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18/ENG03100~~1~~
Civil Engineering
Fluid mechanics (ENG 21A)

① Given Sp. of gravity 0.8, $D_1 = 150mm = 0.15m$
$D_2 = 75mm = 0.075m$, $Z_2 - Z_1 = 150mm = 0.15m$,
$Q = 40lt/sec = 0.04m^3/s$, $Cd = 0.96$
pressure difference $(p_1 - p_2)$

$$A_1 = \frac{\pi D^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.1767m^2$$

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

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

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

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

$$h = \left(\frac{0.04}{0.96 \times 0.004565 \times 4.429}\right)^2 = \underline{4.249m}$$

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

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

$$4.249 = \left(\frac{P_1 - P_2}{PJ}\right) = 0.15$$

$$4.249 + 0.15 = \frac{p_1 - p_2}{\rho g}$$

$(4.249 + 0.15)\rho g = p_1 - p_2$

$p_1 - p_2 = (0.8 \times 1000 \times 9.81)(4.247 + 0.15)$

$p_1 - p_2 = 34.5114 N/m^2$

(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 ~~heat~~ gravity of heavy liquid (mecury) in tube manometer $Sh = 13.6$

specific gravity of liquid (oil) flowing through pipe $SP = 0.9$; Reading of differential manometer, $y = 250mm = 0.25m$

the differential "h" is given by;

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

$$\left(\frac{S_m}{S_p}-1\right)=0.25\left(\frac{13.6}{0.9}-1\right)=3.53 \text{ of oil}$$

Discharge of Oil Q:

Using the relation:

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

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

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

(b) pressure difference between entra and throat section $P_1 - P_2$ we, all know that:

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

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

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

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

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

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

$$P_1 - P_2 = 3.83 w$$

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

$$= 33.8 \, kN/m^2$$