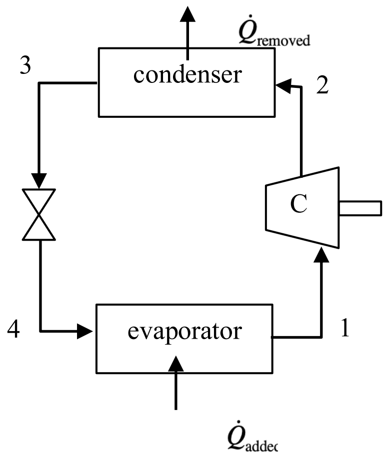
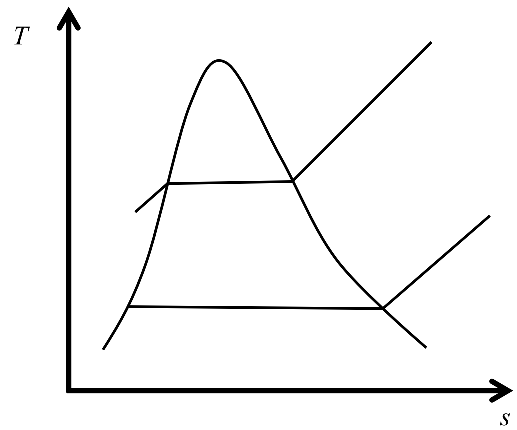
ME 200 (Thermodynamics I)

Vapor Compression Refrigeration Cycle





Apply the 1st Law to each component.

$$\frac{\dot{W}_{\text{on comp.}}}{\dot{m}} = h_2 - h_1$$

$$\frac{\dot{Q}_{\text{added}}}{\dot{m}} = h_1 - h_4$$

($\dot{Q}_{\text{added}}$ is known as the <u>refrigeration capacity</u>. A commonly used unit:

<u>1 ton of refrigeration capacity</u> = 200 Btu/min ≈ 211 kJ/min = 3.517 kW;

= rate of heat transfer to freeze 1 ton of H2O in 24 hrs w/ enthalpy of fusion = 334 kJ/kg)

$$\frac{\dot{Q}_{\text{removed}}}{\dot{m}} = h_2 - h_3$$

Throttling process: $h_4 = h_3$ (inherently irreversible, but adiabatic)

The refrigeration coefficient of performance:

$$\text{COP}_{\text{ref}} \equiv \frac{\dot{Q}_{\text{added}}}{\dot{W}_{\text{on comp}}} = \frac{\dot{Q}_{\text{added}}/\dot{m}}{\dot{W}_{\text{on comp}}/\dot{m}} = \frac{h_1 - h_4}{h_2 - h_1}$$

Notes

1. Real compressors operate best in dry (vapor) conditions rather than in the two-phase region.