
Absorption Chillers

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Absorption Chiller

Condenser water to cooling tower

Steam or hot water (also could be a gas burner)

Condenser water from cooling tower

The refrigerant is water

The absorbent is typically lithium bromide

Operates at a nearly perfect vacuum

Chilled water to and from loads

Absorption Cycle Water Chiller
Taking a Closer Look at an Absorption Chiller
Different Cooling Sources = Different Operating Requirements

**Vapor Compression Chiller**
- Cold condenser water = **Good**
- Many moving parts; frequent or rapid cycling = **Compressor failure**
- Improper start/stop/sequencing = **Energy and demand penalty**
- Set point fine tuning = **Performance and efficiency optimization**

**Absorption Cycle Chiller**
- Cold condenser water = **Bad**
- Fewer moving parts; frequent or rapid cycling = **Not gonna happen**
- Improper start/stop/sequencing = **Angry boiler plant operators**
- Set point fine tuning = **Just fooling your self (you’re lucky it’s running)**

**Free Cooling Cycle**
- Cold condenser water = **Relative thing**
- Some moving parts; frequent or rapid cycling = **Motor overheating**
- Improper start/stop/sequencing = **Cooling tower failure**
- Set point fine tuning = **Performance and efficiency optimization**

Monitoring operating data = **Ongoing performance optimization**
There’s More to Chiller Efficiency than the Compressor

<table>
<thead>
<tr>
<th>Item</th>
<th>kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressor</td>
<td>680</td>
</tr>
<tr>
<td>Evaporator Pump</td>
<td>13</td>
</tr>
<tr>
<td>Condenser Pump</td>
<td>54</td>
</tr>
<tr>
<td>Oil Pump</td>
<td>1</td>
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<tr>
<td><strong>Total</strong></td>
<td>748</td>
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</tbody>
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Tonnage at Full Load 1,000

*kw per Ton at Full Load*.75

Tonnage at Part Load 250

*kw per Ton at Part Load*.95
Start with the preceding and add energy for:
- Cooling tower fans (varies with wet-bulb temperature)
- Distribution pumps (varies with load) (hopefully)

Plant design characteristic
- Constant flow
- Variable flow primary/secondary
- Variable flow primary only

Good rule of thumb – Plant kW per ton = 0.85 – 1.05 kW/ton
600 Ton Absorption vs. Centrifugal Cooling

600 Ton Absorber

600 Ton Centrifugal
600 Ton Absorption vs. Centrifugal Cooling

**600 Ton Absorber**
- COP – 0.70
- Btu/ton-hr – 12,000
- Btu per pound of steam – 950
- Full load steam rate, lb/ton-hr – 18
- Assumed steam system distribution efficiency – 80%
- Assumed gas transmission and distribution cost multiplier – 1.02
- Btu/therm – 100,000
- Steam cost - $0.74 per therm
- Condenser water flow - 2,320 gpm
- Condenser water head – 90 ft.w.c

**600 Ton Centrifugal**
- COP – 5.96
- Btu/ton-hr – 12,000
- Assumed power grid distribution efficiency – 93.5%
- US fossil fuel plant heat rate – 9,756 Btu/kWh
- Btu/therm – 100,000
- Electricity cost - $0.10 per kWh
- Condenser water flow – 1,120 gpm
- Condenser water head – 75 ft.w.c

Assume the evaporator pump flow and head is the same for both chillers and that the condenser pump efficiencies are identical.
600 Ton Absorption vs. Centrifugal Cooling

1. What are the similarities and differences between the two machines?

2. In general terms, how do the two machines compare from an energy efficiency standpoint?
   a. Would it make a difference if the absorber could be fired with gas directly?
   b. Would it make a difference if the absorber could be fired with waste heat?

3. Are the electrical demand impacts different?

4. Is the carbon footprint different?