

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

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

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

$$P_1 - P_2 = 3.83 \nu$$

$$\begin{aligned} P_1 - P_2 &= 3.82 \times 9.81 \times 0.9 \\ &\approx 33.8 \text{ N/m}^2 \end{aligned}$$

$$\text{Q. Diameter of inlet } D_1 = 800\text{mm} = 0.8\text{m}$$

$$\text{Area of inlet } A_1 = \frac{\pi}{4} \times D_1^2 = \frac{\pi \times 0.8^2}{4} = 0.016\text{m}^2$$

$$\text{Diameter of throat } D_2 = 150\text{mm} = 0.15\text{m}$$

$$\text{Area of throat } A_2 = \frac{\pi}{4} D_2^2 = \frac{\pi \times 0.15^2}{4} = 0.01767\text{m}^2$$

Specific gravity of heavy liquid (mercury) in U tube manometer  
 $S_{Hg} = 13.2$

Specific gravity of liquid (oil) flowing through pipe  $S_p = 0.9$   
 Reading of differential manometer,  $y = 250\text{mm} = 0.25\text{m}$

The differential  $h$  is given by;

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

$$= g \left[ \frac{S_{Hg} - 1}{S_p} - 1 \right] = 0.25 \left[ \frac{13.2 - 1}{0.9} - 1 \right] = 3.53\text{m of oil}$$

$$h = 3.53\text{m of oil} = 3.53\text{m}$$

(a) Discharge of oil  $Q$

Using the relation,

$$Q = Cd \times A_1 A_2 \times \sqrt{2gh}$$

$$Q = 0.98 \times 0.07 \times 0.01767 \times \sqrt{2.99 \times 3.53}$$

$$Q = \frac{\sqrt{0.07^2 - 0.01767^2}}{4A_1^2 - A_2^2} \times 1.1 = 0.148\text{m}^3/\text{s}$$

(b) Pressure difference between entrance and throat section  $P_1 - P_2$

We all know that;

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

$$h = \left( \frac{P_1}{w} - \frac{P_2}{w} \right) + (z_1 - z_2) = 3.53 \times 9.81 = 34.4$$

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

Given sp of gravity 0.8,  $D_1 = 150\text{mm} = 0.15\text{m}$ ,  $D_2 = 75\text{mm} = 0.075\text{m}$ .  
 $Z_2 - Z_1 = 150\text{mm} = 0.15\text{m}$ ,  $Q = 40\text{lit/sec} = 0.04\text{m}^3/\text{s}$ ,  $C_d = 0.96$

Pressure difference  $(P_1 - P_2)$

$$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0707\text{m}^2$$

$$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.00442\text{m}^2$$

$$Q = C_d \sqrt{A_1 A_2 \sqrt{2g h}}$$

$$0.04 = \frac{0.96 \times 0.0707 \times 0.00442 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.0707^2 - 0.00442^2}}$$

$$0.04 = \frac{0.96 \times 0.0704565 \times 4.429\sqrt{h}}{4.247} \approx 4.247\text{m}$$

$$h = \left( \frac{0.04}{0.96 \times 0.0704565 \times 4.429} \right)^2 = \left( \frac{0.04}{4.247} \right)^2 = 0.001767\text{m}$$

$$h = \left( \frac{P_1 - P_2}{\rho g} \right) + \left( Z_1 - Z_2 \right) = 0.001767\text{m}$$

$$4.247 = \left( \frac{P_1 - P_2}{\rho g} \right) + 0.001767 \quad \text{Subtract 0.001767 from both sides}$$

$$4.247 + 0.001767 = \frac{P_1 - P_2}{\rho g}$$

$$(4.247 + 0.001767) \rho g = P_1 - P_2 \quad \text{Cancel } \rho g \text{ on LHS}$$

$$P_1 - P_2 = (0.8 \times 1000 \times 9.81) (4.247 + 0.001767) - 0.001767$$

$$P_1 - P_2 = 34.51 \text{ kN/m}^2$$