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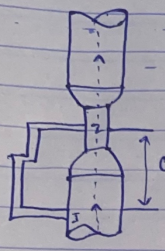
18/ENG06/055

Fluid mechanics

Question;



Given; Sp. gravity = 0.8, D_1 = 150mm = 0.15m ; D_2 = 75mm = 0.075m

$z_2 - z_1$ = 150mm = 0.15m Q_{act} = 40 liter/sec = 0.04 m^3/s C_d = 0.96

Pressure differce (P_1-P_2):

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

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

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

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

$$h = \left(\frac{0.4}{0.96 \times 0.004565 \times 4.429} \right)^2$$

$$= 4.247m$$

Also, $h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} - z_2\right)$

$$4.247 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (z_1 - z_2)$$

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

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

$$= (0.8 \times 1000 \times 9.81)(4.247 + 0.15)\ N/m^2$$

$$= 34.51\ kN/m^2$$

Question 2;

Diameter at inlet, D_1 = 300mm = 0.3m Diameter at throat D_2 = 0.15m

Area of inlet $A_1 = \frac{\pi}{4} \times 0.3^2 = 0.07m^2$ Area at throat $= \frac{\pi}{4} \times 0.15m = 0.0176$

especific gravity of heavy liquid (mercury) in u-tube manometer S_m = 13.6

0.9 of liquid flowing through pipe S_p = 0.9

Reading of differential manometer y = 250mm = 0.25m

The differential 'h' is given by;

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

$= 0.20\left[\frac{13.6}{0.9} - 1\right] = 3.53\text{m of oil}$

i) Discharge of oil

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

$$Q = 0.98 \times \frac{0.07 \times 0.001767}{\sqrt{0.07^2 \times 0.001767}} \times \sqrt{2 \times 9.81 \times 3.53}$$

$= 0.1489\ m^3/s$

ii) $h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right) = 3.53$

$\frac{P_1 - P_2}{w} = 3.53$

$P_1 - P_2 = (9.81) \times 0.9 \times 3.53$

$= 33.8\text{kN/m}^2$