day
- t-Tests to compare between room concentrations, paired by day, for room-averages

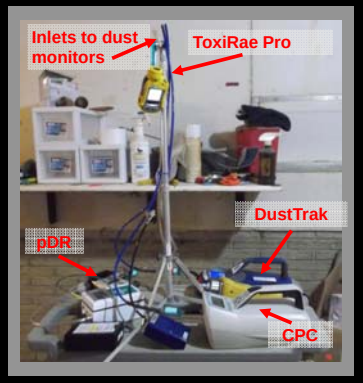

Figure 2: Monitoring cart

Results

Table 1: Mean (range) of room averages over the study period

Room Average	CO_2, ppm	Respirable Dust mg/m³, from DustTrak	Ultrafine, #/cm³, from CPC	# Piglets	# Sows
FR1	**1,450*** (1,200-3,100)	0.3 (0.1-1.6)	**115,100‡** (2,600-2,515,300)	71 (7-146)	14 (6-19)
FR2	2,200 (1,400-2,900)	0.4 (0.1-1.3)	932,600 (7,900-3,502,000)	70 (0-111)	14 (9-17)
Nursery	2,700 (1,700-3,900)	**0.7◊** (0.3-1.8)	1,039,400 (14,000-8,647,600)	75 (65-86)	-
Hallway	2,020 (1,200-3,000)	0.3 (0.1-1.3)	727,100 (13,100-4,340,700)	-	-

*Significantly lower ($p<0.001$) CO_2 concentration in FR1

◊Significantly higher ($p<0.001$) respirable particles in Nursery

‡ Significantly lower ($p<0.02$) ultrafine particles in FR1

Outdoor temperatures ranged from -10.8 to 7.2°C during study period

Results, continued

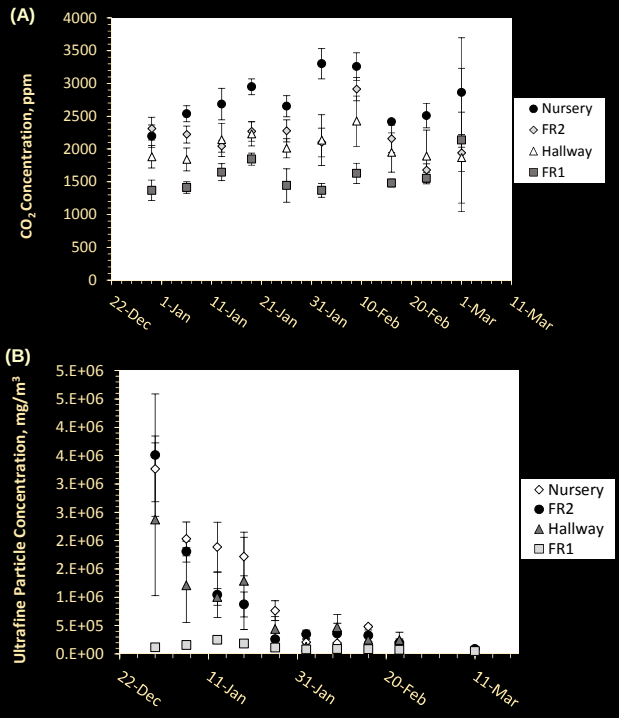

Figure 3: Room-averaged (A) CO_2 and (B) ultrafine particle concentration by sampling date

Conclusions

Study indicates that vented heaters can reduce both CO_2 and ultrafine particle concentrations in wintertime swine buildings.

Differences in respirable dust in the nursery are not due to the heater type.

Additional analysis of these data will compare concentrations nearest the heater and will examine relationship between these two contaminants and building conditions, specifically sow and piglet counts, outdoor temperatures, and other production factors during this winter season.

Acknowledgements

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