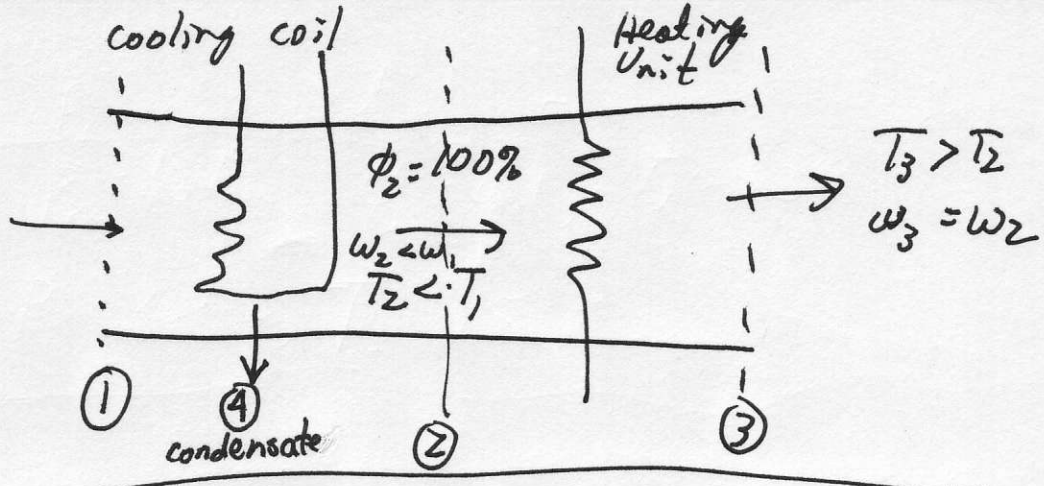
12.72



$T_1 = 26°C \quad \phi_1 = 0.80 \quad \dot{V}_1 = 0.47\ m^3/s$

$T_3 = 26°C \quad \phi_3 = 0.50$

S.S., KE & PE effects are negligible

(a) Heat removed from (1) → (2) = ?

Get states $\quad \omega = 0.622 \dfrac{P_v}{P - P_v}$

$\omega_1 = 0.622 \dfrac{P_{v_1}}{P - P_{v_1}} \qquad P_{v_1} = \phi_1 P_{g_1} \qquad P_{g_1} = .03363$ bar

$\omega_1 = 0.0172$

$\omega_3 = .0106$

$\omega_2 = \omega_3 = .0106 \Rightarrow$ from psychrometric chart, $T_2 = 15°C$

$\dot{m}_a = \dot{V}_1 \rho_{a_1} \qquad P_{a_1} = \rho_{a_1} R_a T \qquad \rho_{a_1} = 1.18\ kg/m^3$

$\dot{m}_a = 0.55\ kg/s$

→

12.72 (continued)

C.O.E. $\frac{dE}{dt} = \dot{Q} - \cancel{\dot{W}} + \sum_i \dot{m}_i h_i - \sum_e \dot{m}_e h_e$

$$\dot{Q} = \dot{m}_a (h_{a2} - h_{a1}) + \dot{m}_{v2} h_{v2} - \dot{m}_{v1} h_{v1} + \dot{m}_{cond} h_{f4}$$

$$\dot{Q} = \dot{m}_a \left[h_{a2} - h_{a1} + \omega_2 h_{v2} - \omega_1 h_{v1} + \frac{\dot{m}_{cond}}{\dot{m}_a} h_{f4} \right]$$

$h_v \approx h_g(T)$

$$\dot{m}_{cond} = \dot{m}_{v1} - \dot{m}_{v2} = \dot{m}_a (\omega_1 - \omega_2)$$

$$\frac{\dot{m}_{cond}}{\dot{m}_a} = \omega_1 - \omega_2$$

$$\dot{Q} = \left(0.55 \frac{kg}{s}\right)\left[288.1 \frac{kJ}{kg} - 299.2 \frac{kJ}{kg} + (.0106)(2528.9\ kJ/kg) - (.0172)\left(2549 \frac{kJ}{kg}\right) + (.0172 - .0106)\left(62.99 \frac{kJ}{kg}\right)\right]$$

$$\boxed{\dot{Q} = -15\ kW = -4.3\ tons}$$

12.72 (continued)

(b) $\dot{Q}$ for heating section

$$\frac{dE}{dt} = \dot{Q} - \dot{W} + \sum_i \dot{m}_i h_i - \sum_e \dot{m}_e h_e$$

$$\dot{Q} = \dot{m}_a (h_{a3} - h_{a2}) + \dot{m}_v (h_{v3} - h_{v2})$$

$$\dot{Q} = \dot{m}_a \left[h_{a3} - h_{a2} + \omega_3 (h_{v3} - h_{v2}) \right]$$

$$= (0.55 \text{ kg/s}) \left[299.2 \frac{\text{kJ}}{\text{kg}} - 288.1 \frac{\text{kJ}}{\text{kg}} + (.0106) \left(2549 \frac{\text{kJ}}{\text{kg}} - 2528.9 \frac{\text{kJ}}{\text{kg}} \right) \right]$$

$$\boxed{\dot{Q} = 6.22 \text{ kW}}$$