

ALANZA IJEOMA SHALOM  
 181SC1011016 (TRANSFER STUDENT)  
 COMPUTER ENGINEERING

ENG 214 (BASIC 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 40 litres/sec and the  $C_d = 0.96$ . Calculate the pressure difference between inlet and throat in  $N/m^2$ .

Solw

$$D_1 = 150 \text{ mm} = 0.15 \text{ m}$$

$$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177 \text{ m}^2$$

$$D_2 = 75 \text{ mm} = 0.075 \text{ m}$$

$$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.0044 \text{ m}^2$$

$$Q = 40 \text{ litres/sec} = 0.04 \text{ m}^3/\text{s}$$

$$C_d = 0.96$$

$$z_2 - z_1 = 150 \text{ mm} = 0.15 \text{ m}$$

$$P = 0.8$$

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

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

$$0.04 = \frac{7.47648 \times 10^{-5} \times \sqrt{19.62h}}{\sqrt{2.9393 \times 10^{-4}}}$$

$$0.04 \times 0.017 = \frac{7.47648 \times 10^{-5} \times \sqrt{19.62h}}{0.017}$$

$$\Rightarrow 6.8 \times 10^{-4} = 7.47648 \times 10^{-5} \times \sqrt{19.62h}$$

$$\sqrt{19.62h} = \frac{6.8 \times 10^{-4}}{7.47648 \times 10^{-5}}$$

$$\sqrt{19.62h} = 9.095$$



$$\therefore Q_{acc} = 0.149 \text{ m}^3/\text{s}$$

ii Pressure Difference

$$\frac{P_1 - P_2}{w} + (z_2 - z_1) = 3.53$$

$$z_2 - z_1 = 300 \text{ mm} = 0.3 \text{ m}$$

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

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

$$\frac{P_1 - P_2}{w} = 3.83$$

$$P_1 - P_2 = 3.83 \times w$$

$$P_1 - P_2 = 3.83 \times 9810 \times 0.9$$
$$= 33,815.07 \text{ N/m}^2$$

$$\therefore P_1 - P_2 = 33.8 \text{ kN/m}^2$$

2. A 300mm \* 150mm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being 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,
- The discharge of oil, and
  - The pressure difference between the entrance section and the throat section. Take the coefficient of metre as 0.98 and specific gravity of mercury as 13.6.

Sol

$$D_1 = 300\text{mm} = 0.3\text{m}$$

$$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.07\text{m}^2$$

$$y = 250\text{mm} = 0.25\text{m}$$

$$D_2 = 150\text{mm} = 0.15\text{m}$$

$$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177\text{m}^2$$

$$h = \frac{p_1 - p_2}{w} = h = y \left[ \frac{S_h}{S_o} - 1 \right] = 0.25 \left[ \frac{13.6}{0.9} - 1 \right]$$

$$\Rightarrow 0.25 (15.1 - 1)$$

$$\Rightarrow 0.25 \times 14.1 = 3.525\text{m}$$

$$\approx 3.53\text{m of oil}$$

$$C_d = 0.98$$

i. Discharge

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

$$Q_{act} = \frac{0.98 \times 0.07 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.07^2 - 0.0177^2}}$$

$$Q_{act} = \frac{0.0101}{0.0677}$$

$$19.62h = 9.095^2$$

$$19.62h = 82.719$$

$$\frac{19.62}{19.62} \quad \frac{82.719}{19.62}$$

$h = 4.216 \text{ m}$  of the liquid.

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

$$4.216 = \left( \frac{P_1}{\omega} - \frac{P_2}{\omega} \right) - (z_2 - z_1)$$

$$4.216 = \left[ \left( \frac{P_1}{\omega} - \frac{P_2}{\omega} \right) - (0.15) \right]$$

$$\frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 4.216 + 0.15 = 4.366$$

Therefore,  $\frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 4.366$

$$P_1 - P_2 = 4.366 \times \rho g$$

$$= 4.366 \times 0.8 \times 9810$$

$$= 34264.368 \text{ N/m}^2$$

$$\approx 34264 \text{ N/m}^2$$

$$= 34.264 \text{ kN/m}^2$$

$\therefore$  Pressure difference,  $P_1 - P_2 = 34.264 \text{ kN/m}^2$