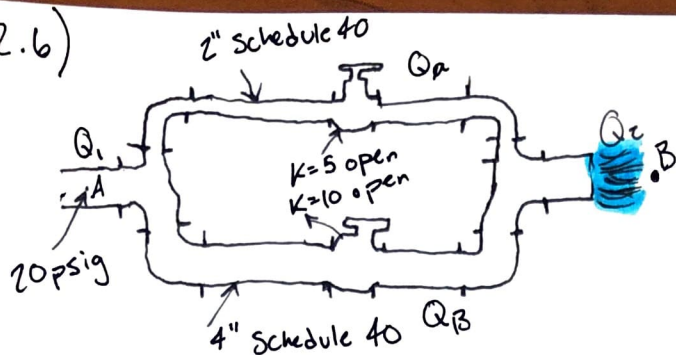


12.6)



Given

$$P_A = 20 \text{ psig}$$

$$K_{\text{elbow}} = 0.9$$

$$K_{\text{small valve}} = 5$$

$$K_{\text{Large valve}} = 10$$

$$D_1 = 2.067''$$

$$D_2 = 4.026''$$

$$A_1 = 3.36 \text{ in}^2$$

$$A_2 = 12.73 \text{ in}^2$$

$$P_B = 0 \text{ psig}$$

$$g = 32.2 \text{ ft/s}^2 = 386.4 \text{ in/s}^2$$

$$\gamma_w = 62.4 \text{ lb/ft}^3 = 0.036 \text{ lb/in}^3$$

a) Both valves open $Q_2 = Q_1$

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

$$\frac{P_A}{\gamma} = h_{LAB}$$

$$\therefore \frac{P_A}{\gamma} = 2 \left(0.9 \frac{V^2}{2g} \right) + 2 \left(0.9 \frac{V^2}{2g} \right) + 5 \left(\frac{V^2}{2g} \right) + 10 \frac{V^2}{2g}$$

$$\frac{P_A}{\gamma} = 2 \left(0.9 \left(\frac{16 Q^2}{\pi^2 (2.067)^4} \right) \right) + 2 \left(0.9 \left(\frac{16 Q^2}{\pi^2 (4.026)^4} \right) \right) + 5 \left(\frac{16 Q^2}{\pi^2 (2.067)^4} \right) + 10 \left(\frac{16 Q^2}{\pi^2 (2.067)^4} \right) \left(\frac{1}{2g} \right)$$

$$\frac{20}{0.036} = 2 \left(0.9 \left(\frac{16 Q^2}{180.1275} \right) \frac{1}{2(386.4)} \right) + 2 \left(0.9 \left(\frac{16 Q^2}{2593.06} \right) (0.0013) \right) + 5 \left(\frac{16 Q^2}{180.1275} \right) (0.0013) + 10 \left(\frac{16 Q^2}{2593.06} \right) (0.0013)$$

$$\frac{20}{0.036} = Q^2 \left(2(0.9(0.0888)(0.0013)) + 2(0.9(0.0062)(0.0013)) + 5(0.0888)(0.0013) + 10(0.0062)(0.0013) \right)$$

$$\therefore Q = \sqrt{\frac{555.56}{0.000886}} = 791.86 \text{ in}^3/\text{s} = 0.46 \text{ ft}^3/\text{s}$$

$$Q_2 = Q_A + Q_B$$

$$\therefore Q_2 = 0.485 + 1.39$$

$$Q_2 = 1.875 \text{ ft}^3/\text{s}$$

b) Valve in branch 2 open only

$$\frac{P_A}{\gamma} = 2 \left(0.9 \left(\frac{16 Q^2}{\pi^2 (4.026)^4} \right) \left(\frac{1}{2(386.4)} \right) \right) + 10 \left(\frac{16 Q^2}{\pi^2 (4.026)^4} \right) \left(\frac{1}{2(386.4)} \right)$$

$$Q = \sqrt{\frac{555.56}{0.00096}} = 2,405.64 \text{ in}^3/\text{s} = 1.39 \text{ ft}^3/\text{s}$$

c) Valve in branch 1 open only

$$\frac{P_A}{\gamma} = 2 \left(0.9 \left(\frac{16 Q^2}{\pi^2 (2.067)^4} \right) \left(\frac{1}{2(386.4)} \right) \right) + 5 \left(\frac{16 Q^2}{\pi^2 (2.067)^4} \right) \left(\frac{1}{2(386.4)} \right)$$

$$\therefore Q = \sqrt{\frac{555.56}{0.00079}} = 838.59 \text{ in}^3/\text{s} = 0.485 \text{ ft}^3/\text{s}$$