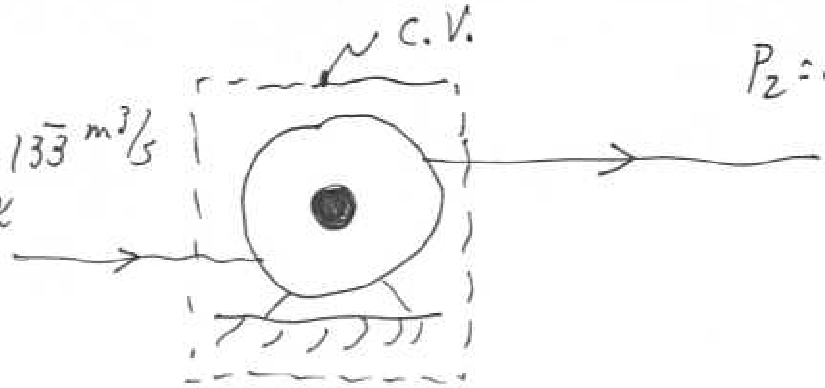
6.163 $\dot{V}_1 =$

$\dot{V}_1 = 8\ m^3/min = .13\overline{3}\ m^3/s$

$T_1 = 23°C = 296K$

$P_1 = 0.12\ MPa$



$P_2 = 1.5\ MPa$

Given: Air, S.S., isothermal compression, no internal irreversibilities,
$\Delta KE = \Delta PE = 0$

Note: $\dot{V}_1$ not necessarily equal to $\dot{V}_2$. This is a gas.

$\dot{W} = ?$ $\dot{Q} = ?$

C.O.E. $\cancel{\frac{dE}{dt}} = \dot{Q} - \dot{W} + \dot{m}_i(h_i + \cancel{\frac{V_i^2}{2}} + \cancel{gz_i}) - \dot{m}_e(h_e + \cancel{\frac{V_e^2}{2}} + \cancel{gz_e})$

S.S.

$$\frac{\dot{Q}}{\dot{m}} - \frac{\dot{W}}{\dot{m}} = h_2 - h_1$$

Forced to assume the air is an ideal gas.

In this case, since $h = h(T)$, $h_2 - h_1 = 0$

$$\frac{\dot{Q}}{\dot{m}} - \frac{\dot{W}}{\dot{m}} = 0 \qquad \dot{Q} = \dot{W}$$

Entropy Balance

$$\underset{0}{\cancel{\frac{dS}{dt}}} = \sum_j \frac{\dot{Q}_j}{T_j} + \dot{m}_i s_i - \dot{m}_e s_e + \cancel{\dot{\sigma}}^{\,0}$$

$$\frac{\dot{Q}}{\dot{m}} = T(s_2 - s_1)$$

For an ideal gas $s(T_2, P_2) - s(T_1, P_1) = \underbrace{s°(T_2) - s°(T_1)}_{=0} - R\ln\left(\frac{P_2}{P_1}\right)$

$$\frac{\dot{Q}}{\dot{m}} = TR\ln\left(\frac{P_2}{P_1}\right) = 214.5\ \frac{kJ}{kg}$$

6.163 continued

$\dot{m} = ?$ $\quad \dot{V}_1 = v\,\dot{m}$ $\quad pv = RT$ $\quad v = \frac{RT}{p} = \frac{(287\,\frac{J}{kg\cdot K})(298\,K)}{(.12\times10^6\,Pa)}$

$v = 0.708\ m^3/kg$

$\dot{m} = 0.188\ kg/s$

$\therefore\ \dot{Q} = \dot{W} = (214.5\,\frac{kJ}{kg})(.188\ kg/s) = \underline{\underline{40.4\ kW}}$