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Mechanical Engineering

1. $D_1 = 300mm = 0.3m$

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

$D_2 = 150mm = 0.15m$

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

Specific gravity of mercury $(S_{hg}) = 13.6$

Specific gravity of liquid (oil) $(S_p) = 0.9$

Reading of differential manometer

$y = 250mm = 0.25m$

The differential 'h' is given by:

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

$$= y\left[\frac{S_{hg}}{S_p} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$$

$= 3.53m$ of oil.

c. Discharge of oil Q:

Using the relation

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

$$Q = 0.98 \times \frac{0.07 \times 0.01767}{\sqrt{0.07^2 - 0.0767^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

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

ii. Pressure difference between entrance and throat section, $P_1 - P_2$

We know that,

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

But,

$Z_2 - Z_1 = 300mm$ or $0.3m$

$\left(\frac{P_1}{\omega} - \frac{P_2}{\omega}\right) - 0.3 = 3.53$ or $\frac{P_1 - P_2}{\omega} = 3.83$

or $P_1 - P_2 = (9.81 \times 0.9) \times 3.83 = 33.8\ kN/m^2$ (Ans)

2. Sp. Grav.ty $= 0.8$

$D_1 = 150mm = 0.15m$

$D_2 = 75mm = 0.075m$

$Z_1 - Z_2 = 150mm = 0.15m$

$Q = 40$ Litres/sec $= 0.04m^3/s$

$A_1 = \frac{\pi}{4} \times 0.15^2 = 0.1767m^2$

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

$Q = Cd \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$ (Using this to find h

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

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

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

$\sqrt{h} = 2.0608$

$h = 2.0608^2$

$\therefore h = 4.247m$

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

$4.247 = \left(\frac{P_1 - P_2}{\omega}\right) - 0.15$

$$\left(\frac{P_1 - P_2}{\omega}\right) = 4.237 + 0.15 = 4.397$$

$$\therefore (P_1 - P_2) = 4.397 \times \omega$$

$$= 4.397 \times (0.8 \times 1000 \times 9.81$$

$$= 34.51 \text{ kN/m}^2 \text{ (Ans)}$$