Importance of Ventilation for Pig Comfort

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Basic Environmental Factors & Their Effects on Pigs

Thermal Environment of the Pig

- Air temperature seldom temperature pig feels
  - Air speed
  - Humidity
  - Group size
  - Building materials, design, surface temperature (insulation)
- Effective Environmental Temperature (EET)
  - What pig really feels
  - Combined influence of many factors

Heat Exchange Between a Pig & It’s Surroundings

- 4 basic forms of heat transfer for the pig
  - Conduction
  - Convection
  - Radiation
  - Evaporation

* Understanding how a pig gains/loses heat is the key to providing the pig with the optimum environment and comfort

Effect of air temp on rectal temp, respiration rate, & pulse rate of growing pigs

LCT, UCT, & TNZ

- Lower Critical Temperature (LCT)
  - Consume more feed
  - Apply extraordinary measures to keep warm
- Upper Critical Temperature (UCT)
  - Suppress feed intake
  - Apply extraordinary measures to stay cool
- Thermal Neutral Zone (TNZ)
  - EET that optimizes production efficiency
**Thermal Neutral Zone, Upper & Lower Critical Temperatures**

- **Cold Stress:** 0°F to 75°F
- **Heat Stress:** 75°F to ??°F

**Cold Stress**
- Meal intake
- Feed/gain
- ADG, lbs

**Heat Stress**
- TNZ
- UCT

**Heat Stress and the Breeding Herd**

<table>
<thead>
<tr>
<th>Month</th>
<th>Heat Stress</th>
<th>Litters affected by heat stress on sows</th>
<th>Reduced boar fertility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul</td>
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<td></td>
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<td>Aug</td>
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<td>Sep</td>
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<td>Oct</td>
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<td>Nov</td>
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<td>Dec</td>
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<td>Jan</td>
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<td></td>
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<tr>
<td>Feb</td>
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</tr>
</tbody>
</table>

**Ventilation Systems Affect:**
- Air temperature
- Fluctuation
- Uniformity
- Moisture and contaminant levels
  - Dust and disease organisms
  - Gas concentrations (odor, unvented heaters)
- Air speed across animals
- Surface conditions
  - Temperature, condensation, drying, etc.

**Conventional, Negative-Pressure Ventilation Systems**
- Exhaust fans
- Air inlets
- Controls
- Total [HVAC] system
  - Heaters
  - Evaporative cooling

**Exhaust Fans**
- Select # and size for cold, mild, and hot weather
- Place so not exceeding suggested maximum spacings.
  - Centrally along regions of room
  - Away from corners of room
  - In banks (groups) for ready wiring & access

**Recommended Ventilation Rates (cfm/pig)**

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Mild</th>
<th>Hot weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow &amp; Litter (cfm/sow)</td>
<td>20</td>
<td>80</td>
<td>500</td>
</tr>
<tr>
<td>Finishing 150-250#</td>
<td>10</td>
<td>35</td>
<td>120</td>
</tr>
<tr>
<td>Gestating Sows</td>
<td>12</td>
<td>40</td>
<td>150</td>
</tr>
<tr>
<td>Breeding Sows</td>
<td>14</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Boars</td>
<td>14</td>
<td>50</td>
<td>300</td>
</tr>
</tbody>
</table>

MWPS
Choosing Fans for Your facilities

Or
access fan data online at:
www.bess.uiuc.edu

www.mwps.org to order

Fan Test Data

<table>
<thead>
<tr>
<th>Static pressure</th>
<th>Speed</th>
<th>Airflow</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>in. H2O</td>
<td>rpm</td>
<td>cfm</td>
<td>cfm/W</td>
</tr>
<tr>
<td>0.00</td>
<td>520</td>
<td>24,600</td>
<td>21.4</td>
</tr>
<tr>
<td>0.05</td>
<td>520</td>
<td>22,800</td>
<td>19.3</td>
</tr>
<tr>
<td>0.10</td>
<td>520</td>
<td>21,000</td>
<td>17.5</td>
</tr>
<tr>
<td>0.15</td>
<td>520</td>
<td>18,900</td>
<td>15.5</td>
</tr>
<tr>
<td>0.20</td>
<td>520</td>
<td>16,100</td>
<td>13.4</td>
</tr>
</tbody>
</table>

BESS Lab

Effect of Drive Belt Tension
48-inch Fan

Air Inlets

- Room
  - Place for even air distribution
  - Size for capacity to meet maximum ventilation needs
  - Include ability to adjust properly
- Attic/building air intake?
  - Ensure there is enough!

As Always, Inlets Are Key.

Powered Inlets
Weighted or Velocity Inlets
Negative Pressure Inlets and Open Doors

- 24 crate farrowing room has 12,000 cfm of summer capacity (500 cfm/crate)
  - 15 ft² of total inlet capacity needed to maintain inlet velocity at 800 fpm.
- One 6ft 8in x 3 ft walk-in door left open
  - Inlet capacity to room increases by 20 ft² and inlet velocity drops to 342 fpm.

When to turn on stirring fans?

- When used for cooling: 3-5°F lower than drip cooling or sprinkling (75-78°F)
  - Goal is to first use direct airflow to cool the pigs, then add water for evaporative cooling.
- If making up for poor air distribution, some fans can always be on, but they must be re-oriented (along ceiling) for colder weather.
Evaporative Cooling Pads (KoolCell Pads)

- Incoming air drawn through wet pads
- Air evaporates water from pads
  - Temp reduced
  - Moisture increased
- Temperature will decrease until RH nears 85%.
- When incoming air is humid (relative humidity >70%), air temp decrease will only be 5-10 F.
- When incoming air is relatively dry (<55% RH), air temp reduction may be 15 F or more.

Impact of Relative Humidity on Effectiveness of Evaporative Cooling

<table>
<thead>
<tr>
<th>Outside Temp (F)</th>
<th>30</th>
<th>50</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad Exit Temp (F)</td>
<td>76</td>
<td>62</td>
<td>66</td>
</tr>
<tr>
<td>84</td>
<td>67</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td>92</td>
<td>73</td>
<td>79</td>
<td>85</td>
</tr>
<tr>
<td>100</td>
<td>79</td>
<td>87</td>
<td>93</td>
</tr>
</tbody>
</table>

Design of Evap Coolers

Pad efficiency drops sharply at >400 fpm

850 females x 250 = 212,500 CFM
8 x 60 x 300 = 445 fpm

6 ft pad height
212,500 / 445 = 480 fpm
531.25 ft² / 6 ft high = 88.5 in feet

Sizing Tunnel Ventilation: Gestation

Use the Higher Fan Capacity:

1) Producing desired airspeed
   \[ \text{Ceiling height} \times \text{Room width} \times \text{Desired velocity} \]
   \[
   \frac{8 \text{ ft} \times 60 \text{ ft}}{300 \text{ ft/min}} = 144,000 \text{ cfm}
   \]

2) Producing desired air exchange
   \# females x 250 cfm/pig
   
   500 hd x 250 cfm/hd = 125,000 cfm \rightarrow 260 fpm
   
   850 hd x 250 cfm/hd = 212,500 cfm \rightarrow 445 fpm

Evaporative Pad Cooler Issues

- Uneven Wetting
- Water Quality
  - Algae growth – use dilution of copper sulfate
  - Mineral deposits
    - Routinely drain 10-15%
    - Alternative – muratic acid or vinegar in water
- Covers
  - Static pressure control point
  - Winter

Evaporative or Direct Cooling

• Wetting the pig and then allowing moisture to evaporate off provides substantial cooling (1050 BTU's lost for every lb of water evaporated)
• Good systems wet the pig & allow the water to evaporate
  – Increased air speed
  – Lower humidity = increased evaporation so want intermittent wetting
• Sprinkling & dripping

Sprinklers

• Used for grow-finish pigs
• Want time interval & nozzle size to deliver 1 gal of water/hr/10 pigs

Sprinklers

• Start sprinkling at 80 °F & wet all pigs
• Once pigs are wet, stop sprinkling and allow water to evaporate off
• If continually wetting, relative humidity in the barn will rise & evaporation will decrease

Sprinklers

• Non-corrosive nozzles
• Should provide a solid cone of water droplets
• Do NOT want a “fogger”
  – Fogger cools the air
  – Raises relative humidity & decreases evaporation
• Sprinkler cools the animal
• Place nozzle 6’ above the dunging area

Sprinkler vs Fogger

80 °F set point

<table>
<thead>
<tr>
<th>Control (no cooling)</th>
<th>Fogger (small droplets, always on)</th>
<th>Sprinkler (1 on, 29 off)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG, lb (I)</td>
<td>1.15</td>
<td>1.28</td>
</tr>
<tr>
<td>ADG, lb (II)</td>
<td>1.44</td>
<td>1.56</td>
</tr>
</tbody>
</table>

[I] = 150 lb at test
[II] = 150 lb at test
K State, 1983
Drip Cooling for Sows

Water Drip and Sow Performance

<table>
<thead>
<tr>
<th></th>
<th>Drip Off</th>
<th>Drip On</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF, lb/d</td>
<td>7.8</td>
<td>12.3</td>
</tr>
<tr>
<td>Wt loss, lb</td>
<td>47</td>
<td>31</td>
</tr>
<tr>
<td>Days to estrus</td>
<td>5.2</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Drip Cooling

- Emit small droplets of water on neck & shoulders (areas of high blood flow)
- Preferred method of cooling lactating sows
  - Cool the sows but keep piglets warm & dry

Drip Cooling

- Start at 80 °F
- Drippers should provide .5-1.0 gal/hr
  - sized for minimal runoff from sow
- Dripper should be placed 20” behind front headgate
  - Reduces feed wetting
  - Keeps young pigs dry
  - Wets a “high bloodflow” area
- Make sure creep area stays dry

Atomizer Cooling

Summary

- Evaporative cooling is most effective cooling system for swine
- Water needs to be properly placed and at the correct flow rate
- Increased air speed & lower humidity greatly increase evaporative heat loss
- Sprinklers for G-F pigs & drippers for sows
Thank You

Questions???