Q1: Answer the following questions. Each one carry (1/2 Mark). (4 Marks)

3

A) What is the main reason behind subcooling of liquid refrigerant at the condenser outlet in vapor compression refrigeration system?
- To increase the refrigerating effect
- To reduce the mass of vapor formed during expansion process
- To reduce vapor bubbles which obstruct the flow of liquid refrigerant
- All of the above

B) The chemical formula for the R12 is ....Cl—C—Cl........ (F above and below C) and R150 is ...Cl—C—C—Cl.... (H above and below each C)

C) Lowering the evaporator temperature while keeping the condenser temperature the same, the COP

Increase Decrease Unaffected Increase then decrease Unpredictable

D) What is the use of Flash Chamber in Rankine cycle. to mixing different phase of water

E) As the heat rejection temperature increases in the vapor power cycle above atmospheric pressure,
- The vacuum in the condenser also decreases
- The vacuum in the condenser increases
- It does not produce any vacuum in condenser
- None of the above

F) Rankine efficiency of a steam power plant
- Improves in summer as compared to that in winter
- Is unaffected by climatic conditions
- Improves in winter as compared to that in summer
- None of the above

$1 - \frac{T_L}{T_H}$

G) Regenerative heating i.e., bleeding steam to reheat feed water to boiler
- Decreases power output of the cycle
- Increases power output of the cycle
- Does not affect power output of the cycle
- May increase or decrease power output of the cycle depending upon the point of extraction of steam

H) In evaporation process of vapor compression refrigeration system
- Heat is rejected from refrigerant to surroundings
- Only pressure change takes place
- Heat is rejected from surroundings to refrigerant
- None of the above

Q2) Based on Thermodynamic Cycles

2-A) First Law and Second Law analysis

Consider a steam power plant that operates on an ideal reheat Rankine cycle. It is designed to supply 85 MW power output to a nearby village. $\dot{W}_{net} = 85 MW = 85 \times 10^3 KW$

Steam enters the ideal High Pressure turbine at 5 MPa and 500 °C.

It is then reheated to 400 °C at 400 kPa where it inters the ideal Low Pressure Turbine.

Finally it expands to the condenser at 10 kPa.

Assume a source temperature of 1700 K and a sink temperature of 293 K.

Draw the T-s diagram of the cycle then determine

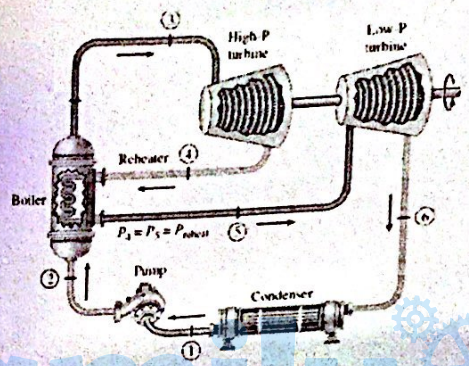
(a) The steam mass flow rate,

(b) The rate of turbine and pump works.

(c) The rate heat added and rejected.

(d) The thermal and second law efficiency,

(e) The exergy destroyed during each processes (except reheat) ~~and~~



Answer Here :

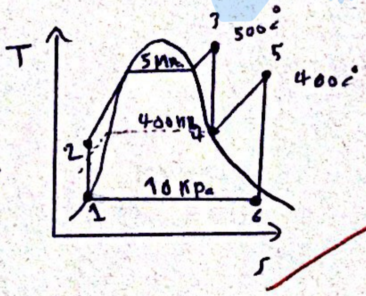
$v_{f_1} = 0.001010 \ m^3/Kg$

1) $h_1 = h_{f@10KPa} = 191.81 \ KJ/Kg$

$h_{fg} = 2392.1 \ KJ/Kg$

$s_f = 0.6492$, $s_{fg} = 7.4996 \ KJ/Kg.K$

$s_g = 8.1488 \ KJ/Kg.K$



2) $h_2 - h_1 = v_{f_1}(P_2 - P_1)$

$h_2 = 196.85 \ KJ/Kg$ $\boxed{s_2 = s_1}$

3) super heated since $T_3 > T_{sat@5MPa}$

$h_3 = 3434.7 \ KJ/Kg$

$s_3 = 6.9781 \ KJ/Kg.K$

4) $s_3 = s_4$, $P = 400 KPa$ $s_{g@400KPa} = 6.8955$

$s_4 > s_g$ ∴ super heated → $h_4 = 2774.04$

after interpolation

h	s
2752.8	6.9306
2860.9	7.1723

Ans Q-2-A Continue

5) super heated since $T_5 > T_{sat@400 KPa}$

$h_5 = 3273.9$ KJ/Kg

$s_5 = 7.9003$ KJ/Kg.K

6) $s_6 = s_5$, P = 10 KPa

$s_6 < s_{g@10KPa}$ ∴ wet mix

$s_6 = s_f + x_6 s_{fg}$

$x_6 = 0.967$ (acceptable)

$h_6 = h_f + x_6 h_{fg} \Rightarrow h_6 = 2504.65$ KJ/Kg

85×10^3 KW ← $\dot{W}_{net} = \dot{m}_s((h_3 - h_4) + (h_5 - h_6) - (h_2 - h_1))$

$\dot{m}_s = 59.655$ Kg/s (a)

(e)

$T_0 = 298 K$

$\dot{X}_{1-2} = 0$ (s = c)

$\dot{X}_{2-3} = \dot{m} T_0 \left[s_3 - s_2 - \frac{q_H}{T_H} \right]$

$= 78651.31$ KW

$\dot{X}_{3-4} = 0 = \dot{X}_{5-6}$

$\dot{X}_{6-1} = T_0 \left[\dot{m}(s_1 - s_6) + \frac{\dot{Q}_L}{T_L} \right]$

$= 27789.3$ KW

$\dot{W}_T = \dot{W}_{T_1} + \dot{W}_{T_2} = 85300.28$ KW (b)

$\dot{W}_P = \dot{m}_s(h_2 - h_1) = 300.66$ KW

$\dot{Q}_H = \dot{m}_s(h_3 - h_2) = 193153.94$ KW

$\dot{Q}_L = \dot{m}(h_4 - h_1) = 154064.4$ KW (c)

$\eta_{th} = 1 - \frac{\dot{Q}_L}{\dot{Q}_H} = 0.221$

$\eta_{carnot} = 1 - \frac{T_L}{T_H} = 0.827$ (d)

$\eta_{II} = 0.267$

2-B) USE P-H Chart ONLY to solve this question

Refrigerant-134a enters the condenser of a residential heat pump at 1000 kPa_abs and 80°C at a rate of 0.025 kg/s and leaves subcooled by 40 °C.

10 Bara

The refrigerant enters the compressor at 150 kPa superheated by 25 °C.

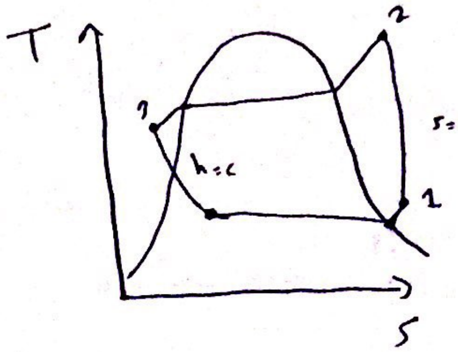
(a) Draw the cycle on the P-H chart and find the value of enthalpies at all points.

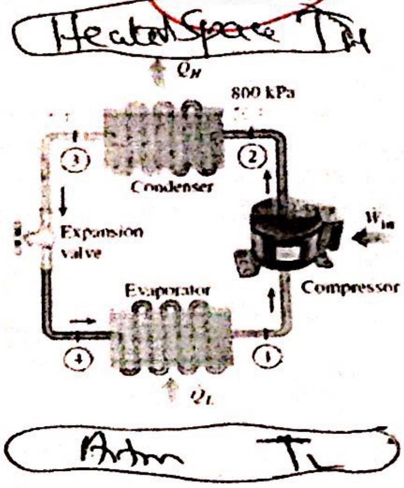
(b) Calculate the isentropic efficiency of the compressor,

(c) The rate of heat supplied to the heated room (in kW and Tonne), and

(d) The COP of the heat pump.

15





Answer Here :

from chart!

$h_1 = 312$ KJ/Kg   4

$h_{2a} = 365$ KJ/Kg   4

$h_3 = 63$ KJ/Kg

$h_4 = h_3$

$h_{2s} = 357$ KJ/Kg

(b) $\eta_{cs} = \frac{357 - 312}{365 - 312} = 0.85$

1 tonn = 3.714 kJ/s

(c) $\dot{Q}_H = \dot{m}_R(h_{2a} - h_3) = 7.55$ KW $= 2.804$ tonn

Check

(d) $COP_{H.P} = \frac{\dot{Q}_H}{W_c} = 5.698$