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18/ENG03/015
CIVIL ENGINEERING
Fluid mechanics ENG 214

1) Given Sp of gravity 0%, $D_1 = 150mm = 0.15m$

$D_2 = 15mm = 0.075m$

$Z_2 - Z_1 = 150mm = 0.15m$, $Q = 40$ lit/sec

$= 0.04m^3/s$ $\quad$ $Cd = 0.96$

Pressure difference.

$$A_1 = \frac{\pi D^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0176\,7m^2$$

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

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

$$0.04 = \frac{0.96 \times 0.01767 \times 0.00448 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.01767^2 - 0.00442^2}}$$

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

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

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

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

$P_1 - P_2 = 34.51 kN/m^2$

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

Area of inlet $A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.07m^2$

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

Area of inlet $A_2 = \pi D_2^2/4 = \frac{\pi \times 0.15^2}{4} = 0.01767m^2$

Specific gravity of heavy liquid <mercury> in U tube manometer $S_{hc} = 13.6$

Specific gravity of liquid (oil) $S_p = 0.9$

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

The differential "h" is given by

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

$$= y\left[\frac{S_h}{S_p} - 1\right] = 0.25\left(\frac{13.6}{0.9} - 1\right) = 3.55m \text{ of oil}$$

Discharge of oil Q

Using the relation

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

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

$Q = 0.1489 m^3/s$

$$h = \left(\frac{0.07}{0.96 \times 0.004505 \times 4.429}\right)^2 = 4.247m$$

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

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

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

$$4.247 + 0.15 = P_1 - P_2 / \rho g$$

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

Area of inlet $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767 m^2$

Specific gravity of heavy liquid <mercury> in U tube manometer $S_{h} = 13.6$

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

2) The differential "h" is given by

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Using the relation

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

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

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

b) Pressure different between entrance and throat section $P_1 - P_2$

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

$h = (P_1/w - P_2/w) - (Z_1 - Z_2) = 3.53$

$Z_2 - Z_1 = 300mm = 0.3m$