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Mat No 18/Eng 06/035
Fluid Mechanics
Eng 214

1 Given specific gravity = 0.8, D_1 = 150mm, D_2 = 75mm
$Z_2 - Z_1$ = 150mm, Q_{act} = 40 Lit/sec c.d = 0.96

D_1 = 150mm = 0.15m
D_2 = 75mm = 0.075m
Q_{act} = 40 Lit/sec = 0.04 m^3/s
$Z_2 - Z_1$ = 0.15m

Pressure Difference $(P_1 - P_2)$

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

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

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

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

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

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

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

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

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

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

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

$= 34.51\ KN/m^3$

Solution To Question 2

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

Area of inlet, $A_1 = \frac{\pi}{4} \times 0.3^2 = 0.07m^3$

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 fluid (mercury) in a U-tube manometer, $S_m = 13.6$

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

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

the differential 'h' is given by

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

$$= y\left[\frac{S}{SP} - 1\right] = 0.25\left[\frac{1.36}{0.9} - 1\right]$$

$= 3.53m$ of oil

Discharge of oil, Q =

using the relation

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

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

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

Ans = $0.1489\ m^3/s$