MAE 3310 Pset # 10

6.98

$$COP_R = \frac{T_L}{T_H - T_L} = \frac{265}{33} = 8.03$$

$$\dot{W}_{min} = \frac{\dot{Q}_L}{COP_R} = \frac{300\ kJ/min}{8.03 \times 60} = 0.623\ kW$$

6.103

$$COP_{HP} = \frac{T_H}{T_H - T_L} = \frac{295}{20} = 14.75$$

$$\dot{W}_{min} = \frac{\dot{Q}_H}{COP_{HP}} = \frac{110{,}000\ kJ/h}{14.75} \times \frac{1}{3600\ s/h}$$

$$= \underline{2.07\ kW}$$

6.110

$$COP_{HP} = \frac{T_H}{T_H - T_L} = \frac{298}{28} = 16.3$$

$$Q_H = (\dot{Q}_H)(24) = (82{,}000)(24) = 1{,}968{,}000\ kJ$$

$$W = \frac{Q_H}{COP_{HP}} = \frac{1{,}968{,}000\ kJ}{16.3} = 120{,}763\ kJ$$

$$\Delta t = \frac{W}{\dot{W}} = \frac{120{,}763\ (kJ)}{8\ kJ/s} = 15{,}092\ s$$

$$= \underline{4.19\ h}$$

(b) Cost: $(8\ kW)(4.19\ h) \times \$.085/kWh$

$$= \$2.85/day.$$

(c) $(1{,}968{,}000\ kJ)\frac{(1\ kWh)}{(3600\ kJ)}(\$.085) = \underline{\$46.47}$

6-113 R-134a

$P = 500\,kPa$, sat. vapor
$h = 259.30\ kJ/kg$
$v = 0.04112\ m^3/kg$

$P_2 = 1.2\,MPa$, $T_2 = 50°C$) SH
$h = 278.27\ kJ/kg$

$$\dot{m}_R = \frac{\dot{V}_1}{v_1} \quad \text{(at the Comp. inlet)}$$
$$= \left(100\ \ell/min\right)\left(\frac{1}{1000\,\ell}\right)\left(\frac{1\,m}{60\,s}\right)$$
$$= 0.0405\ kg/s$$

$$\dot{W}_{in} = \dot{m}_R (h_2 - h_1) = (0.0405)(278.27 - 259.3)$$
$$= \underline{0.769\ kW}$$

$$\dot{Q}_L = \frac{(250)\,6}{60} + 0.9 = \underline{5.067\ kW}$$

$$COP = \frac{\dot{Q}_L}{\dot{W}} = \frac{5.067}{0.769} = 6.59$$

$$COP_{R,max} = \frac{T_L}{T_H - T_L} = \cancel{\frac{299}{8} = 37.4}$$
$$299/8 = \underline{37.4}$$

$$\dot{W}_{min} = \frac{\dot{Q}_L}{37.4} = \frac{5.067}{37.4} = \underline{0.136\ kW}$$

Minimum Refrigerant flow rate is the same as above.

6.122 $$V_{air} = \frac{(0.6)}{2}(8/day)(365) = 876\ m^3/yr$$

$$\rho_o = \frac{P_o}{RT_o} = \frac{95}{(0.28)(277)} = 1.2\ kg/m^3$$

$$m_{air} = \rho V = (876)(1.2) = \underline{1051.2\ kg/year}$$

Moisture $= 1051 \times .006$

$\underline{6.306 \text{ kg/year}}$

$Q_{gain} = Q_{sensible} + Q_{latent}$

$Q_{Total} = 32,500 \text{ kJ/year}$

$\dot{W} = \frac{Q}{COP} = \frac{32,500}{1.4} = 6.5 \text{ kWh/yr.}$

$\text{Cost} = 6.5 \times .075$

$\underline{\$0.48/\text{yr}}$

(b) Same as above except for latent.

$\underline{151}$ $\dot{m}_{water} = (0.4)(20)(1) = 8 \text{ kg/hr.}$

Sensible load: $(8)(4.18)(22-8) = 468 \text{ kJ/h}$

$= \underline{130 \text{ W}}$

$\dot{Q}_{gain} = 45 \text{ W}$

$Q_{Total} = 130 + 45 = 175 \text{ W}$

$COP_R = 2.9$

$\dot{W}_{ref} = \frac{\dot{Q}_{ref}}{COP} = \frac{175 \text{W}}{2.9} = \underline{\underline{60.3 \text{W}}}$

$\underline{159}$ $\dot{Q}_H = \dot{m} c_p (\Delta T)$

$= \left[\frac{(0.02)\text{m}^3}{60 \text{ s}}\right] \times \frac{1}{.001 \text{ (m}^3\text{/kg)}} (4.18) (40°C)$

$= \underline{55.7 \text{ kW}}$

$COP_{HP} = \frac{T_H}{T_H - T_L} = \frac{303}{30} = \underline{\underline{10.1}}$

$\dot{W}_{in} = \dot{Q}/COP = \frac{55.7}{10} = \underline{\underline{5.57 \text{ kW}}}$