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18/SCI14/025
CIVIL ENGINEERING
FLUID MECHANICS

1) Sp of gravity 0.8
$D_1 = 150mm \Rightarrow 0.15m$
$D_2 = 75mm \Rightarrow 0.075m$
$Z_2 - Z_1 = 150mm \Rightarrow 0.15m$
$Q = 40l/sec \Rightarrow 0.04m^3/s$
$Cd = 0.96$
Pressure differe $(P_1 - P_2) = ?$

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

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

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

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

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

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

$$= 4.247m$$

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

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

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

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

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

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

$$P_1 - P_2 = 34.51\ KN/m^2$$

2.) $D_1 = 300mm = 0.3m$

$$A_1 = \frac{\pi \times D_1^2}{4} = \frac{\pi \times 0.3^3}{4} = 0.07m^2$$

$D_2 = 150mm = 0.15m$

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

Specific gravity of mercury = 13.6

Specific gravity of oil = 0.9

$y = 250mm = 0.25m$

The Differential h is given by;

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

$$y_{h} = y\left[\frac{S_h}{S_g} - 1\right]$$

$$\Rightarrow 0.25\left[\frac{13.6}{0.9} - 1\right] = 3.53 \text{ of Oil}$$

*) Discharge of oil

Using the relation,

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

$$\Rightarrow Q = \frac{0.98 \times 0.07 \times 0.01767 \times \sqrt{2 \times 9.81 \times 8.53}}{\sqrt{0.07^2 - 0.01767^2}}$$

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

b) Pressure difference $(P_1 - P_2)$

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

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

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

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

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

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

$$P_1 - P_2 = 3.83w$$

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

$$= 33.8 KN/m^2$$