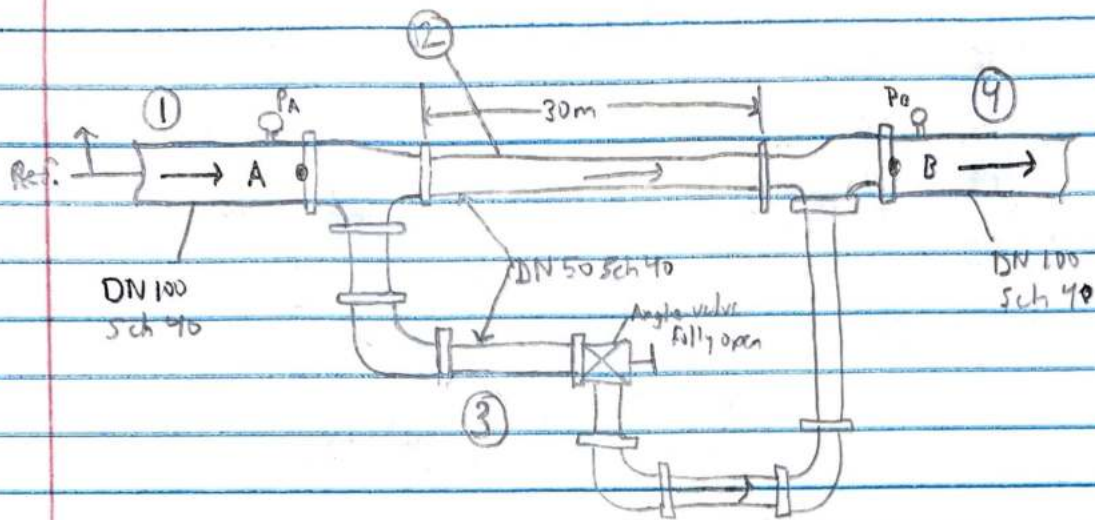


12.3.) Given:



$$Q = 850 \text{ L/min} = 0.0141 \text{ m}^3/\text{s}$$

Fluid = water @ 10°C

$$L_{\text{pipe}} = 60\text{m}$$

Determine: a) flow rate in each branch
b) pressure difference $P_A - P_B$

$$\text{Solution: a) } \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{LA-B}$$

$$\frac{P_A - P_B}{\gamma} = h_{LA-B}$$

$$\text{Branch 2: } h_{LA-B(2)} = f_2 \frac{L_2}{D_2} \frac{V_2^2}{2g}$$

$$h_{LA-B(2)} = \left(\frac{0.02}{0.0525} \right) \frac{V_2^2}{2g}$$

$$= 11.43 \frac{V_2^2}{2g}$$

$$\text{Branch 3: } h_{LA-B(3)} = f_3 \frac{L_3}{D_3} \frac{V_3^2}{2g} + 3 K_{elb} \frac{V_3^2}{2g} + K_{valve} \frac{V_3^2}{2g}$$

$$f_{IT} = 0.019 \text{ (Table 10.5)}$$

$$L_e/D_{elbow} = 30$$

$$L_e/D_{valve} = 150$$

$$h_{LA-B(3)} = f_3 \left(\frac{60}{0.0525} \right) \frac{V_3^2}{2g} + 3 \left((30 \times 0.019) \frac{V_3^2}{2g} \right) + (150 \times 0.019) \frac{V_3^2}{2g}$$

$$h_{LA-B(3)} = (1192.86 f_3 + 4.56) \frac{V_3^2}{2g}$$

$$\text{Guess } f_2, f_3: \frac{D}{E} = \frac{0.0525 \text{ m}}{4.6 \times 10^{-5}} = 1141.30$$

$$f_2, f_3 = 0.02$$

$$h_{LA-B(3)} = (1192.86(0.02) + 4.56) \frac{V_3^2}{2g}$$

$$h_{LA-B(3)} = 27.42 \frac{V_3^2}{2g}$$

$$h_{LA-B(2)} = h_{LA-B(3)}$$

$$11.43 \frac{V_2^2}{2g} = 27.42 \frac{V_3^2}{2g}$$

$$V_2 = 1.55 V_3$$

$$Q_T = A_2 V_2 + A_3 V_3$$

$$A = 2.168 \times 10^{-3} \text{ m}^2$$

$$Q_T = (2.168 \times 10^{-3})(1.55 V_3) + (2.168 \times 10^{-3})(V_3)$$

$$0.0141 = 0.00336 V_3 + 0.002168 V_3$$

$$V_3 = 2.55 \text{ m/s}$$

$$V_2 = 1.55(2.55)$$

$$V_2 = 3.95 \text{ m/s}$$

Verify f_2, f_3 : $Ne_2 = \frac{V_2 D_2}{\nu}$

$$= \frac{(3.95)(.0525)}{1.30 \times 10^{-6}}$$

$$= 1.60 \times 10^5$$

Moodys diagram: $f_2 = f_3 = 0.0215$

Substitute new f : $h_{LA-P(2)} = (1142.86(0.0215) + 4.56) \frac{V_2^2}{2g}$

$$= 29.13 \frac{V_2^2}{2g}$$

$h_{LA-P(2)} = (0.0215) \left(\frac{30}{.6525} \right) \frac{V_2^2}{2g}$

$$= 12.29 \frac{V_2^2}{2g}$$

$$h_{LA-P(2)} = h_{LA-P(3)}$$

$$\frac{12.29 V_2^2}{2g} = \frac{29.13 V_3^2}{2g}$$

$$V_2 = 1.54 V_3$$

$$V_2 = (1.54)(2.58) = 3.97 \text{ m/s}$$

$$Q_T = (2.168 \times 10^{-3})(1.54 V_3) + (2.168 \times 10^{-3})(V_3)$$

$$.0141 = .0033 V_3 + .00217 V_3$$

$$V_3 = 2.58 \text{ m/s}$$

$$Q_2 = A_2 V_2 = (2.168 \times 10^{-3})(3.97) = .0086 \text{ m}^3/\text{s} = 516 \text{ L/min}$$

$$Q_3 = A_3 V_3 = (2.168 \times 10^{-3})(2.58) = .0056 \text{ m}^3/\text{s} = 335.61 \text{ L/min}$$

$$b) \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{LA-B}$$

$$\frac{P_A - P_B}{\gamma} = h_{LA-B}$$

$$P_A - P_B = h_{LA-B} \gamma$$

Since $h_2 = h_3$ then $h_{LA-B} = h_{12}$

$$= 12.29 \left(\frac{V_1^2}{2g} \right)$$

$$= 12.29 \left(\frac{3.97^2}{2g} \right)$$

$$= 9.87_m$$

$$P_A - P_B = 9.87_m \times 9.81 \text{ kN/m}^3 = 96.7 \text{ kPa}$$