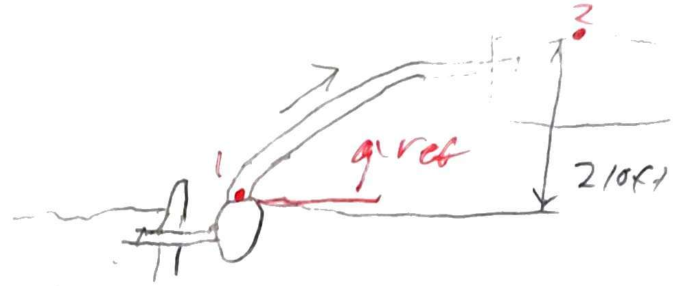
HW 5.2 Ch6



- 46 Water at 60°F - 8in sch 40 Steel
- L = 2500 ft $Q = 4.00\ ft^3/s$ $P_1 = ?$

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + \cancel{z_1}^{0} = \cancel{\frac{P_2}{\gamma}}^{0} + \cancel{\frac{V_2^2}{2g}}^{0} + z_2 + H_{L12}$$

$$\frac{P_1}{\gamma} = -\frac{V_1^2}{2g} + z_2 + H_{L12}$$

$$V = \frac{Q}{A} = \frac{\frac{4.00\ ft^3}{s}}{\frac{\pi}{4}\cdot\left(\frac{7.981\ in}{12\ \frac{in}{ft}}\right)^2} = 11.55\ ft/s$$

$$\frac{P_1}{\gamma} = z_2 + \frac{V_1^2}{2g} + f\frac{L}{D}\frac{V_1^2}{2g}$$

$$\frac{P_1}{\gamma} = z_2 + \frac{V_1^2}{2g}\left(1 + f\frac{L}{D}\right)$$

$$R_e = \frac{VD}{\nu} = \frac{11.55\ \frac{ft}{s^2} \cdot 0.664\ ft}{1.21\times10^{-5}} = 6.34\times10^5$$

$$RR = \frac{D}{\varepsilon} = \frac{0.664\ ft}{1.5\times10^{-4}\ ft} = 4426.7$$

$$f \cong 0.0145$$

$$\frac{P_1}{\gamma} = 210\ ft + \frac{\left(11.55\ \frac{ft}{s}\right)^2}{2\left(32.2\ \frac{ft}{s^2}\right)}\left(1 + 0.0145\ \frac{2500\ ft}{0.664\ ft}\right)$$

$$P_1 = 325\ ft \cdot 62.4\ \frac{lb}{ft^3}$$

$$\boxed{P_1 = 5.21\ lb/ft^2 \quad \text{or} \quad 750\ psi}$$

62. $f = \dfrac{0.25}{\left[\log\left(\dfrac{1}{3.7\left(\frac{D}{\varepsilon}\right)} + \dfrac{5.74}{Re^{0.9}}\right)\right]^2}$

$T = 77°F$

Heavy fuel oil

6 in sch 40 steel pipe

$V = 12$ ft/s

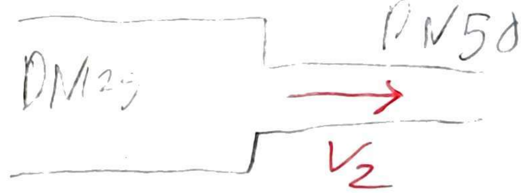
$$RE = \frac{VD}{\nu} = \frac{12\,\text{ft/s} \cdot 0.5054\ \text{ft}}{1.27 \times 10^{-3}\ \frac{\text{ft}^2}{\text{s}}} = 4775$$

$$\text{Relative Roughness} = \frac{D}{\varepsilon} = \frac{0.5054\,\text{ft}}{1.5 \times 10^{-4}\,\text{ft}} = 3369$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(3369)} + \frac{5.74}{4775^{0.9}}\right)\right]^2}$$

$$\boxed{f = 0.0388}$$

Chapter 10



20. $h_L = ?$ Sudden Contraction from DN125 Sch 80 to DN50 Sch 80

$Q = 500\,L/min$

Minor loss $h_L = K \dfrac{v^2}{2g}$

First need to find K from graph

$$Q = 500 \frac{L}{min} \cdot \left(\frac{1\,m^3}{1000\,L}\right)\left(\frac{1\,min}{60\,s}\right) = 0.00833\ \frac{m^3}{s}$$

$$V_2 = \frac{Q}{A} = \frac{0.00833\ \frac{m^3}{s}}{\frac{\pi}{4} \cdot 0.0525\,m^2}$$

$D_1 = ID_{DN125} = 128.2\,mm$

0.1282

$V_2 = 3.85\ m/s$

$D_2 = ID_{DN50} = 52.5\,mm$

$= 0.0525$

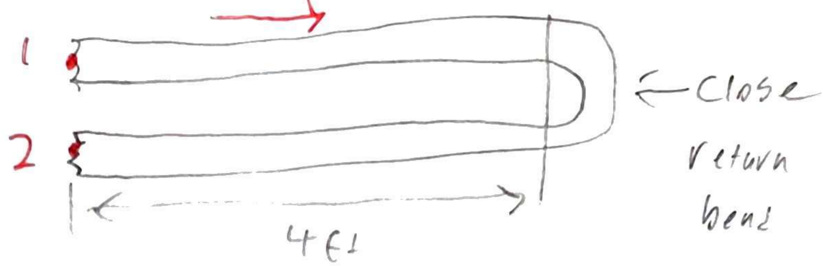
$$\text{Diameter ratio} = \frac{D_1}{D_2} = \frac{0.1282}{0.0525} = 2.44$$

$K \cong 3.9$

$$h_L = 3.9 \frac{(3.85\,m/s)^2}{2(9.81\,m/s^2)}$$

$$\boxed{h_L = 0.765\,m}$$

10.37



V 2
Sch 40
Steel

$\Delta P = ?$ $Q = 12.5$ gal/min ethylene glycol at 77°F

- No height given so I will assume change in elevation is negligible

$$\frac{P_1}{\gamma} + \cancel{\frac{V_1^2}{2g}} + \cancel{z_1} = \frac{P_2}{\gamma} + \cancel{\frac{V_2^2}{2g}} + \cancel{z_2} + h_{L12}$$

- $V_1 = V_2$ so they can be canceled too

$$\frac{P_1}{\gamma} = \frac{P_2}{\gamma} + h_{L12} \rightarrow \frac{P_1}{\gamma} - \frac{P_2}{\gamma} = h_{L12}$$

$$\frac{1}{\gamma}(P_1 - P_2) = h_{L12} \rightarrow P_1 - P_2 = \gamma(h_{L12})$$

Losses in pipe: major losses due to 8 ft of pipe and minor losses due to close return bend

$$h_L = f\frac{L}{D}\frac{V^2}{2g} \qquad K = 50 f_T \qquad h_L = K\frac{V^2}{2g}$$

$$P_1 - P_2 = \gamma\left(f\frac{L}{D}\frac{V^2}{2g} + 50 f_t \frac{V^2}{2g}\right)$$

$$P_1 - P_2 = \gamma\left[\frac{V^2}{2g}\left(f\frac{L}{D} + 50 f_t\right)\right]$$

$$Q = 12.5\ \text{gal/min}\left(\frac{1\ \text{ft}^3/\text{s}}{449\ \text{gal/min}}\right) = 0.0278\ \frac{\text{ft}^3}{\text{s}} \qquad V = \frac{Q}{A} = \frac{0.0278\ \text{ft}^3/\text{s}}{\frac{\pi}{4}\cdot(0.0518\ \text{ft})^2}$$

$D = 0.0518$ ft

$\nu = 1.59 \times 10^{-4}$ ft²/s

$\varepsilon = 1.5 \times 10^{-4}$

$$R_e = \frac{VD}{\nu} = \frac{13.2\ \frac{\text{ft}}{\text{s}} \cdot 0.0518\ \text{ft}}{1.59 \times 10^{-4}\ \text{ft}^2/\text{s}} \qquad V = 13.2\ \text{ft/s}$$

$R_e = 4303.75$

$$RR = \frac{D}{\varepsilon} = \frac{0.0518\,ft}{1.5 \times 10^{-4}\,ft} = 345$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(345)} + \frac{5.74}{4303.75^{0.9}}\right)^2\right]}$$

$$f = 0.0429$$

$$f_T \cong 0.025$$

$$P_1 - P_2 = 68.47 \frac{lb}{ft^3}\left[\frac{(13.2\,\frac{ft}{s})^2}{2(32.2\,\frac{ft}{s^2})}\left(0.0429\,\frac{8\,ft}{0.0518\,ft} + 50(0.025)\right)\right]$$

$$P_1 - P_2 = 1458.95 \frac{lb}{ft^2} \cdot \frac{1\,ft^2}{144\,in^2}$$

$$P_1 - P_2 = 10.13\ lb/in^2$$