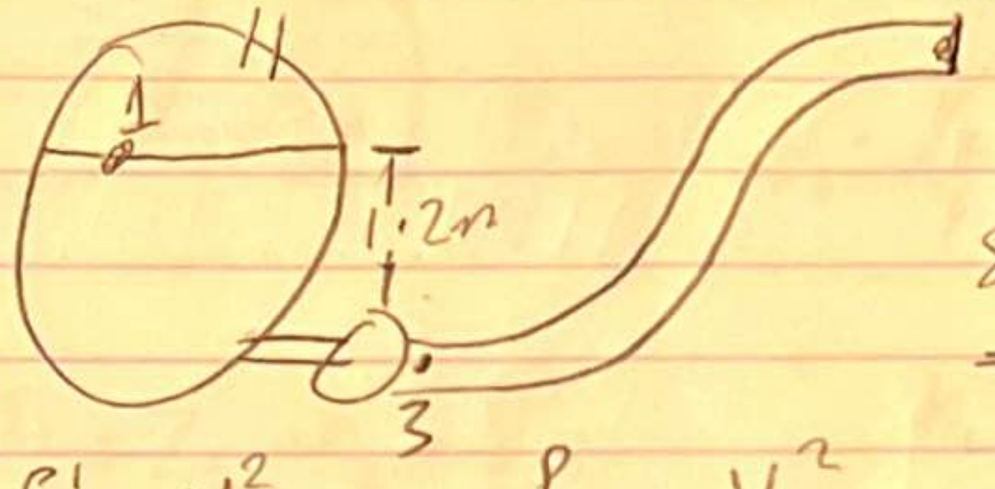
HW 5

Logan Hood

8.33 Ex 1

8.38



Ref

$D = 25mm$

$\gamma = 1.1 \times 9.81 kN/m^3$

$\mu = 2 \times 10^{-3} Pa \cdot S$

$Q = 95 L/min = 1.58 \times 10^{-3} m^3/s$

$$h_A + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$A = \frac{\pi}{4} D^2 = .025^2 \cdot \frac{\pi}{4}$

$A = 4.91 \times 10^{-4} m^2$

$\rho = 1.1 \times 1000 \frac{Kg}{m3}$ $\rho = 1100 Kg/m^3$

$V = \frac{Q}{A} = \frac{1.58 \times 10^{-3} m^3/s}{4.91 \times 10^{-4} m^2}$

$V = 3.22 m/s$

$N_R = \frac{\rho V D}{\mu} = \frac{1100 Kg}{m3} \cdot \frac{3.22 m}{sec} \cdot \frac{.025 m}{2 \times 10^{-3} Pa/s}$ $N_R = 44275$

$$f = \frac{.25}{\left[\log\left(\frac{1}{3.7(\frac{0}{L})} + \frac{5.74}{N_R^{.9}}\right)\right]^2}$$ $f = .0214$

$$h_L = f \frac{L}{D} \times \frac{V^2}{2g}$$ $h_L = .0214 \times \frac{85m}{.025m} \times \frac{(3.22 m/s)^2}{2 \times 9.81 m/s^2}$

$h_L = 38.45 m$

$$h_A = \left(\frac{P_2}{\gamma} - \frac{P_1}{\gamma}\right) + \left(\frac{V_2^2 - V_1^2}{2g}\right) + (z_2 - z_1) + h_L$$

$h_A = \frac{140 KPa}{1.1 \times 9.81 kN/m3} + \frac{(3.22 m/s)^2}{2 \times 9.81 m/s^2} + (8.5m - 1.2m) + 38.45m$

$h_A = 59.25 m$

Power $= h_A \gamma Q = 59.25m \cdot (1.1 \times 9.81 kN/m3) \times 1.58 \times 10^{-3} m3/s$

Power $= 1.01 kW$

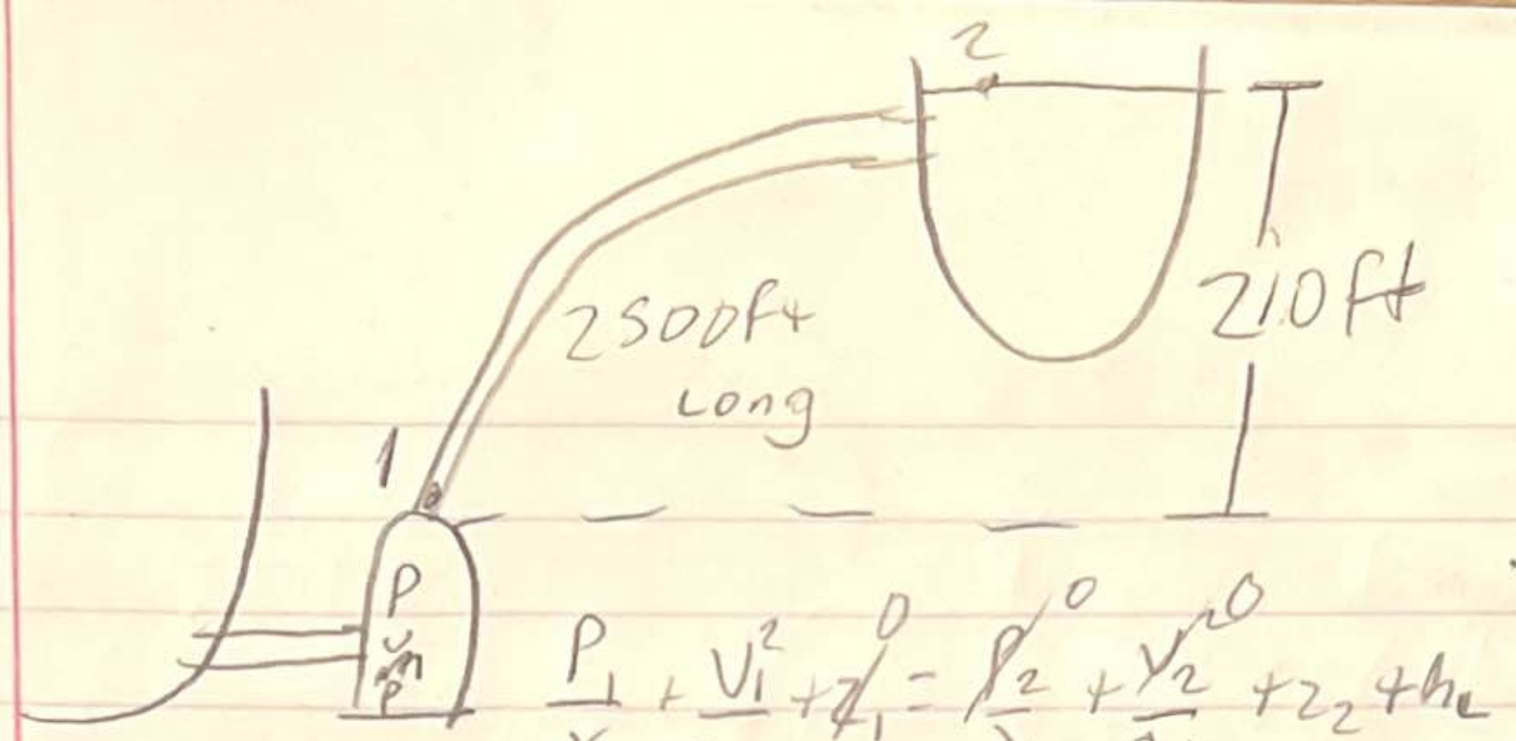
$V_3 = V_2$

$$\frac{P_3}{\gamma} + \frac{V_3^2}{2g} + z_3 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$\frac{P_3}{\gamma} = \frac{140 KPa}{1.1 \cdot 9.81} + 8.5m + 38.45m$

$P_3 = 587.85 KPa$

8.46



$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

60°F

$\eta = 2.35\times10^{-5} \frac{lb\cdot s}{ft^2}$

$D = .6651\,ft$

$\varepsilon = 1.5\times10^{-4}\,ft$

$\gamma = 62.4\,lb/ft^3$

$Q = 4\,ft^3/s$

$A = \frac{\pi}{4} D^2$

$A = \frac{\pi}{4}(.6651ft)^2$

$A = .347\,ft^2$

$V = \frac{Q}{A} = \frac{4\,ft^3/s}{.347\,ft^2} = 11.5\frac{ft}{sec}$

$\rho = 1.94\,slugs/ft$

$$\frac{P_1}{\gamma} = Z_2 + h_L - \frac{V_1^2}{2g} \qquad h_L = f\frac{L}{D}\frac{V^2}{2g}$$

$N_R = \frac{\rho D V}{\eta}$ $\quad \frac{1,94 \cdot .6651 \cdot 11.5}{2.35\times10^{-5}}$ $\quad N_R = 631420,5$

$f = .015$ (from excel)

$h_L = .015 \times \frac{2500ft}{.6651ft} \times \frac{(11.5ft/s)^2}{2\times32.2\frac{ft}{sec^2}}$ $\quad h_L = 115.8ft$

$P_1 = 62.4\frac{lb}{ft^3}\left(210ft + 115.8ft - \frac{(11.5\frac{ft}{sec})^2}{2\times32.2\frac{ft}{sec^2}}\right) \times \frac{1ft^2}{144in^2}$

$\boxed{P_1 = 140.3psi}$

10.22 4" Schedule 80 DN125 (122.3mm) to DN 50 (44.3mm) $Q = 500\frac{L}{min}$

$h_L = K(V_2^2/2g)$ $\quad \frac{D_1}{D_2} = \frac{122.3}{44.3} = 2.5$ $\quad A = \frac{\pi}{4}D^2$

From 10.3A $K = .39$ $\quad A_2 = \frac{\pi}{4}(.0443m)^2$

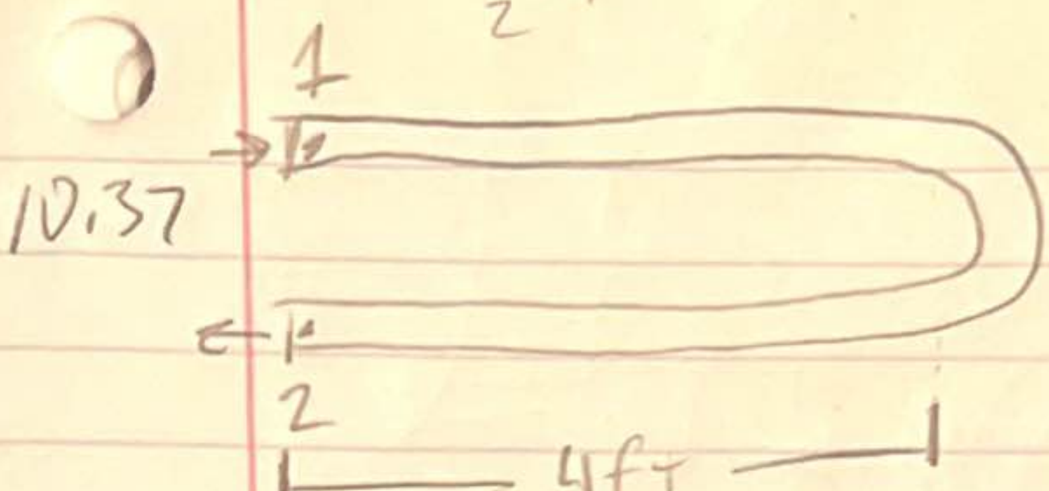
$h_L = .39\frac{(4.139m/s)^2}{2\times9.81m/s^2}$ $\quad \boxed{h_L = .383m}$ $\quad A_2 = .0019m^2$

$V_2 = \frac{Q}{A_2} = \frac{.00853\frac{m^3}{sec}}{.0019m^2}$

$V_2 = 4.139m/s$

$\frac{1}{2}$ in sch 40 pipe

ethylene glycole at 77°F



$Q = 12.5 \frac{g}{min} \times \frac{1 ft^3/s}{449 gpm} \quad Q = .0278 \frac{ft^3}{s}$

$\rho = 2.13 \frac{slug}{ft^3} \quad D = .0518 ft$

$\gamma = 68.47 \frac{lb}{ft^3} \quad A = \frac{\pi}{4} D^2$

$\varepsilon = 1.5 \times 10^{-4} \quad A = \frac{\pi}{4}(.0518ft)^2$

$A = .00211 ft^2$

$h_L = f \frac{L}{D} \frac{V^2}{2g} \quad N_R = \frac{\rho V D}{\eta}$

$V = \frac{Q}{A} = \frac{.0278 ft^3/s}{.00211 ft^2}$

$\eta = 3.38 \times 10^{-4} lb \cdot s/ft^2$

$V = 13.175 \frac{ft}{sec}$

$N_R = \frac{2.13}{ft^3} lbs^2 \cdot \frac{13.175 ft}{sec} \cdot .0518 ft \cdot \frac{ft^2}{3.38 \times 10^{-4} lb \cdot s}$

$N_R = 4300.74 \quad D/\varepsilon = \frac{.0518 ft}{1.5 \times 10^{-4} ft} = 345.33$

$f = .043$

$h_L = .043 \times \frac{8 ft}{.0518 ft} \times \frac{(13.175 ft/s)^2}{2 \times 32.2 \frac{ft}{sec^2}} \quad h_{L_{major}} = 17.9 ft$

$K_{Bend} = (L_e/D) f_{Bend} = 30 \times .026 \quad K = 1.3$

$h_{L_{minor}} = K \cdot \frac{V^2}{2g} = 1.3 \times \frac{(13.175 ft/s)^2}{2 \times 32.2 \frac{ft}{sec^2}} \quad h_{L_{minor}} = 3.5 ft$

$\Delta P = \gamma (h_L) \quad \Delta P = 68.47 \frac{lb}{ft^3} \times (3.5 ft + 17.9 ft) \times \frac{ft^2}{144 in^2}$

$\boxed{\Delta P = 10.18 psi}$