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MECHANICAL ENGINEERING
18/ENG06/021.

(I) 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 ab throat $A_2 = \frac{\pi}{4} \times 0.15^2 = 0.01767m^2$

Sp

Specific gravity of heavy liquid (mercury) in u-tube manometer $S_H = 13.6$

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

Reading of differential manometer, $g = 250mm = 0.25m$

The differential 'h' is given by

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

$$= g\left[\frac{S_w}{S_p} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$$

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

I, Discharge of oil Q:

Using the relation

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

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

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

(II) Pressure difference between entrance throat sections

$$\left[\frac{P_1}{w} - \frac{P_2}{w}\right) + (z_1 - z_2) = 3.53$$

If $z_2 - z_1 = 0.3m$

$$\therefore \left(\frac{P_1}{w} - \frac{P_2}{w}\right) - 0.3 = 3.53$$

2] Specific gravity = 0.8

D_1 = 150mm = 0.15m

D_2 = 78mm = 0.078m

$Z_1 - Z_2$ = 150mm = 0.15m

Q = 40 L/s = 0.04 m³/s

$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4}$

$A_1 = 0.01767$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.078)^2}{4}$

$A_2 = 4.9178 \times 10^{-3}$

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

$0.04 = 0.96 \times \frac{0.01767 \times 0.00492 \times \sqrt{2 \times 9.81} \times \sqrt{h}}{\sqrt{0.01767^2 - 0.00492^2}}$

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

$h = \left[\frac{P_1}{\omega} + z_1 \right] - \left[\frac{P_2}{\omega} + z_2 \right]$

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

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

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

$= (0.8 \times 1000 \times 9.81)(4.247 + 0.15)$ N/m²

$= 34.51$ kN/m²