A hybrid ventilation system in a dairy cow building in Denmark

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Outline

- Introduction of the cattle barn
- Experimental measurements
- Results
- Conclusion
Introduction of the cattle building

Fig. 1 photo of cattle building and the arrangement of openings
Introduction of the cattle building

Fig. 2 sketch of cattle and milking building
Introduction of hybrid ventilation

Fig. 3 Introduction of hybrid ventilation system
Experimental measurements

Fig. 4 Location of measuring concentration and air velocity
Experimental measurements

Velocity:
Windmaster 3-Axis Ultrosinc Anemometer, Gill instruments

Concentration:
Photoacoustic multi-gas analyzer INNOVA 1312 and Multipoint sampler INNOVA 1309
Proton Transfer Reaction – Mass Spectrometry (PTR-MS)

Temperature:
Type T thermocouples

Ventilation rate in Pitvent:
Measuring fans
Results

Fig. 5 Indoor and pit NH$_3$ concentration and indoor temperature

Fig. 6 Relationship between indoor CO$_2$ and CH$_4$ concentration
### Results - Daily emissions

<table>
<thead>
<tr>
<th>Period</th>
<th>Gas</th>
<th>Emission (g HPU⁻¹ d⁻¹)</th>
<th>Emission (g LU⁻¹ d⁻¹)</th>
<th>Emission (g m⁻² d⁻¹)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>02/20/2013-03/13/2013</td>
<td>Building NH₃</td>
<td>4.53</td>
<td>1.49</td>
<td>4.95</td>
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<tr>
<td></td>
<td>CH₄</td>
<td>129.25</td>
<td>34.11</td>
<td>141.34</td>
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<td>Pit NH₃</td>
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<td>1.24</td>
<td>24.17</td>
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<td></td>
<td>CH₄</td>
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</table>

* The emission was summarized as gram per day per square meter of slatted floor, which was 1421.5 m² in the cattle building
Fig. 7 effect of wind speed and angle and temperature difference between indoor and outdoor on ACH. Above was in summer, below was in winter.
Results

Fig. 8 variation of ACH, outdoor temperature and percent of opening ratio with time
Conclusion

- NH$_3$ concentration in the building was much lower than NH$_3$ concentration in the pit.
- Pit ventilation could collect 64% of NH$_3$ emissions in summer and 83% of NH$_3$ emissions in winter.
- ACH increased with larger wind speed generally. In summer, ACH was influenced by wind angle (90-270) while it was not influenced by wind angle in winter. ACH decreased when the temperature difference between indoor and outdoor increased.
Thank you!