OKORIE NNANNA IROHA.
18/ENG03/1046.
CIVIL ENGINEERING.
FLUID MECHANICS. [ENG 2141.

1, Given S_g of gravity 0.8, $D_1 = 150mm = 0.15m$, $D_0 = 75mm = 0.075m$.
$Z_2 - Z_1 = 150mm = 0.15m$, $Q = 40 l/sec = 0.04 m^3/s$, $Cd = 0.96$
Pressure difference $(P_1 - P_2)$?

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

$$A_0 = \frac{\pi D_0^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.00442 m^2$$

$$Q = \frac{Cd \times A_1 A_2 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

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

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

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

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

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

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

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

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

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

$$P_1 - P_2 = 34.51 kN/m^2.$$

5.) Diameter of inlet $D_1 = 500mm = 0.5m$

Area of inlet $A_1 = \frac{\pi \times D_1^2}{4} = \frac{\pi \times 0.5^2}{4} = 0.07m^2$

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

Area of inlet $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.07767m^2$.

Specific gravity of heavy liquid (mercury) in U tube manometer $S_{hg} = 13.6$

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;

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

$$= y\left(\frac{S_{hg}}{S_p} - 1\right) = 0.25\left[\frac{13.6}{0.9} - 1\right] = 3.53m \text{ of oil.}$$

a.) Discharge of oil Q

Using the relation

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

$$Q = \frac{0.98 \times 0.07 \times 0.07767 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.07^2 - 0.7767^2}}$$

$$Q = 0.1489 m^3/s.$$

b) Pressure difference between entrance & throat section $P_1 - P_2$

Given that:

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

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

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

$$\left(\frac{P_1 - P_2}{w}\right) - 0.5 = 3.53$$

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

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

$$P_1 - P_2 = 3.83\,w$$

$$P_1 - P_2 = 3.82 \times 9.81 \times 0.9$$

$$= 33.8 \text{ KN/m}^2.$$