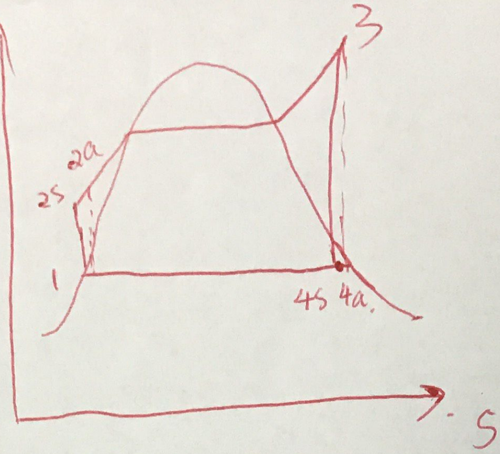
1.



① $T_1 = 20°C$, Sat. liq. } ⇒ $P_1 = P_{sat,20°C} = 2.3392$ kPa.

$h_1 = 83.915$ kJ/kg.

$s_1 = 0.2965$ kJ/kg·K.

$v_1 = 0.001002$ m³/kg.

② $P_{2s} = 0.8$ MPa, $s_{2s} = s_1$ } $w_{1-2,s,in} \cong v_1 (P_{2s} - P_1)$.

$$w_{1-2a,in} = \frac{w_{1-2s,in}}{\eta_c} = \frac{v(P_2 - P_1)}{\eta_c} \doteq 0.841 \text{ kJ/kg}.$$

$h_{2a} - h_1 = w_{1-2a,in} \Rightarrow h_{2a} \doteq 84.76$ kJ/kg.

$P_{2a} = 0.8$ MPa

③ $P_3 = 0.8$ MPa

$h_3 = h_{2a} + 3183$ kJ/kg $\doteq 3267.76$ kJ/kg } ⇒ $T_3 \doteq 400°C$

$s_3 \doteq 7.5735$.

$v_3 = 0.38429$.

④ $P_{4s} \doteq 2.3392$ kPa.

$$x_{4s} = \frac{s_{4s} - s_f}{s_{fg}} \doteq 0.872, \quad h_{4s} \doteq 2225.7 \text{ kJ/kg} \Rightarrow h_{4a} \doteq 2329.9 \text{ kJ/kg}.$$

(2). $W_{net} \doteq \dot{m}\left(h_3 - h_{4a}\right) - \left(h_{2a} - h_1\right)$

$\doteq 0.2 kg/s \cdot 939.96 \; kJ/kg$

$\doteq 187.99 \; kW$.

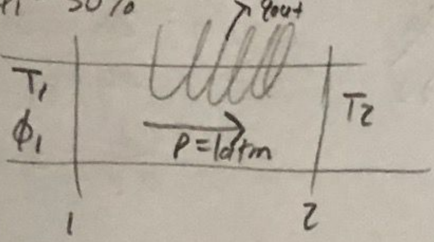
(3). $\eta_{th} = \frac{w_{net}}{q_{in}} = \frac{939.96 \; kJ/kg}{3183. \; kJ/kg} \doteq 29.53\%$.

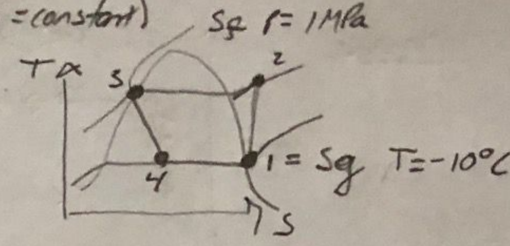
2. Given simple cooling section (ω = constant)

$P = 1atm$ $\dot{V} = 0.01 \ m^3/s$

$T_1 = 35°C \rightarrow T_2 = 25°C$

$\phi_1 = 30\%$





Find: 1) $\dot{Q}_{out}$
2) thermo state of refrigerant at each state
3) $\dot{m}_{R134a}$
4) Win needed

1) using psychrometric chart $h_1 \approx 62 \ KJ/Kg$ $v_1 \approx 0.888$

$\omega_1 = \omega_2 = 0.0105 \ Kg \ H_2O / Kg \ dry air$

$T_2 = 25°C$

$h_2 \approx 52 \ KJ/Kg$

$\phi_2 \approx 52\%$

$\dot{m}_a = \frac{\dot{V}}{v_1} = \frac{0.01 \ m^3/s}{0.888 \ m^3/Kg} = 0.0113 \ Kg/s$

Energy Balance: $\dot{m}_a h_1 = \dot{m}_a h_2 + \dot{Q}_{out}$

$\dot{Q}_{out} = \dot{m}_a (h_1 - h_2)$

$= (0.0113)(62 - 52)$

$\dot{Q}_{out} = 0.113 \ KW$

2) ① $T_1 = -10°C$ sat vapor

$h_1 = h_g = 244.51 \ KJ/Kg$

$s_1 = s_g = 0.93766$

② $s_2 = s_1$, $P_2 = 1 MPa$ $s_2 > s_g$ superheated

$h_2 \approx \frac{282.74 + 271.71}{2} = 277.23 \ KJ/Kg$

$T_2 \approx 45°C$

③ $P = 1MPa$, saturated liq

$h_3 = h_f = 107.32 \ KJ/Kg$

④ throttling, $h_3 = h_4 = 107.32$, $T = -10°C$

3) $\dot{Q}_{out} = \dot{m}_R (h_1 - h_4)$

$0.113 = \dot{m}_R (244.51 - 107.32)$

$\dot{m}_R = .0008 \ Kg/s$

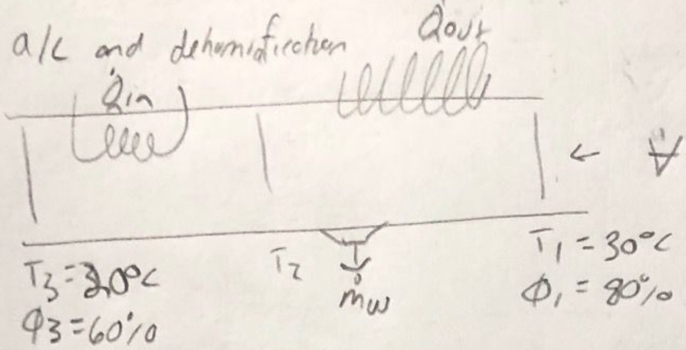
4) $\dot{w}_{in} = \dot{m}_R (h_2 - h_1)$

$= (.0008)(277.23 - 244.51)$

$\dot{w}_{in} = 0.026 \ KW$

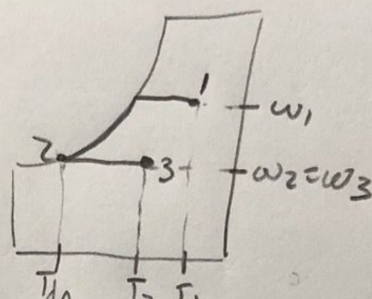
3. Given:

a/c and dehumidification



1. $T_1, \phi_1 \} \; v_1 \approx 0.888,\; h_1 \approx 85,\; w_1 = .0215$ (a)

$T_3, \phi_3 \} \; h_2 \approx 43,\; w_2 = .009$



(b) $\dot{m}_{a1} = \frac{\dot{V}}{v_1} = \frac{0.02}{.888} = .0225\ kg/s$

H_2O Balance $\quad \dot{m}_{a1} w_1 = \dot{m}_{a2} w_2 + \dot{m}_w$

$\dot{m}_w = \dot{m}_a(w_1 - w_2) = 0.0225(.0215 - .009) = 0.0002815\ kg/s$

$\boxed{\dot{m}_w = 2.8575 \times 10^{-4}\ kg/s}$

(c) $h_2 = 35\ kJ/kg$ d.a.

$T_{dp} = T$ @ 100% relative humidity

$T_{dp} = 12°C$

$h_w = h_f @ 12°C \approx 46.4\ kJ/kg = h_2$

Energy balance 1 → 2

$\dot{m}_a h_1 = \dot{m}_a h_2 + \dot{m}_w h_w + \dot{Q}_{out}$

$\dot{m}_a(h_1 - h_2) - \dot{m}_w h_w = \dot{Q}_{out}$

$\dot{Q}_{out} = (.0225)(85 - 35) - (2.8575 \times 10^{-4})(46.4)$

$\boxed{\dot{Q}_{out} = 1.11\ kW}$

(d) 2 → 3 no water addition w = constant

$\dot{Q}_{in} + \dot{m}_a h_2 = \dot{m}_a h_3$

$\dot{Q}_{in} = \dot{m}_a(h_3 - h_2) = (0.0225)(43 - 35) = \boxed{0.2\ kW = \dot{Q}_{in}}$