Kifordu Benedict I
18/ENG06/036
Mechanical engineering
fluid mechanics assignment

1.) Given Sp gr of gravity 0.8, $D_1 = 150mm = 0.15m$, $D_2 = 75mm = 0.075m$ $Z_2 - Z_1 = 150mm = 0.15m$, $Q = 40Lt/sec = 0.04m^3/s$, $Cd = 0.96$ pressure difference $<P_1 - P_2>$

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

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

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

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

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

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

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

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

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

$0.15 \quad 4.247 = \left(\frac{P_1 - P_2}{P_g}\right) \quad +0.15 \quad 4.247 + 0.15 = \left(\frac{P_1 - P_2}{P_g}\right)$

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

$P_1 - P_2 = (0.8 \times 1000 \times 9.81)(4.247 + 0.15)$

$P_1 - P_2 = 34.51 KN/M^2$

2. Diameter of inlet $D_1 = 300mm = 0.3m$

Area of inlet $D_1 = \frac{\pi \times D_1^2}{4} = \frac{\pi \times 0.3^3}{4} = 0.07m^2$

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

Area of inlet $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0176m^2$

S.g of heavy liquid (mercury) in U tube manometer

$S_H = 13.6$

S.g of oil flowing through pipe $S_P = 0.9$

Reading of differential manometer, $y = 250mm = 0.25m$

The differential "h" is given by;

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

$$= y\left[\frac{S_H}{S_P} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right) = 3.53m \text{ of oil}$$

a) Discharge of oil q

Using the relation

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

$$Q = \frac{0.98 \times 0.07 \times 0.07767 \times \sqrt{2 \times 9.81 \times 3.53}}{(0.07^2 - 0.07767^2)^{1/2}}$$

$$Q = 0.1489 m^3 s^{-1}$$

b) Pressure difference between entrance and throat section $P_1 - P_2$. We know;

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

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

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

$$\frac{P_1 - P_2}{w} = 3.53 + 0.3$$

$$\frac{P_1 - P_2}{w} = 3.83$$

$$P_1 - P_2 = 3.83w$$

$$P_1 - P_2 = 3.83 \times 9.81 \times 0.9$$

$$P_1 - P_2 = 33.8 \text{ kN M}^{-2}$$