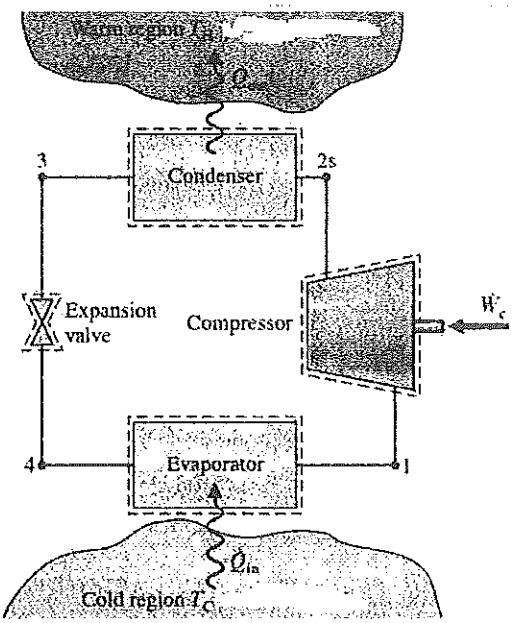
Cankaya University
Faculty of Engineering
Mechanical Engineering Department

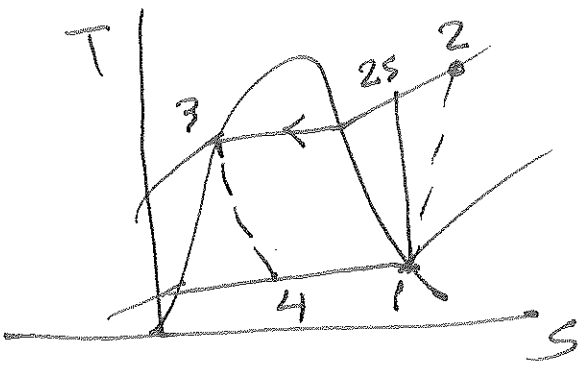
ME 212 Thermodynamics II
Quiz 3
Spring 2017

In a vapor-compression refrigeration cycle, Refrigerant 134a is used as the working fluid. The cycle operates at steady state. Refrigerant enters the condenser at 60°C and 1.2 MPa and exits as saturated liquid. The evaporator temperature is 8°C and refrigerant enters the compressor as saturated vapor. The refrigeration capacity of the cycle is 6 tons. Determine (a) the mass flow rate of the refrigerant in kg/s. (b) the compressor isentropic efficiency. (c) the compressor power in kW. (d) the coefficient of performance.



1) $T_1 = 8°C$, $x_1 = 1$ ⟹ $s_1 = s_g = 0.9150 \frac{kJ}{kgK}$, $h_1 = h_g = 251.80 \frac{kJ}{kg}$

2s) $s_1 = s_{2s} = 0.9150$ kJ/kg, $P_2 = 1.2$ MPa ⟹ $h_{2s} = 275.07 \frac{kJ}{kg}$



2) $P_2 = 1.2$ MPa, $T_2 = 60°C$ ⟹ $h_2 = 287.44 \frac{kJ}{kg}$

3) $h_3 = h_f = 115.76$ kJ/kg
$P_3 = 1.2$ MPa
$x_3 = 0$

4) $h_4 = h_3 = 115.76\ kJ/kg$ (Throttling process)

a) $\dot{Q}_{in} = \dot{m}(h_1 - h_4)$

$\dot{m} = \dot{Q}_{in}/(h_1 - h_4) = \frac{6\ tons}{(251.80 - 115.76)} \cdot \frac{3.52\ kJ/s}{ton}$

$= 0.155\ kg/s$

b) $\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1} = \frac{275.07 - 251.80}{287.44 - 251.80} = 0.653$

65.3 %

c) $\dot{W}_c = \dot{m}(h_2 - h_1)$

$= (0.155\ \frac{kg}{s})(287.44 - 251.80)$

$= 5.52\ kW$

d) $\beta = \frac{\dot{Q}_{in}}{\dot{W}_c} = \frac{6\ tons}{5.52\ kW} \cdot \frac{3.52\ kW}{ton} = 3.826$

Note: $1\ ton = 212\ \frac{kJ}{min} = 212\ \frac{kJ}{min} \cdot \frac{min}{60s} = 3.52\ kW$