18/ENG04/066

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(1)

Given Sp. gravity = 0.8

→ $D_1 = 150mm \rightarrow m$; $\rightarrow A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (0.15)^2}{4} \Rightarrow 0.01767m^2$

$\frac{150}{1000} = 0.15m$

→ $D_2 = 75mm \rightarrow m$; $\rightarrow A_2 = \frac{\pi D_2^2}{4} = \frac{\pi (0.075)^2}{4} \Rightarrow 0.00442m^2$

$\frac{75}{1000} = 0.075m$

→ $Z_2 - Z_1 = 150mm \rightarrow m$

$\frac{150}{1000} = 0.15m$

→ $Q_{act} = 40L/s \rightarrow m^3/s$

$\frac{40}{1000} = 0.04m^3/s$

→ $C_d = 0.96$

To get h, we have

$Q_{act} = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$ [NOTE: h = difference]

$0.04 = 0.96 \times \frac{0.01767 \times 0.00442}{\sqrt{0.01767^2 - 0.0044^2}} \times \sqrt{2 \times 9.81} \times \sqrt{h}$

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

$\therefore h = \left(\frac{0.04}{0.96 \times 0.04565 \times 4.429}\right)^2$

$h = 4.247m$

Recall that,

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

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

Note that $w = \rho g$

$4.247 = \frac{P_1 - P_2}{\rho g} - 0.15$

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

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

$(P_1 - P_2) = (4.4247)(7848)$

$(P_1 - P_2) = 34.51 \, kN/m^2$

0.1767 m^2

0.0442 m^2

(2)

→ Diameter D_1 at Inlet = 300mm → m

$\frac{300}{1000} \Rightarrow 0.3m$

→ $A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (0.3)^2}{4} = 0.07m^2$

→ Diameter D_2 at throat = 150mm → m

$\frac{150}{1000} = 0.15m$

→ $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767m^2$

→ S_h of mercury = 13.6

→ S_p of liquid oil = 0.9

→ Differential manometer y = 250mm → m

$\frac{250}{1000} = 0.25m$

→ Differential 'h' is given by

$h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$ ... (1)

"OR"

$h = y\left[\frac{S_h}{S_p} - 1\right]$ ..... (2)

$h = 0.25\left[\frac{13.6}{0.9} - 1\right]$

$h = 3.53 m$ of oil

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

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

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

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

⇒ Pressure difference $P_1 - P_2$ is gotten as;
From equation (1),

$$h = \left(\frac{P_1}{\omega} + z_1\right) - \left(\frac{P_2}{\omega} + z_2\right) \Rightarrow 3.53$$

$$\left(\frac{P_1}{\omega} - \frac{P_2}{\omega}\right) + (z_1 - z_2) = 3.53$$

→ $z_2 - z_1 = 300mm \rightarrow m$

$$\frac{300}{1000} \Rightarrow 0.3m$$

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

→ $\frac{P_1 - P_2}{\omega} = 3.83$

→ $P_1 - P_2 = (9.81 \times 0.9) \times 3.83 = 33.8\ kN/m^2$