Reference Ch 42
ASARAE Handbook of Refrigeration.
Chiller - refrigerator to cool water
Air cooled \{ condensors
Water cooled \{ condensors
\text{Water cooled} \text{ more efficient/efficient than Air cooled}
Chillers also classified by type of Compressor:
Refrigerating
\text{Reciprocating}
\text{Screw}
\text{Centrifugal}
\text{1 ton refrigeration} = 12,000 \text{ Btu/hr.}
Nominal C.O.P. for chiller (cooling mode) \frac{\dot{Q}_H}{W_{\text{Compressor}}}
\approx 2.5
C.O.P. = \frac{\dot{Q}_{\text{chiller}}}{W_{\text{Compressor}}}
C.O.P._{\text{ideal}} = C.O.P._{\text{CARNOT}} = \frac{T_L}{T_H - T_L}
Note Chiller is more efficient as \(T_L \to T_H\)
To save energy, only chill water to highest temperature required.

1. Less W.amp required for this
2. C.O.P. should increase

Don't oversize - short cycling of compressor will lead to shortened equipment life.

If chiller is water-cooled (condenser), then that water gets hot and in turn needs to be cooled.

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**Cooling Tower**

Counterflow heat exchanger - water and air flow in opposite directions

Direct Contact - water typically percolates through the air.

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\[ T_{\text{in}} \to T_{\text{water-in}} \to T_{\text{water-out}} \to T_{\text{out}} \to T_{\text{in}} \]

Distance.
Approach $\Delta T = T_{\text{water in}} - T_{\text{air in}}$

Cooling water with air in a heat exchanger can economically get within 20°F of $T_{\text{db}}$

Cooling towers can cool water to within 5°F of $T_{\text{wb}}$, about 35°F lower than an air cooled exchanger

Cooling in cooling towers due to

1. Sensible cooling proportional to $T_{\text{water in}} - T_{\text{air in}}$

2. Evaporative cooling proportional to
   Reverberated $h_{\text{fg}}$ (up to 5% of water will evaporate)

Thermal performance of cooling towers mostly directly affected by the entering wet bulb temperature.

5 types of Direct contact exchangers
Cooling towers

> Installation should avoid re circulation of warm moist air

> "Water-side economizer" = Free cooling can realize free cooling by making use of cold water in cooling tower system during favorable mild months of the year.