

ENG 214 (Assignment)

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 Chemical Engineering
 12/ENGR 214/021

- (2) Diameter of inlet, $D_1 = 300\text{mm}$ or 0.3m
 Area at inlet, $A_1 = \pi/4 \times 0.3^2 = 0.07\text{m}^2$
 Diameter of throat, $D_2 = 150\text{mm}$ or 0.15m
 Area at throat, $A_2 = \pi/4 \times 0.15^2 = 0.0176\text{m}^2$
 Specific gravity of heavy liquid (mercury) in U-tube manometer, $S_H = 13.6$
 Reading of differential manometer (oil) flowing through pipe is 0.9

Reading of differential manometer:

$$y = 25\text{mm} \text{ or } 0.25\text{m}$$

The differential 'h' is given by

$$h = \left[\frac{P_1}{\rho} + Z_1 \right] - \left[\frac{P_2}{\rho} + Z_2 \right]$$

$$\Rightarrow \left[\frac{5h}{S_H} - 1 \right] = 0.25 \left[\frac{13.6}{0.9} - 1 \right]$$

$$= 3.53\text{m of oil}$$

Using the relation

$$Q = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

$$Q = 0.95 \times \frac{0.07 \times 0.0176}{\sqrt{0.07^2 - 0.0176^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

$$Q = \frac{0.001212}{0.0677} \times 8.32 = 0.1489\text{m}^3/\text{s}$$

We know that

$$h = \left[\frac{P_1}{\rho} + Z_1 \right] - \left[\frac{P_2}{\rho} + Z_2 \right] = 3.53$$

$$\text{But } Z_2 = 1.5 \times 0.3\text{m} \text{ or } 0.3\text{m}$$

$$\therefore \left[\frac{P_1}{\rho} - \frac{P_2}{\rho} \right] - 0.3 = 3.53 \text{ or } \frac{P_1 - P_2}{\rho} = 3.83$$

$$P_1 - P_2 = (9.81 \times 0.9) \times 3.83 = 33.8\text{kN/m}^2$$



Given Sp Gravity = 0.7, $D_1 = 150 \text{ mm}$, $D_2 = 75 \text{ mm}$

$Z_1 - Z_2 = 150 \text{ mm}$, $Q = 4 \text{ liter/sec}$, $C_d = 0.96$

$$2) A_1 = \frac{\pi D_1^2}{4} = \frac{\pi}{4} \times 0.15^2 = 0.01767 \text{ m}^2$$

$$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi}{4} \times (0.075)^2 = 0.00442 \text{ m}^2$$

$$Q_{act} = C_d \times A_1 A_2 \frac{\sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$0.04 = 0.96 \times \frac{0.01767 \times 0.00442 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.01767^2 - 0.00442^2}}$$

$$0.04 = 0.96 \times 0.004565 \times 4.429 \sqrt{h}$$

$$h = \left(\frac{0.04}{0.96 \times 0.004565 \times 4.429} \right)^2 = 4.247 \text{ m}$$

$$\text{Ans } h = \left[\frac{P_1}{\rho} + Z_1 \right] - \left[\frac{P_2}{\rho} + Z_2 \right]$$

$$0.4247 = \left[\frac{P_1}{\rho} - \frac{P_2}{\rho} \right] \cdot (Z_1 - Z_2)$$

$$= \left(\frac{P_1 - P_2}{\rho} \right) \cdot 0.15$$

$$\therefore (P_1 - P_2) = \rho (4.247 \cdot 0.15)$$

$$= (0.8 \times 1000 \times 9.81) (4.247 \cdot 0.15) \text{ N/m}^2$$

$$= 5451.54 \text{ N/m}^2$$

