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COMPUTER ENGINEERING

18/ENG02/074

FLUID MECHANICS

ASSIGNMENT

1a Diameter at inlet $D_1 = 300mm = 0.3m$

Area of inlet $A_1 = \frac{\pi}{4} \times 0.3^2 = 0.07m^2$

Diameter at throat $D_2 = 150mm = 0.15m$

Area at throat $A_2 = \frac{\pi}{4} \times 0.15^2 = 0.01767m^2$

∴ Specific gravity of heavy liquid (mercury) in U-tube manometer, $S_M = 13.6$

Specific gravity of liquid (oil) flowing through pipe, $S_P = 0.9$

Reading of differential 'h' is give manometer $x = 250mm = 0.25m$

The differential 'h' is given by:

$$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$$

$$= y\left[\frac{S_M}{S_P} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$$

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

→ Discharge of oil

Using the relation:

$$Q = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}, \text{ we have:}$$

$$= 0.98 \times \frac{0.07 \times 0.01767}{\sqrt{0.07^2 - 0.01767^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

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

→ Pressure difference between entrance and throat sections $P_1 - P_2$

$$\left(\frac{P_1}{\rho g} - \frac{P_2}{\rho g}\right) + (Z_1 - Z_2) = 3.53$$

But $Z_2 - Z_1 = 300\,mm$ or $0.3\,m$

or $P_1 - P_2 = (9.81 \times 0.9) \times 3.53 = 33.8\,KN/m^2$

2 Pressure difference $(P_1 - P_2)$:

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

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

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

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

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

$$A(80) \quad 4.247 = \left(\frac{P_1}{\rho g} - \frac{P_2}{\rho g}\right) + (Z_1 - Z_2)$$

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

$$(P_1 - P_2) = \rho g (4.247 + 0.15)$$

$$= (0.8 \times 1000 \times 9.81)(4.247 + 0.15)$$

$$= 54.51\,KN/m^2$$