Olayiwola Zainab
Fluid Mechanics
18/Eng02/108

1) 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 at throat $A_2 = \pi/4 \times 0.15^2 = 0.01767m^2$

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

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

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

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

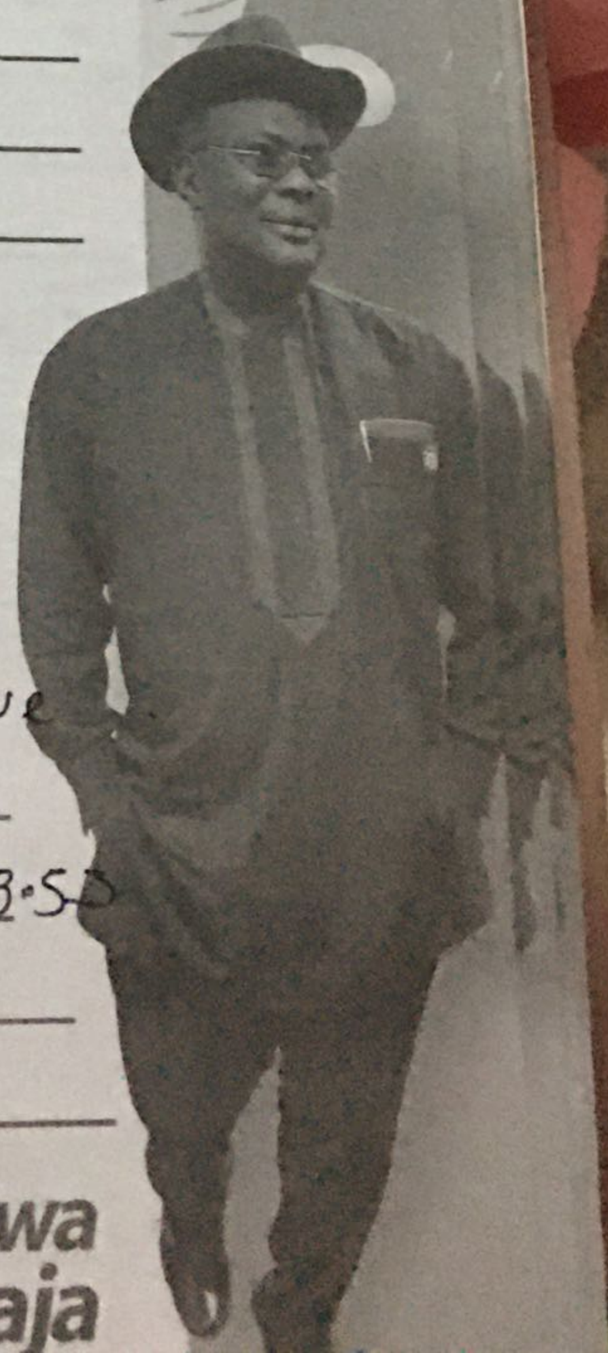
Discharge of oil, Q
Using the relation

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

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

$$= \frac{0.001212}{0.0677} \times 8.32$$

$$= 0.1489 m^3/s$$



pressure difference

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

$$\text{or} \left[\frac{P_1}{w} - \frac{P_2}{w}\right] + [z_1 - z_2] = 3.53$$

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

$$\left[\frac{P_1}{w} - \frac{P_2}{w}\right] - 0.3 = 3.53$$

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 pressure difference

$$A_1 = \pi/4 D_1^2 = \pi/4 \times 0.15^2 = 0.01767 m^2$$

$$A_2 = \pi/4 \times (0.025)^2 = 0.00442 m^2$$

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

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

$$h = \left[\frac{0.04}{0.96 \times 0.00465 \times 4.429}\right]^2 = 4.247 m$$

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

$$\left[\frac{P_1 - P_2}{P_9}\right] - 0.15 = (4.247 - 0.15)$$

$$= (0.8 \times 1000 \times 9.81)$$

$$= 34051 KN/m^2$$