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Elect/Elect

(1) Solution: Given Sp. gravity = 0.8, D_1 = 150 mm = 0.15m; D_2 = 75mm = 0.075m; $Z_2 - Z_1$ = 150 mm = 0.15m, Q_{act} = 40 litres/sec = $0.04 m^3/s$, C_d = 0.96

Pressure difference $(P_1 - P_2)$:

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

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

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

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

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

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

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

or, $4.247 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (Z_1 - Z_2)$

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

or, $(P_1 - P_2) = P_g (4.247 + 0.15)$

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

$= 34.51$ KN/m²

(2) Solution: Diameter of inlet, $D_1 = 300mm = 0.3m$

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

Diameter of throat, $D_2 = 150mm = 0.15m$

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

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, $y = 250mm = 0.25m$.

The differential "h" is given by:

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

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

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

(i) Discharge of oil, Q:

Using the relation,

$$Q = C_1 \times \frac{A_1 A_2}{\sqrt{A_1^2 \times A_2^2}} \times \sqrt{2gh}$$

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

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

(ii) Pressure difference between entrance and throat section, $P_1 - P_2$:

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

$$\text{or, } \left(\frac{p_1}{w} - \frac{p_2}{w}\right) + (z_1 - z_2) = 3.53$$

But, $z_2 - z_1 = 300\text{mm}$ or 0.3m

$$\therefore \left(\frac{p_1}{w} - \frac{p_2}{w}\right) - 0.3 = 3.53 \text{ or } \frac{p_1 - p_2}{w} = 3.83$$

$$\text{or, } p_1 - p_2 = (9.81 \times 0.9) \times 3.83 = 33.8\,\text{KN/m}^2$$