OBE CORNELIUS MBA
18/ENG/06/049
MECHANICAL ENGINEERING
ENG 214
FLUID MECHANICS

Question 1:

i) Diameter at inlet $D_1 = 300mm = 0.3m$

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

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

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

Specific gravity of heavy liquid (Mercury) in U-tube Manometer $S_{hl} = 13.6$

~~Reading~~ 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

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

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

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

i) Discharge of Oil Q

Using ~~the~~ relation

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

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

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

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

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

$Z_2 - Z_1 = 300mm$ Or $0.3m$

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

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

2) Given Sp gravity $= 0.8$, $D_1 = 150mm = 0.15m$

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

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

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

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

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

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

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

$h = \left(\frac{0.04}{0.16 \times 0.004565 \times 4.429}\right)^2 = 4.247m$

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

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

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

Or $(P_1 - P_2) = \rho g (4.247 + 0.15)$

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

$= 34.51 KN/m^2$