Mitigation of Ammonia Emissions from Poultry

Robert Burns
rburns@utk.edu
University of Tennessee

Hongwei Xin
hxin@iastate.edu
Iowa State University

Part I: Mitigation through Housing & Manure Handling and Dietary Manipulation

Hongwei Xin, Professor
Iowa State University
Director, Egg Industry Center
hxin@iastate.edu

Sources of Emission Mitigation

- **Pre-excretion**
  - Dietary manipulation
  - Feed or water additives
  - Genetics

- **Post-excretion**
  - Housing and manure handling schemes
  - Indoor treatment (to reduce generation)
  - Exhaust treatment (to reduce emission)

The archived presentation is available at:
http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
Post-excretion Mitigation

Housing and Manure Handling Schemes

High-Rise Hen House

Manure-Belt House + Manure Storage

The archived presentation is available at:
http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
Forced Air Drying of Manure on Belt

Supplemental Air Drying Chamber

U.S. Layer & Pullet Housing Style Distribution (2008)

<table>
<thead>
<tr>
<th>Housing Style</th>
<th>Birds (millions)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure-belt</td>
<td>71</td>
<td>24%</td>
</tr>
<tr>
<td>High-rise</td>
<td>207</td>
<td>69%</td>
</tr>
<tr>
<td>Shallow pit</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Cage-free</td>
<td>17</td>
<td>6%</td>
</tr>
<tr>
<td>Total</td>
<td>298</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing Style</th>
<th>Birds (millions)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure-belt</td>
<td>22</td>
<td>21%</td>
</tr>
<tr>
<td>High-rise</td>
<td>73</td>
<td>70%</td>
</tr>
<tr>
<td>Shallow pit</td>
<td>&lt;1</td>
<td>0%</td>
</tr>
<tr>
<td>Cage-free</td>
<td>9</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>100%</td>
</tr>
</tbody>
</table>

The archived presentation is available at:
http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
U.S. Trend in Layer Cage Systems

High-rise vs. Manure Belt Layer House NH₃ Emission Rate

Factors Contributing to Lower Emissions of MB Systems

- Reduced manure residence time and hence its decomposition in the hen house
- Reduced emission surface area in storage
- Generally cooler environment in storage
- Drying manure

AU = animal unit = 500 kg live body weight

The archived presentation is available at:
http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
NH₃ Emission (g/hen-d) vs. Hen Manure Accumulation Time

\[ y = 0.0027x^2 + 0.025x \]

\[ R^2 = 0.998 \]

Source: Ning (2008)

NH₃ Emission (g/bird-d) vs. Manure Accumulation Time at Different Ages

Source: Mendes (2010)

Effect of Stacking Configuration on NH₃ Emissions from Hen Manure Storage

Source: Li & Xin (2010)

The archived presentation is available at:
http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
Effects of Hen Manure Moisture & Air Temperature on NH₃ Emission

Source: Li & Xin (2010)

Some Practical Aspects of Manure-Belt Layer Systems

- Higher construction costs (~50% more)
- Potentially higher maintenance needs due to longevity of manure belt and conveying system
- Need of separate manure storage facility

New vs. Built-Up Litter of Broiler Houses on NH₃ Emissions

<table>
<thead>
<tr>
<th>Broiler (4.6 lb, 40 d)</th>
<th>Heavy Broiler (5.4 lb, 49 d)</th>
<th>Roaster (7.2 lb, 63 d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built-up</td>
<td>New</td>
<td>Built-up</td>
</tr>
<tr>
<td>25</td>
<td>17</td>
<td>38</td>
</tr>
<tr>
<td>Built-up</td>
<td>New</td>
<td>Built-up</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>63</td>
</tr>
<tr>
<td>New</td>
<td></td>
<td>New</td>
</tr>
<tr>
<td>32%</td>
<td>26%</td>
<td>21%</td>
</tr>
</tbody>
</table>

Emission unit: g NH₃/bird marketed

Note: New bedding does not necessarily change max daily NH₃ emission.

Gates et al. (2007)
Cumulative per Bird NH$_3$ Emission of Commercial Broiler Houses

Controlling NH$_3$ Level to 25-30 PPM in Broiler Houses via Ventilation

Factors to Consider in Using New vs. Built-Up Litters

- Availability and price of bedding materials
- Higher energy cost helps offset high price of bedding, hence may justify its use every flock.
- Improved bird health and performance
- Built-up litter requires more ventilation to control NH$_3$ level – likely increase emissions.
- Break-even LP gas price in 1992 was $0.75/gal. Analysis based on current pricing is needed.

The archived presentation is available at: http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
Pre-excretion Mitigation

Dietary Manipulation

Dietary Effect on NH₃ Emission of High-Rise Layer Houses

1% lower CP → 11% reduction in NH₃ emission

<table>
<thead>
<tr>
<th>NH₃ ER (g/phen-d)</th>
<th>Standard Diet</th>
<th>LP Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90 (0.24-1.58)</td>
<td>0.80 (0.19-1.37)</td>
<td></td>
</tr>
</tbody>
</table>

Roberts et al. (2007)

SUMMARY

• Frequent removal of manure from animal houses improve IAQ and reduce house-level emissions.
• Daily ammonia emission increases with hen manure accumulation time (1 - 7 days).
• Reducing manure storage surface area reduces ammonia emissions.
• Ammonia emissions increases with higher manure moisture and ambient temperature.

The archived presentation is available at:
http://www.extension.org/pages/Controlling_Ammonia_and_Air_Emissions_in_Poultry_Facilities
SUMMARY

- Nutritionally balanced hen diets with lower crude protein helps reducing ammonia emissions w/o adverse impact on production performance.
- EcoCal (7%) and DDGS (10%) diets have been shown to reduce ammonia emissions from high-rise layer houses by 39% and 14%, respectively, based on a 2-year field study.
- The EcoCal diets showed economic advantages over control or DDGS diet.