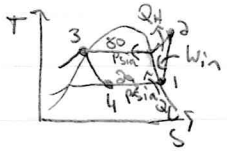
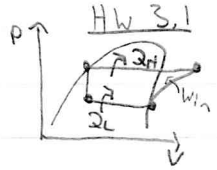
3/31/19

HW 3.1

(11)





[Sat. Refrigerant -134a table]

$h_1(h_g) = 122.74$ Btu/lbm

$s_1(s_g) = 0.22570$ Btu/lbm·R

$s_1 = s_2$

$h_2 = h@s=0.22045 + (h@s=0.22663 - h@s=0.22045)\left(\frac{s_2 - s@s=0.22045}{s@s=0.22663 - s@s=0.22045}\right)$

$h_2 = 112.27 + (115.51 - 112.27)\left(\frac{0.22570 - 0.22045}{0.22663 - 0.22045}\right)$

$h_2 = 115.01$ Btu/lbm

[Sat. Refrigerant - 134a press. table]

$h_3(h_f) = 33.39$ Btu/lbm

$\dot{Q}_L = \dot{m}_{ice}(\Delta h)_{ice}$

$= \left(\frac{1\$}{3600}\right)(169)$

$\dot{Q} = 0.7042$ Btu/s

$\dot{m}_g = \frac{\dot{Q}_L}{h_1 - h_4}$

$= \frac{0.7042}{(122.74 - 33.39)}$

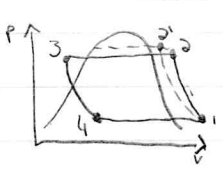
$\dot{m}_g = 0.01015$ lbm/s

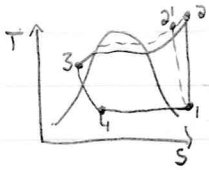
$\dot{W}_{in} = \dot{m}_g(h_2 - h_1)$

$= (0.01015)(115.01 - 122.74)\left(\frac{1hp}{0.7068\ Btu/s}\right)$

$\dot{W}_{in} = 0.1176hp$

(11)





$h_1 = 244.54 + \frac{(-10)(-5)(253.05 - 244.54)}{(-10 - 0)}$ } R-134a Table

$h_1 = 248.795$ kJ/kg

$s_1 = 0.93600 + \frac{(-10)(-5)(0.96898 - 0.93800)}{(-10 - 0)}$ } R-134a Table

[Superheated R-134a Table]

$h_2 = 300.61$ kJ/kg

|Sat. R-134a Table|

$h_3 (h_f) = 114.28 \text{ kJ/kg}$

$h_4 = h_3$

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

$= (0.07)(248.795 - 114.28)$

$= 9.41 \frac{\text{kJ}}{\text{s}} \left(\frac{1\text{kW}}{1\text{kJ/s}}\right)$

$\boxed{\dot{Q} = 9.41 \text{ kW}}$

$\dot{W}_{in} = \dot{m}(h_2 - h_1)$

$= 0.07(300.61 - 248.795)$

$= 3.627 \frac{\text{kJ}}{\text{s}} \left(\frac{1\text{kW}}{1\text{kJ/s}}\right)$

$\boxed{\dot{W}_{in} = 3.627 \text{ kW}}$

b) $s_1 = s_{2s}$ $\quad s_1 = 0.9539 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$

$h_{2s} = 278.27 + \frac{(0.9539 - 0.9297)(289.64 - 278.27)}{(0.9614 - 0.9267)}$ } superheated R-134a tables

$h_{2s} = 286.199 \frac{\text{kJ}}{\text{kg}}$

$\eta_c = \frac{(286.199 - 248.795)}{(300.61 - 248.795)}$

$= 0.721$

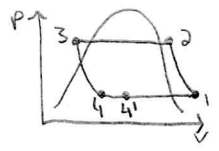
$\eta_c = 72.1\%$

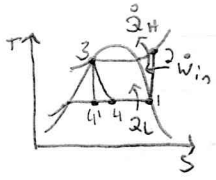
c) $(COP)_R = \frac{\dot{Q}_L}{\dot{W}_{in}}$

$= \frac{9.41}{3.627}$

$\boxed{(COP)_R = 2.594}$

(d)





|Sat. R-134a Table|

$P_4 = P_1$

$h_f = 22.49 \text{ kJ/kg}$

$h_1 (h_g) = 236.96 \text{ kJ/kg}$

$T_1 (T_{sat}) = -22.32°C$

$h_4 = h_f + x_4 (h_g - h_f)$

$= 22.49 + 0.34(236.96 - 22.49)$

$h_4 = 95.41 \text{ kJ/kg}$

b) $h_3 = h_4$

$P_{3,sat} = 800\,kPa$ – Sat. R-134a Press. Table

a) $h_2 = 306.88\,kJ/kg$ – Superheated R-134a Table

$\dot{W}_{comp} = \dot{m}(h_2 - h_1)$

$450 = \dot{m}(306.88 - 236.97) \times 10^3$

$\dot{m} = 0.00644\,kg/s$

c) $\dot{Q}_{evap} = \dot{m}(h_1 - h_4)$

$= 0.00644(236.97 - 95.41) \times 10^3$

$\dot{Q}_{evap} = 911.36\,W$

$COP = \frac{\dot{Q}_{evap}}{\dot{W}_{comp}}$

$= \frac{911.36}{450}$

$COP = 2.026$

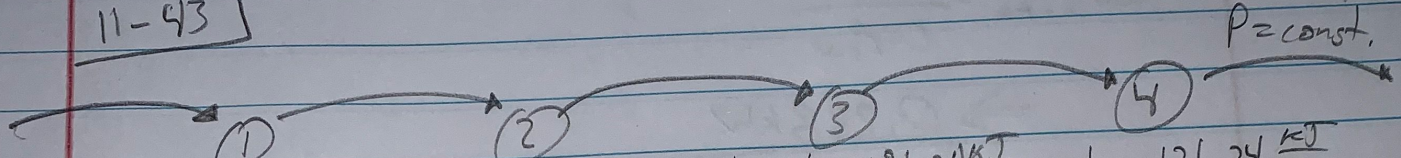
11-38)

From saturation tables for R-134a

$P_{sat@-20°C} = 132.82\ kPa$ - Recommended evaporator pressure

$P_{sat@35°C} = 887.5\ kPa$ - Recomended condenser pressure

11-43)



$P_1 = 572.07\ kPa$

$h_1 = h_{g1} = 261.59\ \frac{kJ}{kg}$

$s_1 = s_{g1} = 0.92234\ \frac{kJ}{kg \cdot K} = s_2$

$h_2 = 280\ \frac{kJ}{kg}$

$h_3 = h_4 = 121.24\ \frac{kJ}{kg}$

$T_3 = 48.59°C$

$T_{sat} = 52.40°C$

$h_4 = 121.24\ \frac{kJ}{kg}$

$P_4 = 572.07\ kPa$

$\Delta T_{sub\text{-}cooling} = T_{sat} - T_3$

$\Rightarrow 3.81°C$

$\dot{W}_{in} = \dot{m}_R (h_2 - h_1) + \dot{Q}_{loss}$

$\Rightarrow 0.6564\ kW$

$h_{61} = 209.34\ \frac{kJ}{kg}$

$h_{60} = 167.53\ \frac{kJ}{kg}$

$\dot{Q}_H = \dot{m}_R (h_2 - h_3)$

$\Rightarrow 3.074\ kW$

$\dot{Q} = \dot{m}(h_{61} - h_{60})$

$\Rightarrow 2.178\ kW$

$COP = \frac{\dot{Q}_H}{\dot{W}_{in}}$

$\Rightarrow 4.683$

$\dot{m}_R = \frac{\dot{Q}}{h_1 - h_4}$

$\Rightarrow 0.01936\ kg/s$

11-43 cont.

$$COP_{rev} = \frac{T_H}{T_H - T_L}$$

$$\Rightarrow \frac{323K}{323K - 298K}$$

$$\Rightarrow COP_{rev} = 12.92$$

$$\dot{W}_{in-min} = \frac{\dot{Q}_H}{COP_{rev}}$$

$$\Rightarrow 0.238kW$$