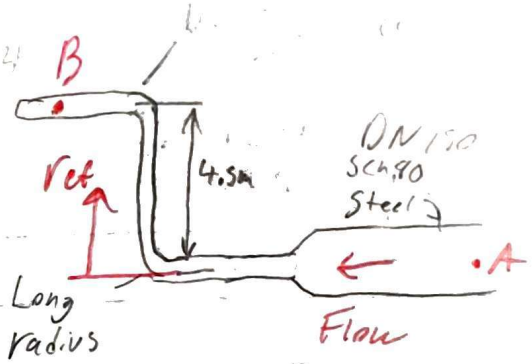
Hw 6.2 Chapter 11 - 5, 13, 20, 22, 23, 24



5. $Q = 0.015\ m^3/s$ $L_A = 180m$
$\gamma = 8.80\ kN/m^3$ $L_B = 8m$
$\nu = 2.12 \times 10^{-5}\ m^2/s$ $P_B = 12.5\ MPa$
$P_A = ?$ $\varepsilon = 4.6 \times 10^{-5}\ m$

$D_A = 146.3\ mm$
$D_B = 49.3\ mm$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{L\,AB}$$

$$P_A = \gamma\left(\frac{P_B}{\gamma} + \frac{V_B^2 - V_A^2}{2g} + z_B + h_{L\,AB}\right)$$

losses: 180m DN150, sudden contraction, 2 elbow, 8m DN50

$$P_A = \gamma\left(\frac{P_B}{\gamma} + \frac{V_B^2 - V_A^2}{2g} + z_B + f_A\frac{L_A}{D_A}\frac{V_A^2}{2g} + f_B\frac{L_B}{D_B}\frac{V_B^2}{2g} + 2\cdot K_{elbow}\frac{V_B^2}{2g} + K_{SC}\frac{V_B^2}{2g}\right)$$

$$V_A = \frac{Q}{A_A} = \frac{0.015\ m^3/s}{\frac{\pi}{4}\cdot(0.1463m)^2} = 0.892\ m/s \qquad V_B = \frac{Q}{A_B} = \frac{0.015\ m^3/s}{\frac{\pi}{4}\cdot(0.0493m)^2} = 7.86\ m/s$$

- $-V_A + V_B$
- Next, need to find f_A

$$Re_A = \frac{V_A D_A}{\nu} = \frac{(0.892\ m/s)(0.1463m)}{2.12\times10^{-5}\ m^2/s} = 6157 \qquad \frac{D_A}{\varepsilon} = \frac{0.1463m}{4.6\times10^{-5}m} = 3180 \qquad f_A \cong 0.037$$

- Find f_B

$$Re_B = \frac{V_B D_B}{\nu} = \frac{(7.86\ m/s)(0.0493m)}{2.12\times10^{-5}\ m^2/s} = 18278 \qquad \frac{D_B}{\varepsilon} = \frac{0.0493}{4.6\times10^{-5}m} = 1071 \qquad f_B \cong 0.028$$

$K_{elbow} = 20 f_T$: $D_B/\varepsilon = 1071$ $f_T \cong 0.019$ $K_{elbow} = 20 \cdot 0.019 = 0.38$

K_{SC}: $D_A/D_B = 2.97$ $V_B = 7.86\ m/s$ $K_{SC} \cong 0.38$

$$h_{L\,A} = 0.037 \cdot \frac{180m}{0.1463m} \cdot \frac{(0.892\ m/s)^2}{2\cdot 9.81\ m/s^2} = 1.85m$$

$$h_{L\,B} = 0.028 \cdot \frac{8m}{0.0493m} \cdot \frac{(7.86\ m/s)^2}{2\cdot 9.81\ m/s^2} = 14.3m$$

$$h_{L\,90} = 0.38\frac{(7.86)^2}{2\cdot 9.81} = 1.196$$

$$h_{L\,SC} = 0.38\frac{7.86^2}{2\cdot 9.81} = 1.196$$

5:

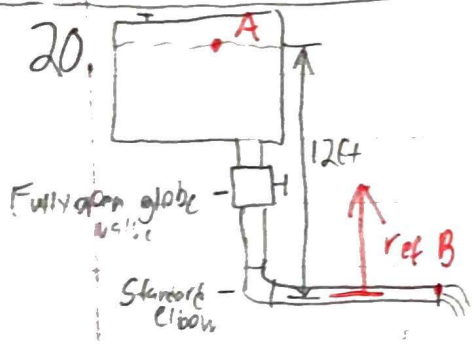
$$P_A = 8800\frac{N}{m^3}\left(\frac{12.5\times10^6\ Pa}{8800\frac{N}{m^3}} + \frac{(7.86\frac{m}{s})^2-(0.892\frac{m}{s})^2}{2\cdot 9.81\ m/s^2} + 4.5m + 1.85m + 14.3m + 2\cdot 1.196m + 1.196m\right)$$

$$P_A = 8800\frac{N}{m^3}(1420m + 3.107m + 4.5m + 1.85m + 14.3m + 2(1.196m) + 1.196m$$

$$P_A = 12{,}740{,}985.07\ \frac{N}{m^2}$$

$P_A = 12.74\ MPa$ ✓

20.



$Q = 400\ gal/min = 0.89\ ft^3/s$

Water @ 80°F $\nu = 9.15\times10^{-5}$

$L = 75\ ft$ SCH 40 Steel $\varepsilon = 1.5\times10^{-4}$

- Losses: major - 75ft pipe, minor: Entrance, Valve, elbow

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B + h_{LAB} \rightarrow Z_A - Z_B = h_{LAB}$$

$$Z_A - Z_B = f\frac{L}{D}\frac{V_c^2}{2g} + K_{ent}\frac{V_c^2}{2g} + K_{valve}\frac{V_c^2}{2g} + K_{elbow}\frac{V_c^2}{2g}$$

$$Z_A - Z_B = \frac{V_c^2}{2g}\left(f\frac{L}{D} + K_{ent} + K_{valve} + K_{elbow}\right) \qquad V_c = \frac{4Q}{\pi D^2}$$

$$Re = \frac{VD}{\nu} \qquad \frac{D}{\varepsilon}$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7\left(\frac{D}{\varepsilon}\right)} + \frac{5.74}{Re^{0.9}}\right)\right]^2} \qquad f_T = \frac{0.29}{\left[\log\left(\frac{1}{3.7\left(\frac{D}{\varepsilon}\right)}\right)\right]^2}$$

$K_{ent} = 0.5$

$K_{valve} = 340\ f_T$

$K_{elbow} = 30\ f_T$

$D = 0.37009\ ft$

$ID_4'' = 0.3355$

$ID_5'' = 0.4266$

$0.3355 < 0.37 < 0.4206$

5" Pipe