Managing Your Unseen Employee: The Ventilation System

Pigs are VERY adaptable to their environment

Keeping Pigs Eating in Hot Weather
Dr. Bob Thaler, South Dakota State University
605-688-5011  robert.thaler@sdstate.edu

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

Thermal Neutral Zone, Upper & Lower Critical Temperatures

Response to Heat Stress

Figure 1: Adaptation of pigs to increasing temperatures; the temperature scale should be read from left to right.
Hot Weather and Added Fat

- If feed intake decreases – energy and amino acid intake decreases
- Dietary fat
  - Less heat of digestion than feed grains (corn)
  - 2.25x energy of corn
  - Can increase bridging of meal diets

Nutrient Levels Need to be Adjusted for Changes in Feed Intake

Hot Weather and Synthetic AA’s

- Synthetic AA’s
  - Include lysine, threonine, methionine, tryptophan
  - Less heat of digestion than intact protein (SBM)

Hot Weather and Diet Ingredients

- Added fat and synthetic AA’s produce less heat for the pig to get rid of
  - Summer diets must contain same lysine:ME ratios as normal diets
  - No benefit from added vitamins/minerals

Effect of Paylean During Heat Stress

<table>
<thead>
<tr>
<th></th>
<th>May 2003 (n=880)</th>
<th>August 2003 (n=870)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High/Low Temp, °F</td>
<td>76 - 66</td>
<td>92 - 80</td>
</tr>
<tr>
<td>Day 0 BW, lbs</td>
<td>220</td>
<td>215</td>
</tr>
<tr>
<td>ADG, lbs</td>
<td>2.31</td>
<td>2.33</td>
</tr>
<tr>
<td>ADFI, lbs</td>
<td>6.10</td>
<td>6.11</td>
</tr>
<tr>
<td>F/G</td>
<td>2.64</td>
<td>2.64</td>
</tr>
</tbody>
</table>
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**Thermal Environment of the Pig**

- Dry bulb 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**
  - **Radiation**
  - **Convection**
  - **Evaporation**

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

**Conduction**

- Transfer of heat by physical contact with another surface
- 10-15% of heat loss

- **Main components:**
  - Core-to-floor temp difference ($\Delta T$)
  - Conductivity of floor
    - Concrete vs plastic vs aluminum
  - Contact area between pig & floor

**Radiation**

- Transfer of heat to a surface without direct contact
- 30-50% of total heat loss

- **Main components:**
  - Pig’s surface area exposed to other surfaces
  - Difference in temperature between pig & surface ($\Delta T$)

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**Uninsulated Concrete Sidewalls**

- $80^\circ F$ Room
- $95^\circ F$ Outdoors
- $90^\circ F$ Surface

**Insulated Concrete Sidewalls**

- $80^\circ F$ Room
- $95^\circ F$ Outdoors
- $82^\circ F$ Surface

Heat Flow
Managing facilities for heat relief is different in September than in June.

Note how inside temperature lags outside temps – large thermal mass in Sept.

Data courtesy: dicamusa.com

Record daily high and low temperatures. However, this doesn’t tell you patterns within 24 hrs.

**Convection**

- Transfer of heat by physical contact with fluid (air, mud, or water) that is at a different temperature than that of the pig
- 35% of total heat loss

- **Main components:**
  - Surface-to-fluid temperature difference (ΔT)
  - Speed of the fluid
  - Contact area with the fluid

- **Examples:**
  - Cold drafts
  - Fans blowing to reduce heat stress

**EET as Affected by Pig Wt and Air Speed**

- Young pigs
  - Greater surface area:weight ratio
  - Less fat (insulation)
  - Greater heat transfer

**Maximum heat transfer occurs at 3.5 mph (310 fpm)**
EET as Affected by Pig Wt and Air Speed

- As temperature increases, effect of higher air speeds decreases
- If pig temp & air temp are equal, NO heat can be lost via convection

Recommended Ventilation Rates

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum</th>
<th>Hot weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow &amp; Litter</td>
<td>20 cfm/sow</td>
<td>500 cfm/sow</td>
</tr>
<tr>
<td>Nursery 12-30#</td>
<td>2 cfm/pig</td>
<td>25 cfm/pig</td>
</tr>
<tr>
<td>Nursery 30-75#</td>
<td>3 cfm/pig</td>
<td>35 cfm/pig</td>
</tr>
<tr>
<td>Finishing 75-150#</td>
<td>7 cfm/pig</td>
<td>75 cfm/pig</td>
</tr>
<tr>
<td>Finishing 150-250#</td>
<td>10 cfm/pig</td>
<td>120 cfm/pig</td>
</tr>
<tr>
<td>Gestating</td>
<td>12 cfm/sow</td>
<td>150 cfm/sow</td>
</tr>
<tr>
<td>Breeding</td>
<td>14 cfm/sow</td>
<td>300 cfm/sow</td>
</tr>
</tbody>
</table>

Effect of Wind Direction on Airflow in Curtain Sided Facilities

Stirring Fans

Stir Fan Placement
Cross-flow fans blowing S to N

- Once a pig gets to 50 lbs, it starts feeling heat stress above 70 °F, and losses occur above 85 °F.
- At higher temperatures, little body heat is lost via conduction, convection (unless a evaporative pad is utilized), and radiation.
- If the pig is to survive in hot conditions, it must lose heat through evaporation.

**Evaporation**

- Transfer of heat by water conversion to vapor
- Drippers & sprinklers
- Main components:
  - Relative humidity
  - Air temperature
  - Air speed
  - Wetted surface area
  - Volume of air respired

**Evaporative or Direct Cooling**

- Wetting the pig and then allowing moisture to evaporate 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

**Sprinklers or Fans?**

<table>
<thead>
<tr>
<th></th>
<th>Fan 500 fpm 78 F</th>
<th>Sprinkler 2 min on 10 min off 78 F</th>
<th>Fan + Sprinkler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>ADG, lb</td>
<td>F/G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.51</td>
<td>1.62</td>
<td>1.68</td>
</tr>
<tr>
<td></td>
<td>3.29</td>
<td>3.27</td>
<td>3.13</td>
</tr>
</tbody>
</table>

**Sprinklers for Grow-Fin**

- Start sprinkling at 80 °F & wet all pigs – goal is:
  - 2 min on-time
  - 60% pen coverage
- Once pigs are wet:
  - STOP sprinkling
  - allow water to evaporate
- If continually wetting:
  - relative humidity will rise
  - evaporation will decrease

Turner et al, 1997
Sprinkler vs Fogger

<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</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.30</td>
<td>1.42</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Nichols et al., 1986

Sprinklers

- Non-corrosive nozzles
- Provide a solid cone of water droplets – 60% pen coverage
- DO NOT use a “fogger”
  - Foggers cool the air
  - Raise relative humidity & decrease evaporation
- Wetting and drying cools the animal
- Place nozzle 6’ above the dunging area

Timers on sprinklers allow for drying

Sprinklers

- Want combination of interval + nozzle size to equal 1 gal of water/hr/10 pigs (0.1 gal/pig/hr)
- Large facilities – total flow (gpm) at one time is an issue

Edstrom controller to control 4 solenoids in sequence

Recommended Flow Rates

<table>
<thead>
<tr>
<th>Pigs/Pen</th>
<th>On/Off Interval</th>
<th>On/Off Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 min/10 min</td>
<td>1 min/30 min</td>
</tr>
<tr>
<td>10</td>
<td>.017 gal/min</td>
<td>.10 gal/min</td>
</tr>
<tr>
<td>20</td>
<td>.033 gal/min</td>
<td>.20 gal/min</td>
</tr>
<tr>
<td>30</td>
<td>.050 gal/min</td>
<td>.30 gal/min</td>
</tr>
</tbody>
</table>

Nozzle Size Recommendations

<table>
<thead>
<tr>
<th>Pigs/Pen</th>
<th>Nozzle Size, gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>.20</td>
</tr>
<tr>
<td>20</td>
<td>.40</td>
</tr>
<tr>
<td>30</td>
<td>.60</td>
</tr>
<tr>
<td>40</td>
<td>2 nozzles at .40</td>
</tr>
<tr>
<td>50</td>
<td>2 nozzles at .50</td>
</tr>
</tbody>
</table>

MWPS-34
Evaporative Pad Coolers

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 RH%</th>
<th>Outside Temp (F)</th>
<th>Pad Exit Temp (F) 80% efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Temp (F)</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>76</td>
<td>62</td>
<td>66</td>
</tr>
<tr>
<td>84</td>
<td>67</td>
<td>73</td>
</tr>
<tr>
<td>92</td>
<td>73</td>
<td>79</td>
</tr>
<tr>
<td>100</td>
<td>79</td>
<td>87</td>
</tr>
</tbody>
</table>

Meyer and Van Fossen, ISU, 1971

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

Average Temperature Decrease with Evaporative Cooling

Average room temperature drop from maximum outdoor temperature, July.

Exchange with the Environment

Goal is to minimize the amount of energy a pig spends to maintain its core temperature in spite of all these factors.
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Summary

• Diet issues
  – Paylean
  – Fat
  – Amino Acids
• Begin wetting at 80°F
• Let the pig dry
• Increase air flow in the pig zone

Questions???