Wintertime Indoor Air Quality Monitoring in a Swine Farrowing Barn

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Background

Concentrated animal feeding operation (CAFO) workers are at risk of developing adverse respiratory health effects. Swine CAFO workers proportionally spend more time in farrowing activities than in other operations.

Respirator protection is effective, but respirator use rates are low.

Ventilation with air pollution control (APC) equipment may provide a practical solution for protecting worker health without relying on the worker themselves to take any action.

Treating and recirculating air might be useful to reduce wintertime contaminant concentrations. A ventilation system was field deployed to control dust concentrations.

Objectives

1. Measure wintertime swine barn inhalable and respirable dust concentrations to determine if existing concentrations exceed industry recommended levels.
2. Determine if wintertime swine barn inhalable and respirable dust concentrations are significantly reduced as a result of introducing ventilation and APC equipment (dust filtration, Shaker Dust Collector, United Air Specialists).
3. Compare respirable dust concentrations measured by pDR and gravimetric dust filters to determine adequacy of direct-reading equipment.

Methods

Equipment:
- Thermo Scientific Personal DataRAM (pDR)
- GK 2.69 BGI Cyclone and IOM
- Universal XR pumps (SKC Inc.)

Collection:
- Deployed at 6 stations for 24 hours
- Sampled over the course of 18 days (December - February)
  - APC off - 3 days pre-deployment, 3 days off in middle, 1 day at end
  - APC on - remainder of period, sampled 11 days

Assessments to compare:
- Mean dust concentrations between APC status (T-test)
- Dust concentrations between sampler type (linear regression)

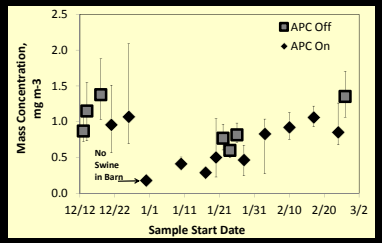
Images of (a) swine farrowing production, (b) return air for ventilation system, (c) samplers in position, and (d) intervention system and sample location

Results

Objective 1:

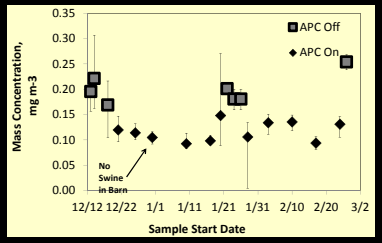
Inhalable Dust

Did *not* exceed the industry recommended limit of 2.8 mg/m³



Respirable Dust (Gravimetric)

Two of the APC-off sampling days had concentrations above the 0.23 mg/m³ limit



Error bars represent minimum and maximum concentration measured from six stations on the indicated sample date.

Results, continued

Objective 2:

Inhalable Dust:
- Mean APC on: 0.67 mg/m³
- Mean APC off: 1.01 mg/m³
- *Significant reduction ($p < 0.001$)*

Respirable Dust:
- Mean APC on: 0.12 mg/m³
- Mean APC off: 0.20 mg/m³
- *Significant reduction ($p < 0.001$)*

Objective 3:

The pDR underestimated gravimetric respirable dust levels:
Gravimetric Mass Concentration = 1.7(pDR) + 0.06
[$R^2 = 0.61$]

A poor relationship between inhalable and respirable dust concentration, even by separating into APC status, was identified. ($R^2 = 0.14$ APC on, 0.33 APC off).

Conclusions

Although inhalable dust concentrations did not approach levels associated with worker health risk with the ventilation system off, operating a ventilation system with recirculated treated air reduced the dust concentrations in the barn by 32% (inhalable) to 40% (respirable).

The pDR may not be a sufficient method to monitor respirable concentrations of dust in swine barns.

Future Research

Future work will assess the effectiveness of ventilation in reducing gaseous contaminants and the consumption of energy during this study.

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