60.

$h_{fg} = 2450 \text{ kJ/kg}$

$\dot{m}_v = 4 \cdot 0.25 \text{ kg} = 1 \text{ kg a day}$

$\dot{Q} = \dot{m}_v h_{fg}$

$= (1)(2450)$

$Q = 2450 \text{ kJ/day}$

67.

$T_1 = 35^\circ C$ at 45% humidity $\quad \omega_1 = \omega_2$

$\omega_1/\omega_2 = 0.0016 \text{ kg } H_2O/\text{kg dry air}$

$h_1 = 76.25 \text{ kJ/kg dry air}$

$V_1 = 0.895 \text{ m}^3/\text{kg dry air}$

$h_g = 750$

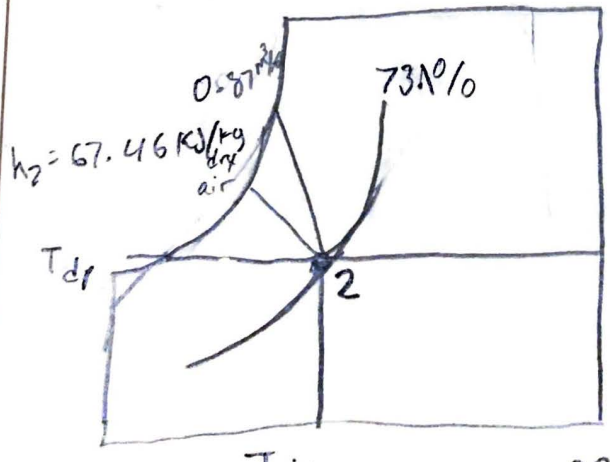
mass flow rate

$\dot{m}_a = \frac{1}{V_{a1}} V_1 \left(\frac{\pi}{4} D_1^2\right)$

$\dot{m}_a = \frac{1}{.895} \quad \frac{(18)\pi}{4} \times 0.5^2 = 1.422 \text{ kg/s}$

$\dot{m}_a h_1 = \dot{m}_a h_2 + Q_{out}$

$h_2 = \frac{\dot{m}_a h_1 - Q_{out}}{\dot{m}_a} = \frac{1.422 \times 76.25 - 750 \times \frac{1}{60}}{1.422} = 67.46 \text{ kJ/kg dry air}$



$\omega_1 = \omega_2$

0.016 kg H_2O / kg dry air

T_2 26.3°C (dry bulb)

67. cont

a) $T_2 = 26.3°C$

b) $\phi = 73.1\%$

$v_2 = 0.87\ m^3/kg$

c) $\dot{m}_a = \frac{V_2 A_2}{v_{a2}}$

$V_2 = \frac{v_{a2}\dot{m}_a}{A_2}$

$= \frac{.87 \times 1.422}{\frac{\pi}{4}(0.3)^2} = \boxed{17.5\ m/s}$

77.

$T_1 = 90^\circ F$ at 90% relative humidity $= \phi$ 90%

$T_2 = 50^\circ F$ at 100% relative humidity $= \phi_2 = 100\%$

$T_3 = 60^\circ F$

Enthalpy of saturated liq

$h_f = 28.08$ Btu/lbm

$\omega_1 = 0.028$ lbm H_2O / lbm dry air

$h_1 = 52.41$ Btu / lbm dry air

section 2.

$T_2 = 50^\circ F$ and $\omega_2 = 0.008$ lbm H_2O / lbm dry air

$\phi_2 = 100\%$ $h_2 = 20.5$ Btu/lbm dry air

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

$$\Delta\omega = \omega_1 - \omega_2$$

$$= .028 - .008$$

$\Delta\omega = 0.0202$ lbm H_2O / lbm dry air

$$q_{out} = h_1 - h_2 - \frac{\dot{m}_w}{\dot{m}_a} h_f = h_1 - h_2 - (\omega_1 - \omega_2) h_f$$

$$= 52.41 - 20.5 - (0.0202)\ 28.08$$

$$= 31.3 \text{ Btu/lbm dry air}$$

93. $T_1 = 40°C$

$\phi_1 = 0.20$

$P = 1$ atm

a) $T_{wb} = 22.04°C$

$\omega_1 = .009199$ kg H_2O/kg dry

$v_1 = .9002\ m^3$/ kg dry air

$T_2 = 23.3°C$

$\omega_2 = 0.01619$ kg H_2O/kg dry air

b)

$$\dot{m}_a = \frac{\dot{V}_1}{v_1} = \frac{7\ m^3/min}{.9002\ m^3/kg\ dry\ air} = 7.776\ kg/min$$

$$\dot{m}_s = m_a(\omega_2 - \omega_1)$$

$$\omega_2 - \omega_1 = .01619 - 0.009199$$

$$7.776(.006991) = \boxed{0.05413\ kg/min}$$

100.

$T_1 = 35^\circ C$

$\phi = .30$

$h_1 = 62.5$ KJ/Kg dry air

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

$P_1 = 10^5$ Pa $\quad T_1 = (35+273)K$

$R = 287$ J/Kg·K

$P_1 V_1 = RT$

$$V_1 = \frac{287(308)}{10^5} = .88396 \text{ m}^3/\text{Kg}$$

$$\dot{m}_1 = \frac{\dot{V}_1}{V} = \frac{15 \text{ m}^3/\text{min}}{.88396 \text{ m}^3/\text{Kg}} = 16.969 \text{ Kg/min}$$

$T_2 = 12^\circ C$

$\phi \quad .90$

$h_2 = 32$ KJ/Kg dry air

$\omega_2 = .008$ Kg H_2O / Kg dry air

$P_2 V_2 = RT_2$

$P_2 = P_1$

$T_2 = (12+273)K$

$$V_2 = \frac{287(285)}{105} = 0.81795 \text{ m}^3/\text{Kg}$$

$$\dot{m}_2 = \frac{\dot{V}_2}{V_2} = \frac{25 \text{ m}^3/\text{min}}{.81795 \text{ m}^3/\text{Kg}} = 30.564 \text{ Kg/min}$$

$\dot{m}_3 = 30.564 + 16.969 = 47.533$ Kg/min

$$\frac{\dot{m}_1}{\dot{m}_2} = \frac{h_2 - h_3}{h_3 - h_1} = \frac{16.969}{30.564} = \frac{32 - h_3}{h_3 - 62.5}$$

$16.969 h_3 - 1060.56 = 978.048 - 30.56\, h_3$

$47.53 h_3 = 2038.61$

$h_3 = 42.89$ KJ/Kg dry air

100 cont

$$\frac{16.969}{30.564} = \frac{0.008 - \omega_3}{\omega_3 - 0.005}$$

$$16.969\omega_3 - 0.17817 = 0.2445 - 30.564\omega_3$$

$$47.533\,\omega_3 = 0.42267$$

$$\boxed{\omega_3 = 0.00889 \text{ Kg } H_2O \text{ /Kg dry air}}$$

$$\boxed{T_3 = 20.2^\circ C}$$

$$\boxed{\phi_3 = 59.7\%}$$

$$P_3 v_3 = RT_3 \qquad T_3 = (20.2 + 273)K$$

$$v_3 = \frac{287 \times 293}{105} = 0.8415 \text{ m}^3/\text{kg}$$

$$\dot{V}_3 = \dot{m}_3 \times v_3$$

$$= 47.533 \times 0.8419$$

$$= \boxed{40 \text{ m}^3/\text{min}}$$