HW 3.2

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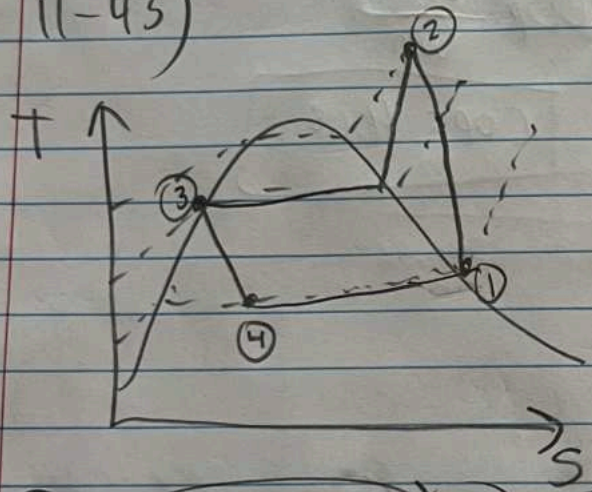
11-38) A temperature difference of 5°C to 10°C should be maintained between the refrigerant and the medium with which is exchanging heat. To maintain the refrigerating space at -10°C, the temp of the refrigerat should remain at about -20°C while it absorbs heat. The temp of the condenser should be at 35°C to reject heat to the environment at 25°C.

11-43)



1	2	3	4
$T_1 = 20°C$	$P_2 = 1.4$ MPA	$P_3 = 1.4$ MPa	$T_4 = 20°C$
$x_1 = 0.23$	$S_2 = S_1$	$T_3 = 25°C$	$x_4 = 1$

h_{f1} at 20°C = 83.84 kJ/kg

h_{fg1} at 20°C = 191.77 kJ/kg

h_{g2} at 1.4 MPa = 272.55

$h_2 = h_{g2} = 272.55$ kJ/kg

$h_1 = h_{f1} + x(h_{fg1})$

$h_1 = 83.84 + 0.23(191.77)$

$h_1 = 128.95$ kJ/kg

given:

$\dot{m}_{water} = 0.065$ kg/s, $T_{in} = 50°C$

$T_{out} = 40°C$

$Q_{evap} = \dot{m}_{water}(c_p)(T_{in} - T_{out})$

$Q_{evap} = 0.065(4.18)(50-40)$

$Q_{evap} = 2.717$ kW

$$\dot{m}_{ref} = \frac{Q_{evap}}{h_4 - h_1}$$

$$\dot{m}_{ref} = \frac{2.717}{275.61 - 128.99} = 0.0194 \text{ kg/s}$$

$Q_{evap} = 2.717 \text{ kW}$, $Q_{loss} = 0.3 \text{ kW}$

$$Q_{cond} = Q_{evap} + Q_{loss}$$

$$Q_{cond} = 2.717 + 0.3 = 3.07 \text{ kW}$$

$$W_{in} = \frac{Q_{cond}}{COP}$$

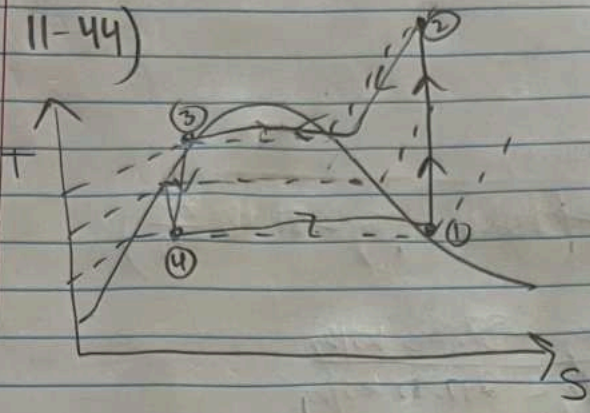
$$W_{in} = \frac{3.017}{4.68}$$

$$W_{in} = 0.644 \text{ kW}$$

$$COP = \frac{Q_{cond}}{W_{in}}$$

$$COP = 4.68$$

11-44)



①	②	③	④
$P_1 = 200 kPa$	$P_2 = 800 kPa$	$P_3 = 750 kPa$	
$T_1 = -6.1°C$	$T_2 = 50°C$		

$T_1 = -10.09°C + 4°C$

$T_1 = -6.1°C$

$$h_1 = \left(244.54 + \left(\frac{-6.09 + 10}{0 + 10}\right)(253.05 - 244.54)\right)$$

$h_1 = 247.87 \ kJ/kg$

$$s_1 = \left[0.9388 + \left(\frac{-6.09 + 10}{0 + 10}\right)(0.9698 - 0.9380)\right)$$

$s_1 = 0.9504 \ kJ/kgK$

A)

$$h_{2s} = \left(276.45 + \frac{286.69 - 276.45}{0.9802 - 0.948}(0.9504 - 0.948)\right)$$

$h_{2s} = 277.21 \ kJ/kg$

$$\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1} = \frac{277.21 - 247.87}{286.69 - 247.87}$$

$\eta_c = 0.755$

$\boxed{\eta = 75.58\%}$

b) $T_3 = (T_{sat\,750kPa} - 3°C)$

$T_3 = 29.06°C - 3°C$

$T_3 = 26°C$

$Q_H = \dot{m}(h_2 - h_3) = 0.022\frac{kg}{s}\left(286.69\ kJ/kg - 87.83\ \frac{kJ}{kg}\right)$

$\boxed{Q_H = 4.375\ kW}$

c) $COP = \frac{h_2 - h_3}{h_2 - h_1} = \frac{286.69\ kJ/kg - 87.83\ kJ/kg}{286.69\ kJ/kg - 247.87\ kJ/kg}$

$\boxed{COP = 5.123}$

D) $h_1 = (h_g)_{200kPa} = 244.46\ kJ/kg$

$COP_{Ideal} = \frac{h_{2s} - h_3}{h_{2s} - h_1} = \frac{273.29 - 95.47}{273.29 - 244.46}$

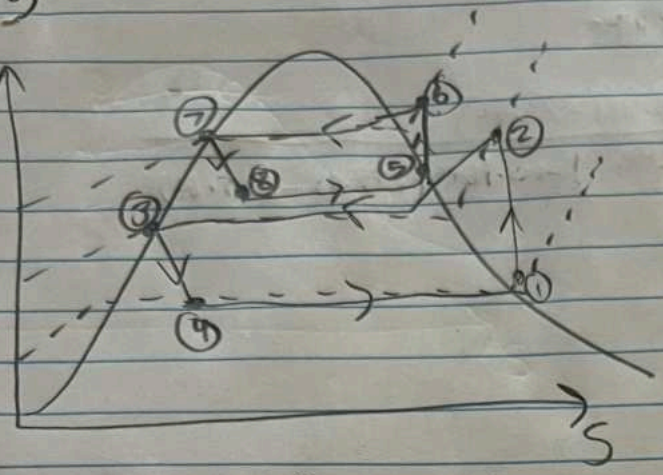
$\boxed{COP_{Ideal} = 6.168}$

$Q_H = \dot{m}(h_{2s} - h_3)$

$Q_H = 0.022 kg/s\left(273\frac{kJ}{kg} - 95.47\ \frac{kJ}{kg}\right)$

$\boxed{Q_H = 3.912\ kW}$

11-58)



$P_1 = 160$ kPa
$h_1 = 241.14$ kJ/kg
$s_1 = 0.942$ kJ/kg·k

$P_2 = 500$ kPa
$s_{2i} = s_1 = 0.942$ kJ/kg·k
$h_{2s} = 264.55$ kJ/kg

$P_3 = 500$ kPa
$h_3 = 73.32$ kJ/kg

$$\eta_{sen} = \frac{h_{2s} - h_1}{h_2 - h_1}$$

$$0.8 = \frac{264.55 - 241.14}{h_2 - 241.14}$$

$h_2 = 270.4$ kJ/kg

$P_5 = 400$ kPa
$h_5 = 255.61$ kJ/kg
$s_5 = 0.927$ kJ/kg·k

$P_6 = 1.4$ MPa
$s_6 = 0.927$

$h_7 = h_F = 127.25$ kJ/kg
$h_8 = h_7 = 127.25$ kJ/kg

A) $\dot{m}_{Lower}(h_2 - h_3) = \dot{m}_{upper}(h_5 - h_8)$

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

$\boxed{\dot{m}_{upper} = 0.1689 \text{ kg/s}}$

B) $Q_L = \dot{m}_{Lower}(h_1 - h_4)$

$= 0.11(241.14 - 73.32)$

$\boxed{Q_L = 18.46 \text{ kW}}$

$$COP = \frac{Q_L}{W_{in,lower} + W_{in,upper}}$$

$$= \frac{0.11(241.14 - 73.32)}{0.11(220.4 - 241.14) + 0.1689(288.05 - 255.61)}$$

$$\boxed{COP = 2.12}$$