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ENG 214

ASSIGNMENT II

1 Given

Sp gravity = 0.8

D_1 = 150mm = 0.15m

D_2 = 75mm = 0.075m

$z_2 - z_1$ = 150mm

Q_{act} = 40 litres/sec = $0.4 m^3/s$

C_d = 0.96

Pressure Difference $(P_1 - P_2)$

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi}{4} \times 0.15^2 = 0.01767 m^2$$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi}{4} \times (0.075)^2 = 0.00442 m^2$$

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

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

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

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

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

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

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

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

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

$= 34.51 KN/m^2$

Solution

Diameter at inlet, D_1 = 300mm = 0.3m

Area of inlet $A_1 = \pi/4 \times 0.3^2 = 0.07m^2$

Diameter at throat D_2 = 150mm = 0.15m

Area of throat $A_2 = \pi/4 \times (0.15)^2 = 0.01767m^2$

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

S.g of Oil = 0.9

Reading of differential manometer

$y = 250mm = 0.25m$

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

$$= y\left(\frac{S_m}{S_o} - 1\right) = 0.25\left[\frac{13.6}{0.9} - 1\right]$$

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

i) Discharge of oil

Using the relation

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

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

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

ii) Pressure Difference

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

$z_2 - z_1 = 300mm$ or $0.3m$

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

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