15.14

$$Q_{rc} = K A_t \sqrt{\frac{2g(p_1 - p_2)}{\rho}}$$

$$K = \frac{C}{\sqrt{1-\beta^4}}$$

$\beta = \frac{d}{D} = .752$

$C = .995$

$K = 1.206$

$A = \pi (3in)^2 = 28.27 in^2$

$\rho = .86 \frac{g_a}{g_{H_2O}} (62.4) = 53.664 \ lb/ft^3$

$\dot{Q} = .14 \ m^3/s$

$V = .14 \ L/s$

$Q = 252 \ L$ in 30 mins

15.16 $Q = KA\sqrt{\frac{2g(\Delta P)}{\rho}}$

$A = .1257 in^2$

$\rho = \frac{P}{RT} = 1.512 \frac{kg}{m^3}$

$K = \frac{C}{\sqrt{1-\beta^4}}$

$\beta = \frac{d}{D} = .867$

$K = 1.099$

$\Delta P = 823.2 \ N/m^2$

$Q = 1.09(.1257)\sqrt{\frac{2(1)(823.2)}{1.512}}$

$Q = 4.562 \ m^3/s$

$\dot{m} = \rho Q$

$\dot{m} = 6.898 \frac{kg}{s}$

15.29 $V = \sqrt{\frac{2(\Delta P)}{\rho}}$

$\Delta P = 6 \ cm H_2O \left(\frac{98.0665 Pa}{1 cm H_2O}\right) = 588.4 Pa$

$V = \sqrt{\frac{2 \cdot 588.4}{1000}} = 1.0848 \frac{m}{s} = 3.6 \ ft/s$

31. $\Delta P = 44110 Pa$

a) $V = \sqrt{\frac{2 \cdot 1 \cdot 44110}{1.105}} = 89.34 \ m/s$

b) $V = \sqrt{2\left(\frac{1.4}{1-1.4}\right)\left(\frac{90.e^3}{1.105}\right)\left[\left(\frac{90e^3 + 4.4e^3}{90.e^3}\right)^{\frac{1.4}{1-1.4}} - 1\right]}$

$V = 88.5 \ m/s$