Managing Your Unseen Employee:
The Ventilation System

HVAC Systems

- **Basic ventilation**
  - Wall openings / Curtains
  - Ridge vents
  - Wall and/or pit fans
  - Room and attic inlets
- **Heaters**
  - Room heat
  - Zone heat
- **Cooling systems**
  - Supplemental cooling fans, tunnel fans
  - Sprinklers, drippers, evaporative pads

Who’s in Control?

It’s convenient to use factory/installer settings, but the manager of a swine unit is ultimately responsible for the environment produced.

Objectives

- Better understand terminology used in setting controllers
- Increase confidence in adjusting controller settings
- Improve capability to enhance pig environment and performance

What kind of information does your controller need?

- **Activation temperatures**
  - Temperatures at which stages are activated or deactivated
- **Temperature increments**
  - Changes in temperature that result in stages being activated or deactivated
- **Other information**
  - Time lags
  - Minimum settings
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**Set-Point Temperature**
- **Target temperature for controller**
- Not the average room temperature
- **Other settings are generally based on the set-point temperature**

<table>
<thead>
<tr>
<th>Room and Stage (lb.)</th>
<th>Stage-1</th>
<th>Stage-2</th>
<th>Stage-3</th>
<th>Stage-4</th>
<th>Stage-5</th>
<th>Stage-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry sow</td>
<td>63</td>
<td>66</td>
<td>69</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Farrowing</td>
<td>61</td>
<td>64</td>
<td>57</td>
<td>64</td>
<td>68</td>
<td>63</td>
</tr>
<tr>
<td>Nursery (15 lb.)</td>
<td>79</td>
<td>82</td>
<td>77</td>
<td>81</td>
<td>84</td>
<td>79</td>
</tr>
<tr>
<td>Nursery (45 lb.)</td>
<td>73</td>
<td>75</td>
<td>72</td>
<td>75</td>
<td>79</td>
<td>72</td>
</tr>
<tr>
<td>Grow/finish (55-130)</td>
<td>64</td>
<td>68</td>
<td>61</td>
<td>66</td>
<td>70</td>
<td>64</td>
</tr>
<tr>
<td>Grow/finish (130-220)</td>
<td>57</td>
<td>61</td>
<td>54</td>
<td>61</td>
<td>63</td>
<td>59</td>
</tr>
<tr>
<td>Grow/finish (55-220)</td>
<td>64</td>
<td>66</td>
<td>63</td>
<td>66</td>
<td>70</td>
<td>64</td>
</tr>
</tbody>
</table>


**Sensor Location**
- **Sensors should be placed to represent the temperature in the pig space.**
- The set-point temperature may need to be adjusted to account for sensor location.

**Setting the Set Point**
- Most controllers have the set-point temperature setting situated near the display of room temperature
  - **Dial setting**
  - **Push-button sequence**

**Temperature Differential**
**Temperature difference (hysteresis) allowed before activation of a stage**
- A fan comes on or speed increases
- A curtain begins to drop, heater turns on, sprinklers activated, etc.

**Setting the Differential: Direct Method**
- **User selects the temperature increment, \( \Delta T \)**

- **Controller calculates activation temperature**
  \( \text{Ex.: Stage activation Temp.} = 82 \, ^\circ\text{F} + 2 \, ^\circ\text{F} = 84 \, ^\circ\text{F} \)
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**Setting the Differential: Indirect Method**

- **User selects activation temperature**
  
  **Example:**
  - Set-point $T = 82^\circ F$
  - Stage 1 activated at ?
    - Enter: $84^\circ F$
  
  - **Controller calculates the differential**
    - Ex.: Differential = $84^\circ F - 82^\circ F = 2^\circ F$

**Setting the Offset**

- **Temperature increment that is used to:**
  - Accommodate lags
    - e.g. rooms w/large heaters
  - Prevent systems from operating simultaneously
    - Heating & curtains / wall fans

**Setting the Offset:**

- **User selects the offset temperature increment, $\Delta T$**
  
  **Example:**
  - Heater offset = ?
    - Enter: $0.5^\circ F$
  - Heating differential = ?
    - Enter: $1.5^\circ F$
  
  - **Controller calculates activation and deactivation temperatures**
    - Ex.: Activation Temp.: $82^\circ F - 0.5^\circ F - 1.5^\circ F = 80^\circ F$
    - Deactivation Temp.: $82^\circ F - 0.5^\circ F = 81.5^\circ F$

**3-Stage Control with Single-Speed Fans**

**Heating Offset**

- **Establisches a new basis for heating differentials**
  
  **Heater Stage Control**
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**Ramped Control**
- Stage output varies with temperature
  - Variable-speed fans
  - Variable-output heaters
  - Some curtain controllers
- Output commonly expressed as % of Max. output

**Bandwidth**
The temperature increment defining the temperature range over which output is to vary.

\[ \Delta T = T_{upper} - T_{lower} \]

**Ramped Stage Output**
Primary function is to moderate output to better suit the thermal needs of the animals.

**Control of Variable-Speed Fans**
- Range of fan output
  - Set indirectly
  - Minimum & maximum %
- Temperature range for change to occur
  - Set directly
  - Differential
  - Bandwidth (ramp length)

**Model Scenario: 2 V-S & 2 S-S Fans**

**Control of Variable-Speed Fans**
- What is being adjusted?
  - Generally voltage
  - Voltage affects speed which affects airflow rate (cfm)
- Does % value shown = voltage %?
  - Generally no
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Variable-Speed Controllers

Results from the Air Dispersion Lab, ISU

Variable-Speed Fans: Getting Control

- Without adjusting a motor curve
  - Conduct trial runs with empty room, a high fan differential/offset, and a variety of minimum %.
  - Sense the % range over which most of the rise in output occurs.
- With adjustment of motor curve
  - Select a motor curve that has a better linear fit of controller % vs. voltage.
  - In either case,
    - Determine an acceptable minimum setting.
    - May want to control the fan to operate in the % range over which most of the rise in output occurs.

Selecting an Operating Range for Improved Control of V-S Fans

Buffering of Stages

- When a new fan stage is activated, the operating variable-speed fans are dropped back to minimum speed, then slowly ramp back up.
- Reduces ‘shock effect’ of activating large fans

Buffered Scenario: V-S & S-S Fans

Influenced Settings

- Shifting of activation temperatures occurs during certain conditions.
  - Cold outside air temperature
  - Extended periods at maximum ventilation
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Ventilation Curves

- Automated adjustment of activation temperatures with time [growth].
- Need to establish “bend points” and settings

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activation Temperature</th>
<th>Ideal Curve</th>
<th>Actual Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days in room</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Sometimes used to achieve a lower rate of air exchange than can be delivered by the installed fan(s)
- Generally not recommended for controlling fans in humid livestock environments
- Results in a lot of fluctuation in conditions
- Useful for controlling sprinklers and other events that are intended to occur intermittently

On/Off or Cycle Timers

- Use of On/Off or Cycle Timers can result in a lot of fluctuation in conditions
- Useful for controlling sprinklers and other events that are intended to occur intermittently

Cooling Fan & Sprinkler Control Using a Cycle Timer

If your controller has an adjustable cycle timer, consider using this feature to counter heat waves.

<table>
<thead>
<tr>
<th>Set point</th>
<th>Differential 1</th>
<th>Differential 2</th>
<th>Differential 3</th>
<th>Differential 4</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtains start to drop</td>
<td>Cooling fans activated</td>
<td>Sprinklers activated @ 1/30 minutes</td>
<td>Sprinklers activated @ 1/15 minutes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions??