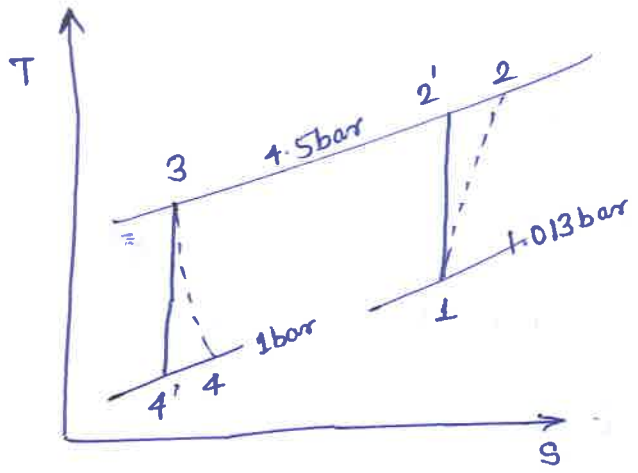
81498

Q.2.b. Tonnage = 21/3.5 = 6

$$T_2' = T_1\left(\frac{P_2}{P_1}\right)^{\gamma-1} = 303\left(\frac{4.5}{1.013}\right)^{0.286} = 465.15K$$

$$\eta_c = \frac{465.15 - 303}{T_2 - 303} = 0.84 \Rightarrow T_2 = 494.85K$$



$$\epsilon = 0.8 = \frac{T_2 - T_3}{T_2 - T_1} \Rightarrow T_3 = 341.3k$$

$$T_4' = \frac{T_3}{(P_3/P_4)^{0.286}} \Rightarrow T_4' = 222.85K$$

$$T_4 = T_3 - \frac{(T_3 - T_4')}{\eta_e} \Rightarrow T_4 = 246.55K$$

$$\dot{m} = \frac{\dot{Q}_c}{q_c} = \frac{21}{C_p(T_e - T_4)} = 0.3929\ kg/s$$

$\dot{Q}_{rej}$ = 59.57 KW

COP = 0.2820

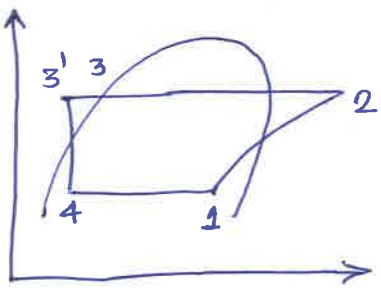
COP' = 0.5644

$P = \dot{m}C_p(T_2 - T_3) = 74.46KW$

$P_{blower} = \dot{m}C_p(T_3 - T_4) = 37.25KW$

i.e. 90% improvement in COP.

Q.3.a.



Ammonia P-h chart.

At −12°C $h_f = 150\ KJ/kg$

$h_g = 1450\ KJ/kg$

$h_1 = h_f + x h_{fg}$

$= h_f + x(h_g - h_f)$

$x = 0.95$ given.

$\therefore h_1 = 1385\ KJ/kg$ [2 marks]

Following isentropic lines from h_1 we get h_2 as.

$h_2 = 1575$ KJ/kg

$T_2 = 60°C$ ..... condition at comp. outlet.

$h_3 = 325$ kJ/kg $= h_4$

$T_3 = 23°C$

$$COP = \frac{h_1 - h_4}{h_2 - h_1} = 5.57$$ [2 marks]

$RE = h_1 - h_4 = 1060$ kJ/kg

$Q = 210 \times TR = 2100$ kJ/min

$\dot{m}_R = Q/RE = 1.98$ kg/min [2 marks]

$$\text{Work done} = \frac{\dot{m}_R (h_2 - h_1)}{60}$$

$= 6.27$ KW. [2 marks]

Q.4. b. $Td = 30°C$

$Pb = 1.01325$ bar

$\phi = 80\%$.

From steam table

$P_s = 0.04246$ bar

$$\phi = 0.8 = \frac{P_v}{P_s} \Rightarrow P_v = 0.34 \text{ bar}$$

$$w = 0.622 \frac{P_v}{P_b - P_v} = 0.622 \times \frac{0.34}{1.01325 - 0.34}$$

$w = 0.314$ kg/kg.

$$v = \frac{R_a T_d}{P_b - P_v} = \frac{287.2 \times 303.}{(1.01325 - 0.34) \times 10^5}.$$

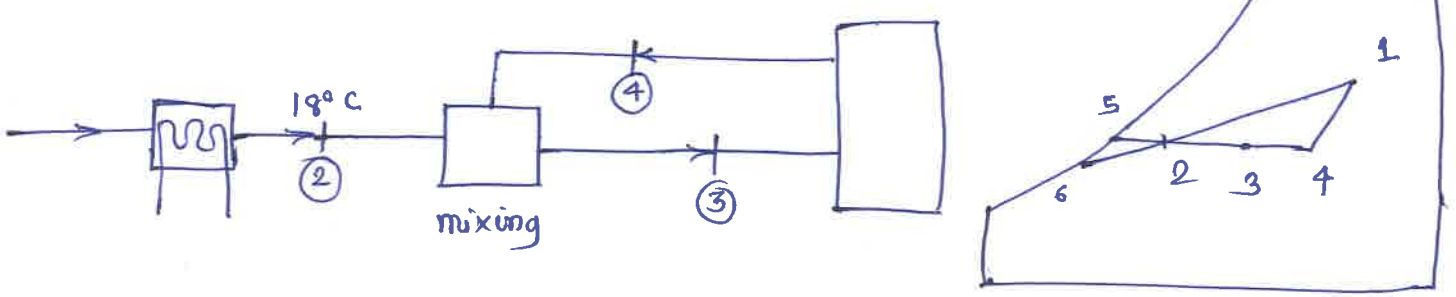
$$= 1.3 \text{ m}^3/\text{kg of dry air.}$$

$t_{dp} = 11.3°C$ corresponding to P_v from steam table

Q.5. a. Given: $t_{d4} = 27°C$, $\phi_4 = 60\%$. $t_{d1} = 40°C$, $t_{w1} = 30°C$

RSH = 100000 kJ/h. ; RLH = 40,000 kJ/h. $t_{d2} = 18°C$

$$RSHF = \frac{RSH}{RTH} = 0.714.$$



$t_{d3} = 23°C$

$t_{w3} = 19.5°C$

$\phi_3 = 72\%$.

$h_4 = 61$ kJ/kg of dry air

$h_3 = 56$ kJ/kg of dry air.

$$\dot{m}_s = \frac{RSH + RLH}{h_4 - h_3} = 28000 \text{ kg/hr.}$$

man of makeup air = $0.4 \times 28000 = 11200$ kg/hr.

ADP = $t_{d6} = 13°C$

$$BPF = \frac{t_{d2} - ADP}{t_{d1} - ADP} = \frac{18-13}{40-13} = 5/27 = 0.185.$$

——— x ———