Summer Cooling

**Designing a Fan and Pad System**

- Air exchange rate (cfm’s) required
  - “standard” recommendation is 1 exchange per minute
  - remove and replace entire ft³ volume of greenhouse
  - means you must calculate greenhouse volume
  - the 8 cfm/ft² of floor area is no good! --why not?
Summer Cooling

*Designing a Fan and Pad System*

- Modify “standard” cfm as needed:
  - account for density of air (elevation)
  - use Table 4-1 to select $F_{\text{ELEV}}$
  - account for maximum light
  - use Table 4-2 to select $F_{\text{LIGHT}}$
Summer Cooling

Designing a Fan and Pad System

- Modify “standard” cfm as needed:
  - account for maximum temperature rise
    - use Table 4-3 to select $F_{\text{TEMP}}$
    - multiply $F_{\text{ELEV}} \times F_{\text{LIGHT}} \times F_{\text{TEMP}}$ to get $F_{\text{HOUSE}}$
  - account for short fan-to-pad distances (less than 100 ft)
    - use Table 4-4 to select $F_{\text{VEL}}$
    - multiply “standard” cfm by the largest factor-- $F_{\text{HOUSE}}$ OR $F_{\text{VEL}}$
Summer Cooling

*Designing a Fan and Pad System*

- Fan selection and placement
  - total fan cfm = calculated cooling requirements
  - fans should be = in cfm’s
  - usually placed on the wall opposite the pads
  - max distance between fans and pads = 200 ft
  - place fans close to plant height
  - no more than 25 ft between fans; evenly spaced
Summer Cooling

Designing a Fan and Pad System

- Fan selection and placement
  - individual fan cfm = total cfm ÷ number of fans
  - select fan capacity at 0.1” static pressure (0.05” for slant-wall-housing fans)
  - fans should be housed on the leeward side
  - exhaust on the windward side = 10% greater capacity
  - 50 feet minimum from exhaust to the pads of an adjacent greenhouse
Summer Cooling

Designing a Fan and Pad System

• Fan selection and placement
  – if fans from two adjacent greenhouses exhaust towards each other, greenhouses should be at least 15 feet apart
    • stagger fans so they do not blow directly into each other
  – give exhaust fans clearance of at least 1.5x fan diameter between fans and adjacent buildings
    • a 24” diameter fan needs 3 feet clearance between the fan and the adjacent building
Summer Cooling

Designing a Fan and Pad System

• Pad types and specifications
  – two majors types of pads--excelsior (Aspen) pads and cellulose (Kool-Cel) pads
  – cellulose pads are more expensive, but last much longer (10 years as compared to about 2 max for excelsior pads)
  – excelsior pads require a wire mesh frame for support while cellulose pads are self-supporting
Summer Cooling

*Designing a Fan and Pad System*

- Pad types and specifications
  - supply correct fpm velocity for proper evaporation
    - divide the total cfm by pad velocity (fpm) to calculate the required ft$^2$ of pad area
  - supply correct water flow rate (gpm/ft) to maintain adequate pad moisture
    - match your pump capacity to the total flow rate needed
Summer Cooling

*Designing a Fan and Pad System*

- Pad types and specifications
  - supply correct sump (holding tank) capacity to hold enough water to circulate through the pad system
  - capacity is based on ft² of pad area
<table>
<thead>
<tr>
<th>Pad type</th>
<th>Pad velocity (fpm)</th>
<th>Water flow rate (gpm/ft)</th>
<th>Sump capacity (gal/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1” to 2 1/4” aspen</td>
<td>150</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>4” thick cellulose</td>
<td>250</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>6” thick cellulose</td>
<td>350</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Summer Cooling

*Designing a Fan and Pad System*

- Pad types and specifications
  - run pads the entire length of the wall
  - some water must be “bled off” to prevent salt build up
    - use 0.05 gpm/1000 cfm of fan capacity OR
    - bleed off 1% to 2% of the gpm pumped onto pads
  - use algaecides such as sodium hypochlorite (bleach), bromine (Agribrom), quaternary ammonium chloride salts (PT 2000 or Green-Shield), and benzylkonium chloride (Physan 20)
Summer Cooling

*Designing a Fan and Pad System*

- Pad types and specifications
  - distribute water via a sump pump and a delivery tube on top of the pads
  - maximum length of delivery tube (per pump) is 100 feet
- 50 feet in EITHER DIRECTION from the pump; situate sumps and pumps in the middle of distribution pipes
- water leaves the delivery tube through \( \frac{1}{8}'' \) diameter holes in the top of pipe at 3” spacings
Summer Cooling

*Designing a Fan and Pad System*

• Pad types and specifications
  – spray water upward, against an impingement cover
  – uniform film should flow onto the pad top edges
  – collection gutter at bottom returns water to sump
  – use fill line with float valve for proper sump volume