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1. A vertical venturimeter carries a liquid of relative density 0.8 and has inlet and throat diameters of 150mm and 75mm respectively. The pressure connection at the inlet is 150mm above that of the throat. If the actual flowrate through is 40 litres/sec and the $C_d = 0.96$, Calculate the pressure difference between inlet and throat in N/m^2

Soln

$D_1 = 150mm = 150 \times 10^{-3} = 0.15m$

$D_2 = 75mm = 75 \times 10^{-3} = 0.075m$

$\rho_{oil} = 0.8$

$Z_1 - Z_2 = 150mm = 150 \times 10^{-3} = 0.15m$

$Q = 40 litres/sec$

$= \frac{40 litres}{1 sec} \times \frac{1m^3}{1000 litres}$

$= 0.04 m^3 sec^{-1}$

$Q = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$ ---> (1)

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.0177 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times (0.075)^2}{4} = 0.0044 m^2$

Making h sof in (1)

$h = \left\{ \frac{Q \cdot \sqrt{A_1^2 - A_2^2}}{C_d A_1 A_2} \right\}^2 \times \frac{1}{2g}$

$h = \left\{ \frac{0.04 \times \sqrt{0.0177^2 - 0.0044^2}}{0.96 \times 0.0177 \times 0.0044} \right\}^2 \times \frac{1}{2 \times 9.81}$

$h = 4.288m$

Recall for vertical venturimeter

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

ω for oil $= \rho \times g = 0.8 \times 9.81 \times 1000$

$= 7848 N/m^2$

$h = \frac{P_1 - P_2}{\omega} + (Z_1 - Z_2)$

$P_1 - P_2 = (h - (Z_1 - Z_2)) \times \omega$

$P_1 - P_2 = (4.288 - (-0.15)) 7.848 N/m^2$

$P_1 - P_2 =$

$= 34829.424 N/m^2$

Question 2

A 300m x 150mm venturimeter is a vertical pipeline carrying oil of specific gravity 0.9 flowing upward, The difference between the elevation of the throat and entrance of the venturimeter is 300mm. The differential U-tube mercury manometer shows a guage deflection of 250mm, Calculate

i. The discharge of oil and

ii. The pressure difference between the entrance section and the throat section. Take the coefficient of meter as 0.98 and specific gravity of mercury as 13.6.

Solu

$D_1 = 300mm = 300 \times 10^{-3} = 0.3m$

$D_2 = 150mm = 150 \times 10^{-3} = 0.15m$

$S_{oil} = 0.9 \quad S_{Hg} = 13.6$

$z_2 - z_1 = 300mm = 300 \times 10^{-3} = 0.3m$

$y = 250mm = 250 \times 10^{-3} = 0.25m$

$C_d = 0.98$

$h = \left\{\frac{P_1}{\omega} - \frac{P_2}{\omega} + (z_1 - z_2)\right\} = y\left(\frac{S_{Hg}}{S_l} - 1\right)$.

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

$h = 3.528m$

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

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.0707 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177 m^2$

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

$= \frac{0.98 \times 0.0707 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.528}}{\sqrt{0.0702^2 - 0.0177^2}}$

$= 0.151 m^3/s$

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

$\omega = 1000 \times 0.9 \times 9.81$

$= 8829 N/m^3$

$3.528 = \frac{P_1 - P_2}{8829} + (-0.3)$

$(3.528 + 0.3)\,8829 = P_1 - P_2$

$P_1 - P_2 = 33379.742 N/m^2$