Table 1. Expected results for operating various cooling systems for a 1,500-square-foot area under non-monsoon summer conditions (temperature = 100°F, relative humidity= 10%) and monsoon summer conditions (temperature = 90°F, relative humidity = 50%). Includes maximum temperature reductions (ê Temp) and relative humidity increase (è RH), energy use, water use during operation and for electric energy generation, hourly operating cost (assuming continuous operation), and unit purchase cost (installation not included).

<table>
<thead>
<tr>
<th>Application</th>
<th>Indoor Cooling*</th>
<th>Outdoor/Ag Cooling†</th>
<th>Indoor Cooling§</th>
<th>Outdoor/Ag Cooling§</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling System</td>
<td>Swamp A/C Outdoor Mist High-Press Fog</td>
<td>Swamp A/C Outdoor Mist High-Press Fog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Temp (°F)</td>
<td>-20°F</td>
<td>-40°F</td>
<td>-35°F</td>
<td>-40°F</td>
</tr>
<tr>
<td>Max RH (%)</td>
<td>+ 40%</td>
<td>+ 0%</td>
<td>+ 80%</td>
<td>+ 90%</td>
</tr>
</tbody>
</table>

Energy Use
- Energy Use (kWh/hr) | 0.6 | 14 | 1.3 | 2.5 | 0.6 | 14 | 1.3 | 2.5

Water Use
- Operation (gall/hr) | 7.5 | 0 | 45 | 17 | 3.8 | 0 | 11 | 5
- Electricity Generation** (gal/hr) | 0.3 | 7.0 | 0.7 | 1.3 | 0.3 | 7.0 | 0.7 | 1.3
- Total (gall/hr) | 7.8 | 7.0 | 45.7 | 18.3 | 4.2 | 7.0 | 11.7 | 6.3
- Energy Cost†† ($/hr) | $0.05 | $1.12 | $0.10 | $0.20 | $0.05 | $1.12 | $0.10 | $0.20
- Water Cost— ($/hr) | $0.08 | $0.0 | $0.48 | $0.16 | $0.04 | $0.0 | $0.12 | $0.05
- Unit Cost ($) | $525 | $2500 | $150 | $2000 | $525 | $2500 | $150 | $2000

1. Indoor cooling systems designed for a 1500-square-ft home.
2. Outdoor/Agricultural cooling systems designed for a 1500-square-foot outdoor or agricultural area.
3. Indoor cooling systems designed for a 1500-square-ft home.
4. Outdoor/Agricultural cooling systems designed for a 1500-square-foot outdoor or agricultural area.
5. Water is required to generate electricity. In Tucson, the majority of electricity is generated with coal, which uses 0.5 gallons of water per kWh electricity produced.
6. Hourly operating cost is based on electricity price of 8¢/kWh.
7. Water costs assume $0.01/gallon water use for system operation.

ADVANTAGES AND DISADVANTAGES
1. Forcing Air through a Wet Pad
   - Fans ensure evaporation occurs
   - Can control amount of cooling with fans
   - All water is evaporated (no losses)
   - Cooling is not uniform ‡ Lowest temperatures near the wet pad
   - Need electric power for fans

2. Forcing Water into Dry Air
   - Can cool occupied space more uniformly
   - Low energy use because wind provides air exchange
   - Low wind speeds will restrict evaporation
   - Need a pump (energy) to boost water pressure
   - When evaporation is poor ‡ inefficient water use, wet people, plants, floors, etc.

FACTS AND FIGURES
Increasing airflow (cfm) has a diminishing return on temperature reduction, but always uses more water and energy, and increases capital and operation costs.

Figure 1. Operational diagram of a common household swamp cooler. Courtesy of Wikipedia.

Partnered with: Cooperative Extension
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WHAT IS EVAPORATIVE COOLING?

Definition:
Evaporating water to reduce air temperature and increase air humidity. This process occurs when heat in the air is transferred to the water, causing it to evaporate.

Examples:
- Sweating/Perspiring
- “Swamp Coolers”
- Outdoor Misters

Reasons to Use Evaporative Cooling:
- Uses less energy than air-conditioning systems
- Alleviates health problems associated with dry air and “sick building syndrome”
- Reduces water and heat stress on plants and animals

Applications:
- In-home cooling
- Outdoor cooling
- Horticulture
- Controlled Environment Agriculture (greenhouses and animal housing)

FORCING AIR THROUGH A WET PAD

Principles of Operation
- Outside air pulled through wet pad and fans
- Cooled and humidified air enters the occupied area

Residential Application
“Swamp Coolers”
“Swamp coolers” are commonly used for residential cooling. Swamp coolers house the wet pad, fan and water distribution lines all within a single box. The fan pulls outside air through the wet pad and blows the cooled air into the home. Swamp coolers are usually placed on the roof, with air moving down across the wet media. They may also be located on the outside wall and delivered horizontally into the home.

Improving Performance:
- Use mult-speed fan to control airflow
- Use temperature control to operate fan
- Inspect and maintain system

FORCING WATER INTO DRY AIR

Principles of Operation
- Small water droplets are sprayed directly into air
- Use temperature control to operate fan
- Cooled and humidified within the occupied area

Residential Application
Outdoor Misters
Outdoor misters are commonly used for commercial patio dining, residential patios, and amusement park areas. Mist lines are located overhead, where water is sprayed through low-pressure nozzles (25 PSI) into the air above the occupied area. Water droplets can be evaporated in the air or off of surfaces, such as people’s skin. For evaporation in the air, cooled air falls downward and is carried by the wind. The most effective cooling, though, occurs when water droplets evaporate from people’s skin because heat is transferred directly from the skin to the water.

Improving Performance:
- Use multi-speed fan to control airflow
- Use temperature control to operate fan
- Inspect and maintain system

SAVING WATER:
Improving performance will help save water, including:
- Use temperature control to operate fan
- Use multi-speed fan to control airflow

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Horticulture/Agriculture Application
Pad-and-Fan Systems
Pad-and-fan systems are commonly used for cooling plants inside greenhouses (nurseries, residential and commercial vegetable or flower production, etc). Exhaust fans pull outside air through a wet pad, bringing cooled and humidified air into the greenhouse. Typically, the wet pad and fans are located on opposing walls so that the evaporatively cooled air is pulled from one end of the structure to the other.

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- Use temperature control to operate fan
- Inspect and maintain system

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