Refrigeration (Chiller)

Ideal Cycle

\[
T = 85^\circ F \quad \text{to cooling tower}
\]

\[
T = 95^\circ F
\]

\[
\text{CONDENSER}
\]

\[
\text{EVAPORATOR}
\]

\[
\text{LWT} \quad \approx 45^\circ F
\]

\[
\text{EWT} = \text{entering water temp}
\]

D Ideal refcry cycle

\[
q_{1-4} = \dot{Q}_L = h_1 - h_4
\]

\[
q_{2-3} = \dot{Q}_H = h_2 - h_3
\]

\[
\dot{W}_{1-2} = \frac{\dot{W}_c}{\dot{W}_{\text{refcry}}} = h_2 - h_1 = \frac{h_{25} - h_1}{\eta_{\text{comp}}}
\]

"Efficiency" of chiller \(
\rightarrow\)

Coefficient of Performance COP.

\[
\text{for cooling COP} = \frac{\dot{Q}_L}{\dot{W}_c} = \frac{\dot{Q}_L}{\dot{Q}_H - \dot{Q}_L} = \frac{q_{1-4}}{\dot{W}_{1-2}} = \frac{q_{1-4}}{q_{2-3} - q_{4-1}}
\]
For Ideal (reversible) 

\[ \text{C.O.P.}_{\text{max}} = \frac{T_L}{T_h-T_L} \]

Raising \( T_L \) to highest possible value

will increase maximize C.O.P.

And maximize WAT

Closer \( T_{cw} \) is to \( T_L \), the more reversible the machine will be, but the larger the HX needed to accomplish, \( Q_c \) will be

Look at Performance of Some Real Chillers

(HAERS simplified, Table 5.10)

<table>
<thead>
<tr>
<th>Watercooled Models</th>
<th>75°F</th>
<th>85°F</th>
<th>95°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled LMT</td>
<td>40</td>
<td>38.0</td>
<td>36.5</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>41.8</td>
<td>40.1</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>45.9</td>
<td>43.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air Cooled Models</th>
<th>75°F</th>
<th>85°F</th>
<th>95°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>35.3</td>
<td>31.7</td>
<td>27.8</td>
</tr>
<tr>
<td>45</td>
<td>38.5</td>
<td>34.7</td>
<td>30.5</td>
</tr>
<tr>
<td>50</td>
<td>42.0</td>
<td>37.8</td>
<td>33.3</td>
</tr>
</tbody>
</table>

\[ \text{C.O.P}_{\text{ideal}} \]

\[ \frac{\text{C.O.P.}_{\text{ideal}}}{\text{C.O.P.}_{\text{ideal}}} = \frac{\text{C.O.P.}_{\text{ideal}}}{\text{C.O.P.}_{\text{ideal}}} \]

See -- \[ \left( \frac{3.6}{3.94} \right) \approx \left( \frac{9.09}{10.10} \right) \]

\[ \frac{1.09}{3.94} \approx \left( \frac{11.33}{10.10} \right) \]

\[ \text{Wm, about 5%} \]

Can use "ideal" to estimate performance of "real" at a "nearby" temperature.