MAXIMIZING FACILITY PERFORMANCE WITH INNOVATIVE HVAC & IRRIGATION SYSTEMS

Moderator: Michael Thomas, Denver Water
Panelists:
Keith Coursin, Desert Aire
Brandy Keen, Surna
Lucas Targos, urban-gro
HVAC Challenges

● Growers and HVAC industry speak different languages
● What are best design conditions
  • Maximize yield
  • Eliminate mold/mildew
  • Minimize cost
● Unique and variable loads
  • Lights on
  • Lights off
Transpiration

- Leaf temperature determines the vapor pressure in the leaf
- Air temperature and humidity determine the vapor pressure in the air
- Differential pressure drives transpiration – force for nutrients to be brought to upper areas of plant
Transpiration

- Boundary Layer
- Cuticle
- Epidermis
- Sub-stomatal Cavity
- Mesophyll (Chloroplasts)

CO$_2$ → H$_2$O
Key HVAC Design Elements

- Maintain temperature
- Maintain humidity
  - Eliminate possibility of mold/mildew
- Maintain air turnover
  - Homogenous environments
  - Eliminate microclimates under canopies
Vapor Pressure Deficit

- VPD
  - Called Vapor Pressure Difference by HVAC
- Defined by combination of two parameters
  - Temperature
  - Absolute humidity (not relative humidity)
- Deficit or Difference
  - Pressure exerted at room conditions vs. pressure at saturation
  - Indicator of Evapotranspiration potential
Low VPD

- Occurs at higher RH values
  - Higher dewpoints @ constant temperature
- Stomata close because transpiration is impaired
- Results
  - Water droplets/condensation on leaves
  - High probability of mold/mildew formation
  - Yield reduced
High VPD

● Occurs at lower RH values
  • Lower dewpoints @ constant temperature
● Plant wants to transpire at maximum rate
● However, stomata close to avoid dehydration
● Results
  • Yield is reduced
  • Plant health compromised
VPD Impact on HVAC

● Cooling
  • VPD has only small impact on performance of the cooling function
  • Dehumidifiers without cooling can add to load

● Dehumidification
  • VPD has large impact
  • Lower dewpoint air makes it harder to condense moisture
  • A larger machine is required
# Lights On – Dehum. Load

## Impact on unit size @ various design conditions

<table>
<thead>
<tr>
<th></th>
<th>Example #1</th>
<th>Example #2</th>
<th>Example #3</th>
<th>Example #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (F° db)</td>
<td>82</td>
<td>78</td>
<td>74</td>
<td>70</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>62%</td>
<td>57%</td>
<td>51%</td>
<td>44%</td>
</tr>
<tr>
<td>Wet Bulb (F)</td>
<td>71.9</td>
<td>67.0</td>
<td>61.9</td>
<td>56.8</td>
</tr>
<tr>
<td>Dewpoint (F)</td>
<td>67.7</td>
<td>61.6</td>
<td>54.7</td>
<td>47.1</td>
</tr>
<tr>
<td>VPD (kPa)</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>HVAC Size (nominal tons)</td>
<td>34</td>
<td>36</td>
<td>43</td>
<td>53</td>
</tr>
<tr>
<td>Increase in size</td>
<td>--</td>
<td>5%</td>
<td>26%</td>
<td>57%</td>
</tr>
</tbody>
</table>
Impact on Costs

- Larger HVAC equipment
  - Increase in capital costs
  - Increase on monthly energy costs
Conclusions

- The grow room climate must be controlled to achieve effective yields
  - Temperature vs. Humidity
  - Complicated balance
- HVAC energy optimization
  - Careful selection of temperature and RH is critical to reduce capital & operating costs
  - System to control both the sensible and latent components will be the most energy efficient
Creative Efficiencies in Mechanical & Irrigation Systems

Brandy Keen
Surna
Mechanical Systems

• Your mechanical system will be the single most important decision you make as a cultivator

• Most significant expense

• Most significant energy consumption (average of 51%)

• Most risk to crop
Economization

- Utilization of ambient conditions to create ideal conditions within the grow space
  - Conventional wisdom - "Just open a window!"
  - Most energy codes require economization once you get over a certain tonnage of cooling in the space
Inherent Problems with Economization in Cultivation

- Odor Control
- Biosecurity
- CO2 Conservation (works against intent of code)
- Cost of preconditioning the air (humidity)
With a Chilled Water System

• Chilled water is extremely common in process cooling and high tonnage/mission critical HVAC systems

• Chilled water systems rely on circulation of chilled water through fan coils or air handlers instead of refrigerant for heat exchange (closed loop)
Chilled Water System Continued

• Water side economization allows you to utilize the ambient conditions instead of a compressor to cool the fluid when ambient temperatures are below 40°F
  • Through use of a Fluid Cooler (giant radiator)
  • No cooling tower, no special maintenance

• This allows you to take advantage of the ambient conditions to eliminate the need for compressors in your climate control system
  • Compressors consume the vast majority of the energy in mechanical systems
  • In most cases water side economizers pay for themselves in 2 years or less

• Works for cooling AND dehumidification (air side economization can work for or against you for humidity)
Other Benefits of Chilled Water

• Manipulate water temperature (in addition to fan speed) to achieve best possible mix of sensible and latent cooling at lowest possible energy consumption
  • Sensible-Heat Removal
  • Latent-Dehumidification
And More Benefits of Chilled Water

• Significantly reduce electrical infrastructure for mechanical system when operating on a “flip”-share compressors without sharing air between on/off rooms
  • Reduces cost/scale of power upgrade
  • Reduces cost/scale of electrician

• Heat Recovery
  • Allows you to inject heat from room A (“on” room) into room B (“off” room) without mixing air between rooms
  • Free reheat-forces cooling system to run for night time dehumidification of off room
  • More energy efficient than small stand alone dehumidifiers
  • Free reheat-only consumption is operation of pump
Condensate Recovery

- Plants don’t consume water, they borrow it
  - Water in = Water out

- Dehumidification is condensation of water transpired by plants

- Condensate is distilled water
  - 0 PPM

- Recycled condensate can result in up to 90% less consumption of water in cultivation
  - Oxygenate
  - pH
  - Sterilize
  - Carbon Filter

- Check local code requirements
Commercial Cannabis Fertigation: Automation, Efficiency, & Sustainability

Lucas Targos
urban-gro
What is Fertigation?

- Fertigation is the application of a commercial fertilizer, soil amendment, or reclaimed water from food processing and wastewater treatment facilities with irrigation water. (WSDA, 2009)

- Controlled by a fertigation system:
  - Irrigation timing, what gets irrigated and when
  - Concentrations and ratios of nutrients
  - Precise volumes of nutrient solution to each plant
  - pH of final nutrient solution
Thermal Evaporator
UV Disinfection
Leachate Reclamation
CANNABIS SUSTAINABILITY SYMPOSIUM

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