Uba Chukwuma Raphael
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Mechanical Engineering ENG 214

Question 1

A 300mm x 150mm Venturimeter is provided a Vertical pipeline carrying Oil of Specific gravity 0.9 flow being Upward. The difference in elevator of the Throat Section and entrance Section of the Venturimeter is 300mm. The differential U-tube mercury manometer shows guage deflection of 250 mm. Calculate, (a.) The discharge of oil and b.) The Pressure difference between the entrance Section and the throat Section. Take the C.O effecient of meter as 0.98 and Specific gravity of Mercury as 13.6.

Solution To Question 1

Diameter of inlet $(D) = 300mm = 300 \times 10^{-3} \Rightarrow 0.3m$

Area $(A_1) = \frac{\pi d^2}{4} = \frac{\pi (0.3)^2}{4} = 0.070695 m^2$

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

Diameter of throat $(d_2) = 150mm = 150 \times 10^{-3} = 0.15m$.

Let Section (1) represent Inlet and Section 2 represent Throat

Then $Z_2 - Z_1 = 300mm = 0.3m$; Specific gr of oil $= 0.9$,

Specific gr of mercury $= 13.6$ Reading of diff Manometer $x = 250mm = 0.25m$

Differential head h is given by $h = \left(\frac{P_1}{\rho g} + Z_1\right) - \left(\frac{P_2}{\rho g} + Z_2\right)$

$= x\left[\frac{S_y}{S_o} - 1\right] = 0.25$

$\left[\frac{13.6}{0.9} - 1\right] = 3.5277 m$ of oil

i The discharge Q of oil $Cd \times \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$

$= \frac{0.98 \times 0.070695 \times 0.01767}{\sqrt{(0.070695)^2 - (0.01767)^2}} \times \sqrt{2 \times 9.81 \times 3.5277}$

$\frac{1.224197037 \times 10^{-3} \times 8.59146}{0.0684511} = 0.14879 m^3/s$

$= 148.79 Litres/s$

11. Pressure difference between entrance and throat section

$$h = \left(\frac{P_1}{\rho g} + z_1\right) - \left[\frac{P_2}{\rho g} + z_2\right]$$

3.5277 Recall $z_2 - z_1 = 0.3$

$$\therefore \left(\frac{P_1}{\rho g} - \frac{P_2}{\rho g}\right) - 0.3 = 3.5277$$

$$\therefore \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 3.5277 + 0.3 = 3.8277 \text{ m of oil}$$

Question 2

A Vertical Venturimeter Canes a liquid of relative density 0.8 and has inlet and throat diameters of 150mm and 75mm respectively. The pressure Connection at the throat is 50mm above that at the inlet. If the actual flow rate of flow is 40 litres/sec and the C.d = 0.96, Calculate the pressure difference between inlet and throat in N/m^2

Solution of Question 2

Specific gravity = 0.8, $D_1 = 150mm = 0.15m$

$z_1 = 150mm = 0.15m$, $D_2 = 75mm = 0.075m$

$z_2 = 75mm = 0.075m$ $Qad = 40 litres/sec = 0.04 m^3/secs$

$Cd = 0.96$

Pressure difference $(P_1 - P_2)A_1 = \frac{\pi d^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.01767m^2$

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

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

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

$$h = (0.04/0.96 \times 0.004565 \times 4.429)^2$$

$$h = 4.247m$$

$$4.247 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (z_1 - z_2) - \left(\frac{P_1 - P_2}{\rho g}\right) - 0.15$$

$(p_1 - p_2 = eg(4.247 + 0.15)$

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

$= 34.511\ kN/m^2$