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19/ENG06/065
MECHANICAL ENGINEERING
FLUID MECHANICS

1 $D_1 = 150mm \rightarrow 0.15m$

$A_1 = \frac{\pi}{4} \times d_1^2 = \frac{\pi}{4} \times 0.15^2 = 0.0176m^2$

$D_2 = 75mm \rightarrow 0.075m$

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

$Z_2 - Z_1 = 150mm = 0.15m$

relative density = 0.8 $C_d = 0.96$

$Q = 40 litres/sec = 0.04m^3/s$

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

$$0.04 = 0.96 \times \frac{0.0176 \times 0.075}{\sqrt{(0.0176)^2 (0.075)^2}} \times \sqrt{2 \times 9.81 \times h}$$

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

$$0.04 = 0.0194 \times \sqrt{h}$$

$$\sqrt{h} = \frac{0.04}{0.0194}$$

$$\sqrt{h} = 2.062$$

$$h = (2.062)^2$$

$$h = 4.25m$$

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

$$4.25 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (Z_1 - Z_2)$$

$$4.25 = \left(\frac{P_1 - P_2}{\rho g}\right) + (Z_1 - Z_2)$$

$$4.25 = \frac{P_1 - P_2}{0.8 \times 1000 \times 9.81} + 0.15$$

$$4.25 \times 7848 = P_1 - P_2 - 0.15$$

$P_1 - P_2 = 33354 + 0.15$

$P_1 - P_2 = 33354.15\ N/m^2$

$= 33.35\ kN/m^2$

2 $D_1 = 300mm \rightarrow 0.3m$

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

$D_2 = 150mm \rightarrow 0.15m$

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

S.G of oil = 0.9 S.G of mercury = 13.6

Reading of differential manometer = 250mm → 0.25m

$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$ $Z_2 - Z_1 = 300mm$

$h = y\left[\frac{S.G\ of\ Hg}{S.G\ of\ oil} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$

$= 3.53m$

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

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

$= \frac{0.001212}{0.0677} \times 8.32$

$= 0.1489\ m^3/s$

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

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

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

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

$P_1 - P_2 = (9.81 \times 0.9) \times (3.53 + 0.3)$

$= 33.8\ kN/m^2$