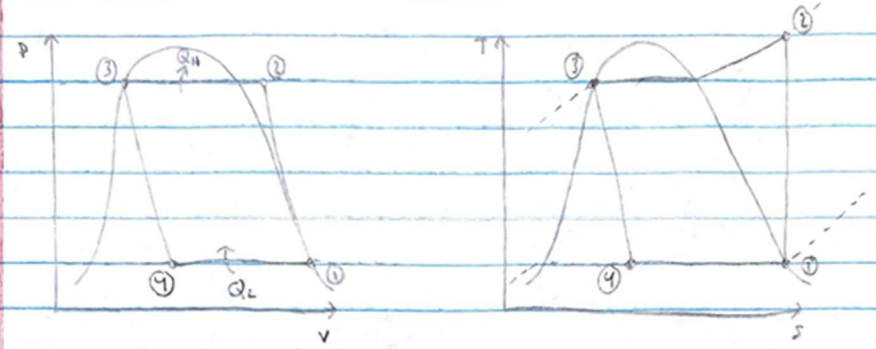
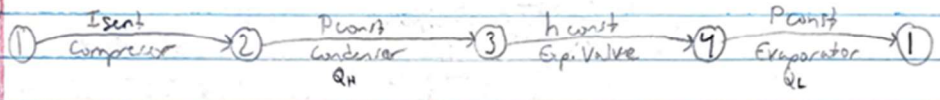
Cameron Sutton and Shawn Newnam HW 3.2

11-38)



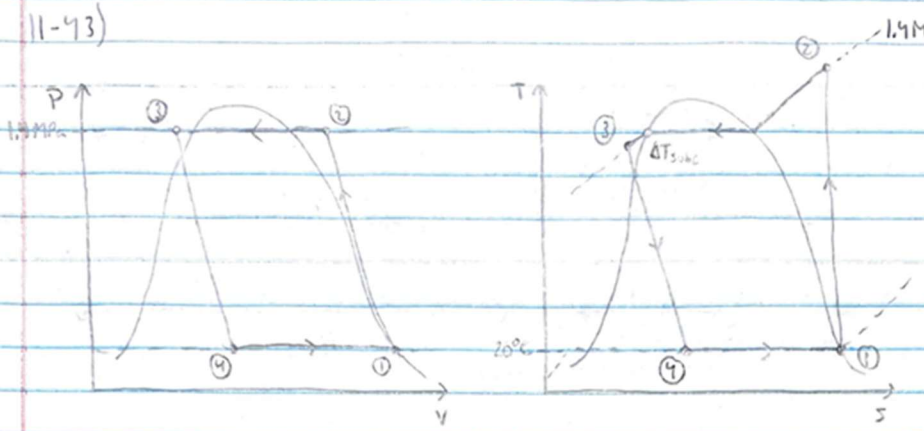


$Q_H = 25°C$

$Q_L = -10°C$

The temperature difference should be 10°C for heat transfer of the Evaporator and condenser, -20°C and 35°C, respectively. Using the corresponding refrigerant-134a tables, the saturation pressure of the evaporator is 132.82 kPa and condenser is 887.73 kPa. (using interpolation calculator). Therefor, the recommended pressures are 132.82 kPa for evaporator and 887.73 for condenser.

11-43)



① Isent Compressor → ② P const Condenser → ③ h const Exp valve → ④ P const Evaporator → ①

①	②	③	④
$P_1 = 572.07$ kPa	$P_2 = 1.4$ MPa	$P_3 = 1.4$ MPa	$T_4 = 20°C$
$x_1 = 1$	$s_2 = 0.92254$ kJ/kg·K	$h_3 = 121.26$ kJ/kg	$x_4 = 0.23$
Sat table	S.H. Table	$T_3 = T_{sat\ @\ h_3 = h_4}$	Sat table
$h_1 = 261.64$ kJ/kg	$h_2 = 280.07$ kJ/kg	$T_3 = 48.55°C$	$P_4 = 572.07$ kPa
$s_1 = 0.92254$ kJ/kg·K	$T_2 = 54.2°C$		$h_4 = h_{f\ 20°C} + x_4 h_{fg\ 20°C}$
$T_1 = 20°C$			$h_4 = 79.32 + (0.23)(182.33)$
			$h_4 = 121.26$ kJ/kg

a.) $\Delta T_{subc} = T_{sat\ @1.4MPa} - T_3$

$= 52.40 - 48.55$

$\boxed{\Delta T_{subc} = 3.85°C}$

b.) $\dot{Q}_{in} = \dot{m}_{H_2O} C_p \Delta T$

$= (0.065)(4.18)(10)$

$\dot{Q}_{in} = 2.717$ kW

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

$2.717 = \dot{m}_r (261.64 - 121.26)$

$\boxed{\dot{m}_r = 0.0194 \text{ kg/s}}$

c.) $\dot{Q}_{HW} = \dot{m}(h_2 - h_1)$

$= (0.0194)(280.07 - 121.26)$

$\dot{Q}_{HW} = 3.08\ kW$

$COP = \frac{\dot{Q}_{HW}}{\dot{W}_{in}} = \frac{3.08}{0.6575} = 4.68\ kW$

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

$= (0.0194)(280.07 - 261.64)$

$\dot{W}_{in} = 0.3575\ kW$

$\dot{Q}_{total} = 300W = 0.3kW$

$\dot{W}_{in} = 0.3575 + 0.3 = 0.6575\ kW$

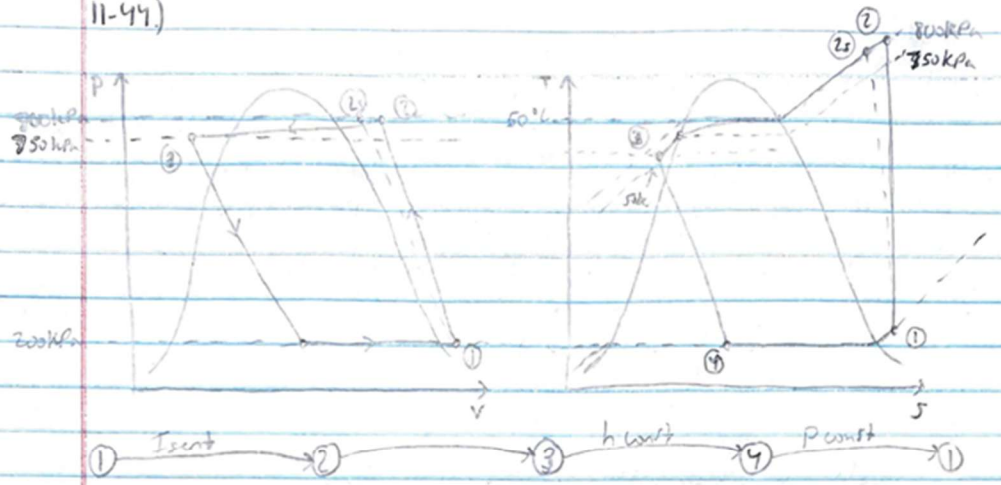
d.) $COP = \frac{1}{1 - \frac{T_L}{T_H}} = \frac{1}{1 - \frac{297}{321.5}} = 11.26$

$COP = \frac{\dot{Q}_{out}}{\dot{W}_{in,min}}$

$11.26 = \frac{3.08}{\dot{W}_{in,min}}$

$\dot{W}_{in,min} = 0.273\ kW$

11-44.)



$P_1 = 200kPa$	$P_2 = 800kPa$	$P_3 = 750kPa$	$P_4 = 200kPa$
SH by 4°C	$T_2 = 50°C$	Sat Liquid table	$h_4 = 87.92 \frac{kJ}{kg}$
$T_1 = -10.09 + 4$	$h_2 = 286.71 \frac{kJ}{kg}$	$T_3 = 29.06°C$	
$T_1 = -6.09°C$	$S_2 = 0.9505 \frac{kJ}{kg}$	$T_{3\,subc} = 29.06 - 3 = 26.06°C$	
calculator $h_1 = 247.87 \frac{kJ}{kg}$	$h_{2s} = 277.22 \frac{kJ}{kg}$	$h_3 = 87.92 \frac{kJ}{kg}$	
$S_1 = 0.9505 \frac{kJ}{kg \cdot k}$			

a.) $\eta_{comp} = \frac{h_{2s} - h_1}{h_2 - h_1} = \frac{277.22 - 247.87}{286.71 - 277.87} = 0.76 = \boxed{76\%}$

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

$= 0.022(286.71 - 87.92)$

$\boxed{\dot{Q}_H = 4.37 kW}$

c.) $COP_{HP} = \frac{\dot{Q}_H}{\dot{W}_{in}} = \frac{4.37}{0.85} = \boxed{5.14}$

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

$= 0.022(286.71 - 247.87)$

$\dot{W}_{in} = 0.85 kW$

d.) Ideal Cycle:

$h_1 = 244.50\ kJ/kg$ $P_2 = 800kPa$ $P_3 = 800kPa$ $h_4 = h_3$

$P_1 = 200kPa$ $S_3 = 0.93788\ kJ/kg \cdot K$ $h_3 = 95.48\ kJ/kg$ $P_4 = 200kPa$

$S_1 = 0.93788\ kJ/kg \cdot S$ $h_2 = 273.31\ kJ/kg$

$$COP = \frac{h_2 - h_3}{h_2 - h_1} = \frac{273.31 - 95.48}{273.31 - 244.50} = \boxed{6.17}$$

$$Q_H = \dot{m}(h_2 - h_3)$$

$$= 0.022(273.31 - 95.48)$$

$$\boxed{\dot{Q}_H = 3.91\ kW}$$

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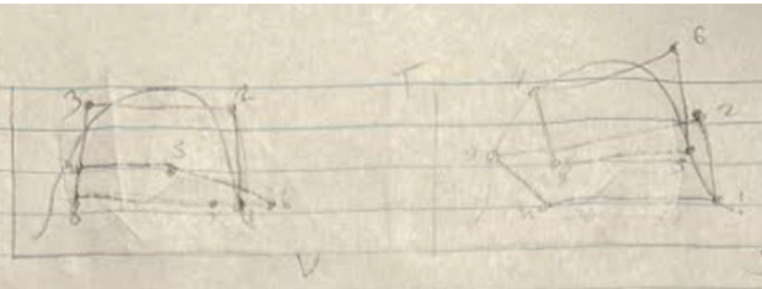

$h_2 = 270.4 \frac{kJ}{kg}$

$h_8 = 127.25 \frac{kJ}{kg}$

$P_3 = 1.4 MPa$

$h_3 = 127.25 \frac{kJ}{kg}$

$\dot{m}_2(h_2 - h_3) = \dot{m}_4(h_5 - h_8)$

$0.11(270.4 - 73.32) = \dot{m}_4(255.61 - 127.25)$

$\dot{m}_4 = 0.169 \, kg/s$

$Q = \dot{m}_2(h_1 - h_4)$

$Q = 0.11(241.14 - 73.32)$

$Q = 18.5 \, kW$

$COP = \frac{Q_L}{W_{in_L} + W_{in_H}}$

$COP = \frac{\dot{m}_2(h_1 - h_4)}{\dot{m}_2(h_2 - h_1) + \dot{m}_4(h_5 - h_8)}$

$COP = \frac{0.11(241.14 - 73.32)}{0.11(270.4 - 241.14) + 0.169(288.05 - 255.61)}$

$COP = 2.12$

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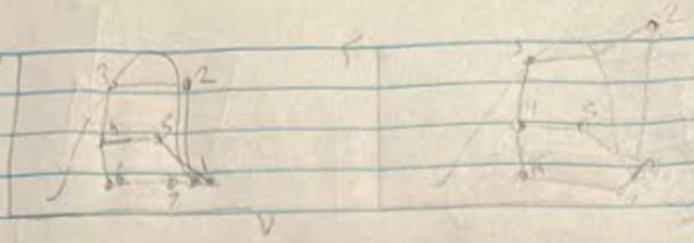

① $P_1 = 100 kPa$ $h_1 = 241.23$ $s_1 = 0.4755$

② $P_2 = 800 kPa$ $h_2 = 286.76$ $T_2 = 0$

③ $P_3 = 800 kPa$ $h_3 = 95.47 kJ/kg$

④ $h_4 = 95.47$ $T_4 = 0°C$

⑤

⑥

⑦ $h_7 = 256.41 kJ$ $T = 0$

$Q = m_2(h_2 - h_3)$

$m_2 = \frac{Q}{h_2 - h_3}$

$m_2 = \frac{5}{286.76 - 95.47} = 0.05757 kg/s$

$m_1 + m_2 = 0.1$

$m_1 = 0.1 - 0.5757$

$m_1 = 0.04243$

$m_1 h_5 + m_2 h_2 = m h_1 \rightarrow h_1 = \frac{m_1 h_5 + m_2 h_2}{m}$

$h_1 = \frac{0.04243 \cdot 250.05 + 0.1575 \cdot 286.76}{0.1}$

$h_1 = 241.23 kJ/kg$

$Q = \dot{m}_1(h_5 - h_4)$

$Q = 0.04243(750.45 - 95.47)$

$Q = 6.58 kW$

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

$W_{in} = 0.1(286.76 - 241.23)$

$W_{in} = 4.50 kW$

$COP = \frac{Q_H}{W_{in}}$

$COP = \frac{6.58 + 7}{4.50}$

$COP = 3.24$