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18/ENG02/013
COMPUTER ENGINEERING
FLUID MECHANICS

1.) Diameter of inlet at P_1 = 300mm = 0.3m
Area of inlet $A_1 = \pi/4 \times 0.3^2 = 0.07m^2$
Diameter of throat P_2 = 150mm = 0.15m
∴ Area of throat $A_2 = \pi/4 \times 0.15^2 = 0.01767m^2$

Specify gravity of heavy liquid (mercury) in
$S_{ht} = 13.6$
Specific gravity of liquid (oil) flowing through pipe
$S_p = 0.9$
Reading at differential manometer, $y = 250mm = 0.25m$

⇒ The differential 'h' is given by:

$$h = \left[\frac{P_t}{\rho} + Z_1\right] - \left[\frac{P_2}{\rho} + Z_2\right] = y\left(\frac{S_{ht}}{S_y} - 1\right)$$

$= 3.53m$ of oil

ii) Discharge of oil, Q:
Using the equation:

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

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

$$= \frac{0.001212}{0.0677} \times 8.62$$

$$= 0.1489 m^3/s$$

iii) Pressure difference between entrance and throat section $P_1 - P_2$

$$h = \left(\frac{P_1}{\rho w} - t_1\right)\left(\frac{P_2}{\rho w} - t_2\right)$$

But $Z_2 - Z_t = 300mm$ or $0.3m$

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

$$\therefore P_1 - P_2 = (9.81) \times 0.9 \times 3.83$$

$$= 33.8 kN/m^2 //$$

2.) Pressure difference $(P_1 P_2)$:

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

$$A_2 = \frac{\pi}{4} D_2^2 = \frac{\pi}{4} \times (0.075)^2 = 0.0012 m^2$$

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

$$0.04 = 0.96 \times \frac{0.0176 \times 0.00442}{\sqrt{0.01767} \times \sqrt{0.0044^2}} \times \sqrt{2 \times 9.81} \times \sqrt{h}$$

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

$\Rightarrow$ Also $h = \left(\frac{P}{w} + y_1\right)\left(\frac{P_2}{w} + y_2\right)$

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

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

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

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