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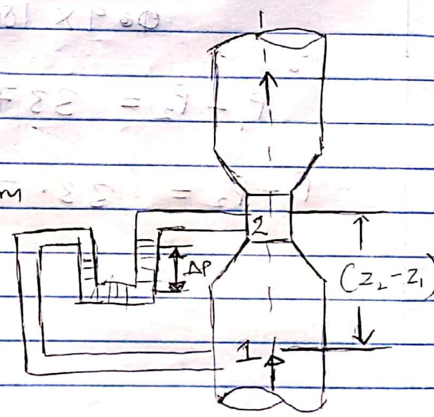
19/ENG06/064
MECHANICAL ENGINEERING
ENG 214 [FLUID MECHANICS]

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 throat is 150mm above that at the inlet. If the actual flow rate is 40litres/secs and the $C_d = 0.96$, calculate the pressure difference between inlet and throat in N/m^2

Solution

Parameters



Relative density = 0·8

d_1 = 150mm = 0·15m

d_2 = 75mm ⟹ 0·075m

Q = 40 L/s

1000L → 1m³

$40\frac{L}{s} \times \frac{1m^3}{1000}$

$= 0.04 m^3/s$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 4.4179 \times 10^{-3} m^2 \approx 4.42 \times 10^{-3} m^2$

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

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

$$0.04 = \frac{7.04977 \times 10^{-5}}{0.01711} \times \sqrt{19.62} \times \sqrt{h}$$

$$9.12813 = \sqrt{19.62} \times \sqrt{h}$$

$$\sqrt{h} = 2.06078$$

Squaring both sides

$$h = 2.06078^2$$

$$\therefore h = 4.2468 m$$

To find pressure difference

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

$$z_2 - z_1 = 150 mm = 0.15 m$$

$$\therefore z_1 - z_2 = -0.15 m$$

$$4.2468 = \frac{P_1 - P_2}{800 \times 9.81} - 0.15$$

$$33328.8864 = (P_1 - P_2) - 1177.2$$

$$P_1 - P_2 = 34506.0864 \ N/m^2$$

$$P_1 - P_2 = 34.506 \ kN/m^2$$

Question 2

A 300mm x 150mm Venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow begins upward. The difference in elevation of the throat section and entrance of the venturimeter is 300mm. The differential U-tube mercury manometer shows a gauge deflection of 250mm, calculate

i) The discharge of oil and

ii) The ~~diff~~ 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

Solution

Parameters

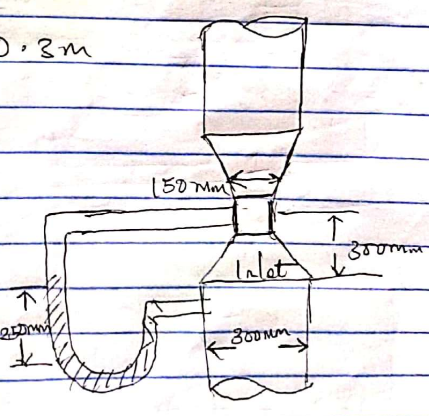
S.G of oil $= 0.9$

$Z_2 - Z_1 = 300\text{mm} = 0.3\text{m}$

$d_1 = 300\text{mm} = 0.3\text{m}$

$d_2 = 150\text{mm} = 0.15\text{m}$

guage reading $= 250\text{mm}$



To find h

$$h = \left(\frac{13.6}{0.9} - 1\right) \times 0.25$$

$h = 3.5278\text{m}$ of oil

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

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.070686\text{ m}^2$$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.017671\text{ m}^2$$

$$Q = 0.98 \times \frac{0.070686 \times 0.017671}{\sqrt{0.070686^2 - 0.017671^2}} \times \sqrt{2 \times 9.81 \times 3.5278}$$

$$Q = 0.017885 \times \sqrt{19.62 \times 3.5278}$$

$$Q = 0.1488 \ m^3/s$$

Discharge of oil $= 0.1488 \ m^3/s$

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

$$3.5278 = \frac{P_1 - P_2}{0.9 \times 1000 \times 9.81} - 0.3$$

$$P_1 - P_2 = 33795.6462 \ N/m^2$$

$$P_1 - P_2 = 33.795 \ kN/m^2$$