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MECHATRONICS
FLUID MECHANICS
ASSIGNMENT
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18/ENG05/1062

(1) Solution

Diameter at inlet, $D_1 = 300mm = 0.3m$

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

Diameter at throat, $D_2 = 150mm = 0.15m$

$\therefore$ Area at throat, $A_2 = \frac{\pi}{4} \times 0.15^2 = 0.01767m^2$

Specific gravity of heavy liquid (mecury) in U-tub manometer, $S_{h1} = 13.6$

Specific gravity of liquid (oil) flowing through pipe, $S_p = 0.9$

Reading of differential manometer,

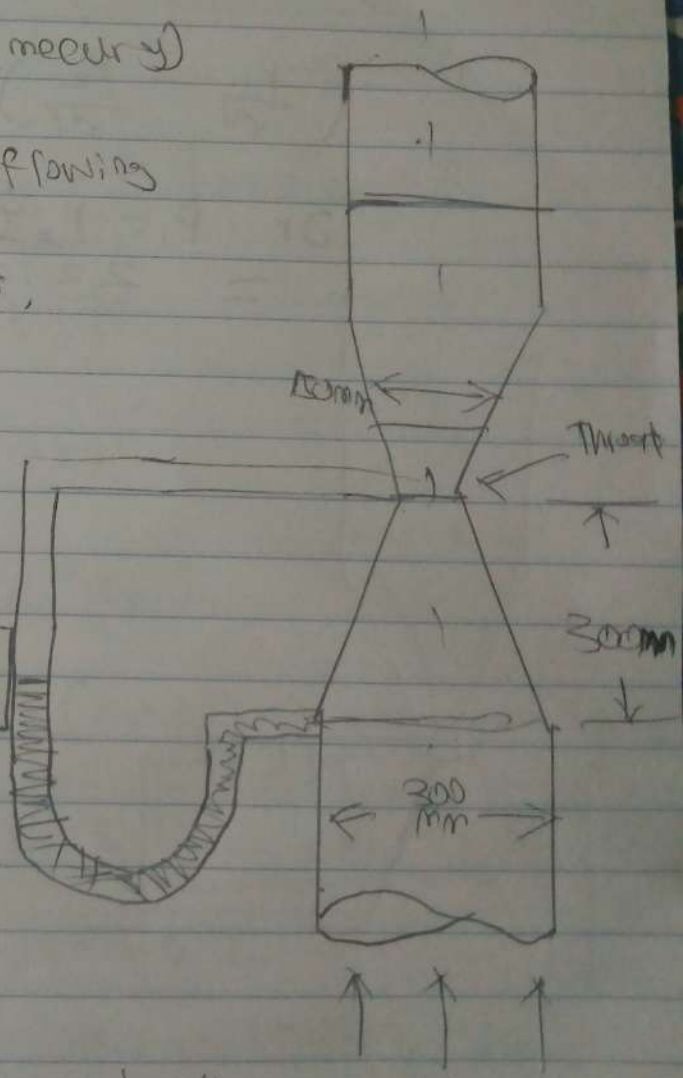
$y = 250 = 0.22m$

The differential 'h' is given by

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

$$y\left[\frac{S_{h1}}{S_p} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$$

$= 3.53m$ of oil



(2) Discharge of oil Q:

Using relation,

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

$$Q = \frac{0.95 \times 0.07 \times 0.01767}{\sqrt{0.07^2 - 0.01767^2}} \times \sqrt{2 \times 9.81 \times 3.53}$$

$= 0.00121$

ii) Pressure Different between entrance and throat section, $P_1 - P_2$

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

$= 3.53$

OR $\left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (Z_1 - Z_2) = 3.53$

But, $Z_2 - Z_1 = 300mm$ or $0.3m$

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

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

$= 33.8 \, KN/m^2$

(2) Solution

Given: Sp. gravity = 0.8, $D_1 = 150mm = 0.15m$,

$D_2 = 75mm = 0.075m$; $Z_2 - Z_1 = 150mm = 0.15m$

$Q_{act} = 40 litres/sec = 0.04 m^3/s$ $C_d = 0.96$

Pressure difference $(P_1 - P_2)$:

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

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

$$Q_{act} = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}, \text{ we get}$$

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

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

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

$$= 4.247 m$$

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

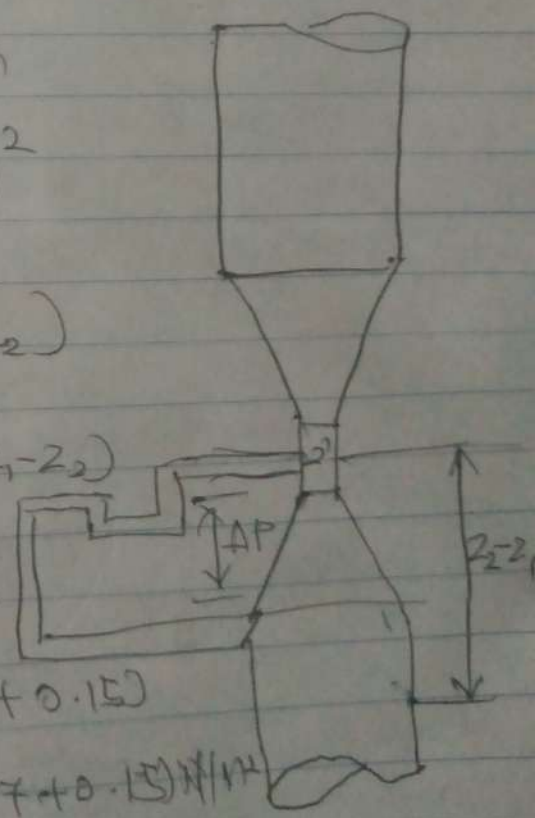
$$\text{Or } 4.247 = \left(\frac{P_1}{w} - \frac{P_2}{w} \right) + (Z_1 - Z_2)$$

$$= \left(\frac{P_1 - P_2}{\rho g} \right) - 0.15$$

$$\text{or } (P_1 - P_2) = \rho g (4.247 + 0.15)$$

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

$$= 34.514 kN/m^2$$



C: $Z_2 - Z_1 = 0.15m$