HW7.2 3,4,5,6 K=? So that Q = 0.00833 going thru each branch

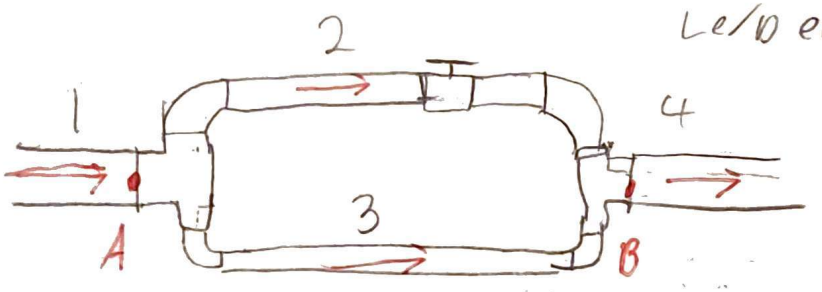
12.5 $L_1 = L_2 = 30m$ $\gamma = 9.81\ KN/m^3$ $\nu = 1.3 \times 10^{-6}\ m^2/s$

$D_1 = D_4 = 149\ mm = .149m$ $Q = 500\ L/min$ in each branch

$D_2 = 93mm = 0.093m$ $= 0.00833\ m^3/s$

$D_3 = 47mm = 0.047m$ L_e/D tee $= 60$

L_e/D elbow $= 30$



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

$$\frac{\Delta P}{\gamma} = h_{L\,AB_2} \qquad \frac{\Delta P}{\gamma} = h_{L\,AB_3}$$

Path 2 losses

Major: Pipe 2

Minor: 2 tees, reduction, valve, 2 elbows, enlargement

Path 3 losses

Major: pipe 3

Minor: 2 tees, reduction, 2 elbows, enlargement.

Path 2

$$\frac{\Delta P}{\gamma} = f_2 \frac{L_2}{D_2} \cdot \frac{V_2^2}{2g} + 2f_1\left(\frac{L_e}{D}\right)_{tee} \cdot \frac{V_1^2}{2g} + K_{red}\frac{V_2^2}{2g} + K_{valve}\frac{V_2^2}{2g} + 2f_2\left(\frac{L_e}{D}\right)_{elbow} + K_{enl}\frac{V_2^2}{2g}$$

$$= f_2 \frac{L_2}{D_2}\frac{16Q_2^2}{\pi^2 D_2^4 2g} + 2f_1\left(\frac{L_e}{D_1}\right)_{tee} \cdot \frac{16Q_1^2}{\pi^2 D_1^4 2g} + K_{red}\frac{16Q_2^2}{\pi^2 D_2^4 2g} + K_{valve}\frac{16Q_2^2}{\pi^2 D_2^4 2g} + 2f_2\left(\frac{L_e}{D}\right)_{elbow}\frac{16Q_2^2}{\pi^2 D_2^4 2g}$$

$$+ K_{enl}\frac{16Q_2^2}{\pi^2 D_2^4 2g}$$

$$\frac{\Delta P}{\gamma} = f_2 \frac{L_2}{D_2} \frac{8Q_2^2}{\pi D_2^4 g} + 2f_1 \left(\frac{Le}{D}\right)_{tee} \frac{8Q_1^2}{\pi^2 D_1^4 g} + K_{red} \frac{8Q_2^2}{\pi^2 D_2^4 g} + K_{valve} \frac{8Q_2^2}{\pi^2 D_2^4 g} + 2f_2 \left(\frac{Le}{D}\right)_{el} \frac{8Q_2^2}{\pi^2 D_2^4 g}$$

$$+ K_{enl} \frac{8Q_2^2}{\pi^2 D_2^4 g}$$

$$\frac{\Delta P}{\gamma} = f_2 \frac{8Q_2^2}{\pi^2 D_2^4 g} \left(\frac{L_2}{D_2} + 2\left(\frac{Le}{D}\right)_{elbow}\right) + \frac{8Q_2^2}{\pi D_2^4 g} \left(K_{red} + K_{valve} + K_{enl}\right) + 2f_1 \left(\frac{Le}{D}\right)_{tee} \frac{8Q_1^2}{\pi D_1^4 g}$$

Path 3

$$\frac{\Delta P}{\gamma} = f_3 \frac{8Q_3^2}{\pi^2 D_3^4 g} \left(\frac{L_3}{D_3} + 2\left(\frac{Le}{D}\right)_{elbow}\right) + \frac{8Q_3^2}{\pi D_2^4 g} \left(K_{red} + K_{enl}\right) + 2f_1 \left(\frac{Le}{D}\right)_{tee} \frac{8Q_1^2}{\pi^2 D_1^4 g}$$

$Q_1 = Q_4 = Q_2 + Q_3 = 0.00833\ m^3/s + 0.00833\ m^3/s = 0.01667\ m^3/s$

$V_1 = V_4 = \frac{4Q_1}{\pi D_1^2} = \frac{4 \cdot 0.01667\ m^3/s}{\pi \cdot 0.149 m^2} = 0.9558\ m/s$

$V_3 = \frac{4Q_3}{\pi D_3^2} = \frac{4 \cdot 0.00833\ m^3/s}{\pi \cdot 0.047 m^2} = 4.8\ m/s$

$Re_1 = \frac{V_1 D_1}{\nu} = \frac{0.9558 \frac{m}{s} \cdot 0.149 m}{1.3 \times 10^{-6} m^2/s} = 109549 \quad 1.09 \times 10^5$

$\frac{D_1}{\varepsilon} = \frac{0.149\ m}{1.5 \times 10^{-6} m} = 99333 \quad f_1 \cong 0.0175$

$Re_3 = \frac{V_3 D_3}{\nu} = \frac{4.8 \frac{m}{s} \cdot 0.047}{1.3 \times 10^{-6} m^2/s} = 173538 \quad 1.73 \times 10^5$

$\frac{D}{\varepsilon} = \frac{0.047 m}{1.5 \times 10^{-6} m} = 31333 \quad f_3 \cong 0.0155$

K_{red}

$\frac{D_1}{D_2} \quad \frac{0.149}{0.047} = 3.17$

$\theta = 30°$

$K = 0.045$

K_{enl}

$\frac{D_2}{D_1} \quad \frac{0.149}{.047} = 3.17$

$\theta = 30°$

$K = .48$

$$\frac{\Delta P}{\gamma} = 0.0155 \cdot \frac{8 \cdot (0.00833 m^3/s)^2}{\pi^2 \cdot 0.047^4 m^4 \cdot 9.81 \frac{m}{s^2}} \left(\frac{30 m}{0.047 m} + 2.30\right) + \frac{8 \cdot (0.00833 m^3/s)^2}{\pi^2 \cdot 0.047^4 m^4 \cdot 9.81 \frac{m}{s^2}} \left(0.045 + 0.48\right)$$

$12.71 + 0.616 + .0977$

$+ 2 \cdot 0.0175 (60) \frac{8 (0.01667 m^3/s)^2}{\pi^2 \cdot 0.149^4 m^4 \cdot 9.81 m/s^2}$

$\frac{\Delta P}{\gamma} = 13.43$

$$h = f_2 \frac{8Q_2^2}{\pi^2 D_2^5 g}\left(\frac{L_2}{D_2} + 2\left(\frac{Le}{D}\right)_{elbows}\right) + \frac{8Q_2^2}{\pi^2 D_2^4 g}\left(K_{red} + K_{valve} + K_{ent}\right) + 2f_1\left(\frac{Le}{D}\right)_{tee}\frac{8Q_1^2}{\pi^2 D_1^4 g}$$

$$V_2 = \frac{4Q}{\pi D_2^2} = \frac{4 \cdot 0.00833}{\pi \cdot 0.093m^2} = 1.226 m/s$$

$$Re_1 = \frac{V_2 D_2}{\nu} = \frac{1.226 \cdot 0.093}{1.3\times10^{-6}} = 87,738 \quad 8.7\times10^4$$

$$\frac{D}{\varepsilon} = \frac{0.093m}{1.5\times10^{-6}} = 62000 \qquad f_2 = 0.018$$

K_{red} $D/D_2 = 0.149/0.093 = 1.6$ $\theta = 30°$ 0.042

K_{ent} $D_2/D_1 = 0.149/0.093 = 1.6$ $\theta = 30°$ 0.41

$$13.43 = 0.018 \cdot \frac{8 \cdot .00833^2}{\pi^2 \cdot .093^4 \cdot 9.81}\left(\frac{30m}{0.093m} + 2 \cdot 30\right) + \frac{8 \cdot 0.00833^2}{\pi^2 \cdot .093^4 \cdot 9.81}\left(0.042 + K_{valve} + 0.41\right)$$

0.52

$$+ 2 \cdot 0.0175 \cdot 60 \frac{8 \cdot 0.01667^2}{\pi^2 \cdot 0.149^4 \cdot 9.81}$$

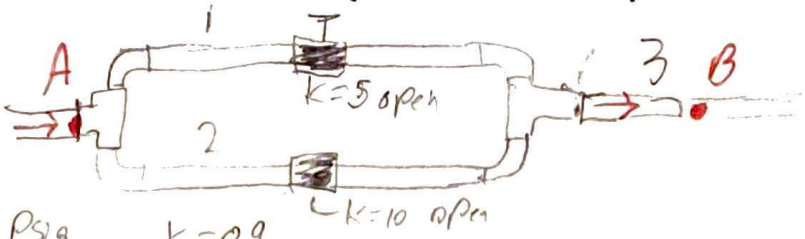
$$13.43 = 0.52 + 0.0766\left(K_{valve} + 0.452\right) + 0.097$$

$$12.8 = 0.0766\left(K_{valve} + 0.452\right)$$

$$167 = K_{valve} + 0.452$$

$K_{valve} = 166$ ✓

6.



$P_A = 20\ psig$ $K_{elbow} = 0.9$ neglect tee and pipe losses

D_1 = 2 in Sch 40 Steel = 0.1723 feet

D_2 = 4 in Sch 40 Steel = 0.3355 feet

$$\frac{20\ lb}{in^2} \cdot \frac{144\ in^2}{1\ ft^2}$$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{LAB} \quad (P_B = 0\ psig)$$

$$\frac{P_A}{\gamma} = h_{LAB} \qquad \frac{P_A}{\gamma} = h_{LAB_1} \qquad \frac{P_A}{\gamma} = h_{LAB_2}$$

$$\frac{P_{A_1}}{\gamma} = 2 \cdot K_{elbow} \frac{V_1^2}{2g} + K_{valve} \frac{V_1^2}{2g}$$

$$\frac{P_{A_2}}{\gamma} = 2 K_{elbow} \frac{V_2^2}{2g} + K_{valve} \frac{V_1^2}{2g}$$

$$Q_1 + Q_2 = Q_3$$

$$\frac{P_{A_1}}{\gamma} = \frac{V_1^2}{2g}\left(2 \cdot K_{elbow} + K_{valve}\right)$$

$$\frac{P_{A_1}}{\gamma} = \frac{16 Q_1^2}{\pi^2 D_1^4 \cdot 2g}\left(2 \cdot K_{elbow} + K_{valve}\right)$$

$$\frac{P_{A_1}}{\gamma} = \frac{8 Q_1^2}{\pi^2 D_1^4 g}\left(2 \cdot K_{elbow} + K_{valve}\right)$$

$$\frac{P_{A_1}}{\gamma} \cdot \frac{1}{2 \cdot K_{el} + K_{valve}} = \frac{8 Q_1^2}{\pi^2 D_1^4 g} \rightarrow \frac{P_{A_1}}{\gamma} \cdot \frac{\pi^2 D_1^4 g}{2 \cdot K_{el} + K_{valve}} = 8 Q_1^2$$

$$Q_1 = \sqrt{\frac{1}{8} \frac{P_{A_1}}{\gamma} \cdot \frac{\pi^2 D_1^4 \cdot g}{2 \cdot K_{elbow} + K_{valve}}} \qquad Q_2 = \sqrt{\frac{1}{8} \cdot \frac{P_{A_2}}{\gamma} \cdot \frac{\pi^2 D_1^4 g}{2 \cdot K_{el} + K_{valve}}}$$

$$Q_1 = \sqrt{\frac{1}{8} \cdot \frac{2880}{62.4\ lb/ft^3} \cdot \frac{\pi^2 \cdot 0.1723^4 \cdot 32.2\ ft/s^2}{2(0.9) + 5}} \qquad Q_2 = \sqrt{\frac{1}{8} \cdot \frac{2880}{62.4\ lb/ft^3} \cdot \frac{\pi^2 \cdot 0.3355^4 \cdot 32.2\ ft/s^2}{2(0.9) + 10}}$$

$Q_1 = 0.487\ ft^3/s$ $Q_2 = 1.40$

a. $0.487 + 1.40\ ft^3/s$
$Q_3 = 1.89\ ft^3/s$

b. $1.40\ ft^3/s$

c. $0.487\ ft^3/s$