Wintertime Factors Affecting Contaminant Distribution in Farrowing Barns

Kelsie A. Reeve, MS and T. Renée Anthony, PhD
Department of Occupational and Environmental Health, The College of Public Health, The University of Iowa

Background
Exposed to dusts and waste gases generated by swine inside CAFOs, workers have experienced both acute and chronic respiratory diseases:
- Irritation to respiratory tract
- Airflow obstruction
- Bronchial inflammation
- Reduction in pulmonary function
- Chronic bronchitis

Concentrations of dusts and gaseous contaminants differ depending on:
- Size of operation
- Feed and waste handling procedures
- Level of swine activity
- Tasks included in a work shift
- Ventilation practices
- Season

In the Midwest, winter swine confinement operations have little ventilation.

Occupational exposure limits (OSHA, ACGIH) based on time-weighted averages of an 8-hour work shift exist for contaminants found in CAFOs. However, due to the exposure mixture, industry guidelines have been proposed for swine CAFO workers to prevent a decrease in pulmonary function. Personal exposures should be below these limits to prevent illnesses.

Contaminant Exposure Limits

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>OSHA PEL</th>
<th>ACGIH TLV</th>
<th>Industry Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respirable Dust</td>
<td>5 mg/m³</td>
<td>3 mg/m³</td>
<td>0.23 mg/m³</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>5000 ppm</td>
<td>5000 ppm</td>
<td>1540 ppm</td>
</tr>
<tr>
<td>Ammonia (NH₃)</td>
<td>50 ppm</td>
<td>25 ppm</td>
<td>7 ppm</td>
</tr>
<tr>
<td>Hydrogen Sulfide (H₂S)</td>
<td>10 ppm</td>
<td>1 ppm</td>
<td>---</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>50 ppm</td>
<td>25 ppm</td>
<td>---</td>
</tr>
</tbody>
</table>

OSHA – regulatory permissible exposure limit (PEL)
ACGIH – international consensus threshold limit value (TLV)
*Donham, et al. 1989

Study Questions
1. Does the pit fan reduce concentrations?
2. Does concentration change throughout the day?
3. What is the most efficient method to characterize concentrations?

Methods
Measured 5 random days over 3-weeks, in winter, 19-crate farrowing room
- Fixed areas:
  - 7 stations (A-G)
  - Continuously throughout day
- Mobile monitoring for mapping:
  - 43 positions
  - Three 90-minute events per day

Samples were collected from 7:00 AM – 12:00 PM
- Afternoon concentrations were not measured

Results

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respirable Dust, mg/m³</td>
<td>0.28</td>
<td>0.52</td>
</tr>
<tr>
<td>CO₂, ppm</td>
<td>2710</td>
<td>4000</td>
</tr>
<tr>
<td>NH₃, ppm</td>
<td>&lt;0.001</td>
<td>3.61</td>
</tr>
<tr>
<td>H₂S, ppm</td>
<td>0.95</td>
<td>1.30</td>
</tr>
<tr>
<td>CO, ppm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pit fan reduced mean concentration of:
- Respirable dust, mg/m³:
  - Off = 0.47
  - On = 0.33
- CO₂, ppm:
  - Off = 3660
  - On = 2920
- NH₃, ppm:
  - Off = 8.36
  - On = 3.92
- H₂S, ppm:
  - Off = 0.48
  - On = 0.11

Respirable dust levels were highest before 10:00 AM
- Potentially related to feeding time

Every day, CO₂ levels increased over time. Larger increases were seen with the pit fan off.

Recommend not to use a single ‘central barn’ sampler as an indication of average room exposure in a farrowing CAFO.

Conclusions
Contaminant area concentrations did not exceed regulatory occupational exposure limits.
Respirable dust, CO₂, and NH₃ fixed-area station mean concentrations exceeded industry guidelines.

Pit ventilation reduced contaminant concentration in a farrowing barn during winter, but not below industry guidelines for respirable dust, CO₂, and NH₃.

Acknowledgements
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http://www.public-health.uiowa.edu/gpcah/research/center-funded/