MEZE HANNAH CHIBUEZE
18/ENG05/051
MECHATRONICS ENGINEERING
ENG 214

1) Given specific gravity of 0.8, $D_1 = 150mm = 0.15m$,
$Z_2 - Z_1 = 150mm = 0.15m$ $D_2 = 95mm = 0.075m$
$Q = 40dl/s = 0.04m^3/s$, $C_d = 0.96$
Pressure difference $(P_1 - P_2)$

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767m^2$$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.00442m^2$$

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

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

$$0.04 = 0.96 \times 0.004565 \times \sqrt{19.62h}$$

$$\sqrt{19.62h}\ h = \left(\frac{0.04}{0.96 \times 0.004565 \times 4.429}\right)^2 = 4.247m$$

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

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

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

$$4.247 + 0.15 = \frac{P_1 - P_2}{\rho g}$$

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

~~$= 38821.113 N/m^2$~~

$= 34.51 kN/m^2$

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

Area of inlet $A_1 = \frac{\pi \times d_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.07m^2$

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

Area of inlet $A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767m^2$

Specific gravity of heavy liquid (mercury) in U tube manometer, sac = 13.6

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

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

The differential ch' is given by

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

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

i) Discharge of oil Q,

using the relation,

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

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

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

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

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

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

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

$$P_1 - P_2 = 3.83w$$

$$P_1 - P_2 = 3.82 \times 9.81 \times 0.9 = 33.8 kN/m^2$$