

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

Pressure difference  $(P_1 - P_2)$

$$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.01767 \text{ m}^2$$

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

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

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

$$0.04 = 0.96 \times 0.004565 \times 4.429 \sqrt{h}$$

$$h = \left( \frac{0.04}{0.96 \times 0.004565 \times 4.429} \right)^2 = 4.247 \text{ m}$$

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

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

$$4.247 = \left( \frac{P_1 - P_2}{\rho} \right) - 0.15$$

$$4.247 + 0.15 = \frac{P_1 - P_2}{\rho}$$

$$(4.247 + 0.15) \rho = P_1 - P_2$$

$$P_1 - P_2 = (0.8 \times 1000 \times 9.81) (4.247 + 0.15)$$

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

3. Diameter of Inlet  $D_1 = 300\text{mm} = 0.3\text{m}$

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

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

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

Specific gravity of heavy liquid (mercury) in U tube manometer  
 $S_{hc} = 13.6$

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:

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

$$= y \left[ \frac{S_{hc}}{S_p} - 1 \right] = 0.25 \left[ \frac{13.6}{0.9} - 1 \right] = 3.53\text{m of Oil}$$

a) Discharge of Oil Q

Using the relation,

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

$$Q = \frac{0.98 \times 0.07 \times 0.01767 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.07^2 - 0.01767^2}}$$

$$Q = 0.1487\text{m}^3/\text{s}$$

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

we all know that,

$$h = \left( \frac{P_1}{\rho} + Z_1 \right) - \left( \frac{P_2}{\rho} + Z_2 \right) = 3.53$$

$$h = \left( \frac{P_1}{\rho} - \frac{P_2}{\rho} \right) - (Z_1 - Z_2) = 3.53$$

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

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

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

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

$$P_1 - P_2 = 3.83w$$

$$P_1 - P_2 = 3.82 \times 9.81 \times 0.9$$
$$= 33.8 \text{ kN/m}^2$$