NNAMDI PRECIOUS
ENG 214
19/Eng01/021 Fluid Mechanics

1

1) Diameter of inlet $D_1 = 300mm \simeq 0.3m$

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

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

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

The Specific gravity of heavy liquid (mercury) in U tube Manometer $S = 13.6$

Specific gravity of liquid flowing Through Pipes $Sp = 0.9$

Reading of differential manometer

$y = 250mm = 0.25m$

The differential "h" is given by

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

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

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

(i) Discharge of oil, Q:

Using the relation

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

$$Q = 0.98 \times \frac{0.07 \times 0.01767}{\sqrt{0.07^2 - 0.0176^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

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

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

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

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

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

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

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

2) Sp gravity $= 0.8$

$D_1 = 150mm \simeq 0.15m$

$D_2 = 75mm \simeq 0.075m$

$z_2 - z_1 = 150mm \simeq 0.15m$

$Q = 40 litres/sec \simeq 0.04 m^3/s$

$C_d = 0.96$

Pressure difference $(P_1 - P_2)$

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

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

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

$$0.04 = 0.96 \times \frac{0.01767 \times 0.00442}{\sqrt{0.01761^2 - 0.00442^2}} \times \sqrt{2 \times 9.81 \times \sqrt{h}}$$

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

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 $(P_1 - P_2) = P_g(4247 \div 0.15)$

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

$= 34.51\ KN/m^2$