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

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

$$w = (9.81 \times 0.9) = 8.829$$

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

② Diameter at inlet, $D_1 = 300mm = 0.3m$

Area of inlet, $A_1 = \frac{\pi \times 0.3^2}{4} = 0.07m^2$

Diameter at throat, $D_2 = 150mm = 0.15m$

Area at throat, $A_2 = \frac{\pi \times 0.15^2}{4} = 0.01767m^2$

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

Specific gravity of liquid (oil) flowing through pipe, $S_p = 0.9$

Reading of differential manometer, $y = 250mm = 0.25m$

The differential 'h' is given by:

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

$$= y\left[\frac{S_{HI}}{S_p} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$$

① Discharge of oil, Q:

using this relation

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

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

$$= \frac{0.001212}{0.0677} \times 8.32 = 0.148 m^3/s$$

(11) Pressure difference between entrance throat sections

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

if $z_2 - z_1 = 0.3m$

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

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Computer Engineering

① Sp gravity = 0.8
$D_1 = 150mm = 0.15m$
$D_2 = 75mm = 0.075m$
$Z_2 - Z_1 = 150mm = 0.15m$
$Q_{act} = 40L/s = 0.04 m^3/s$
$C_d = 0.96$

Pressure difference $(P_1 - P_2)$

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767\ m^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.075)^2}{4} = 0.00442\ m^2$$

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

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

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

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

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

$$(P_1 - P_2) = P_g (4.247 + 0.15)$$
$$= (0.8 \times 1000 \times 9.81)(4.247 + 0.15)$$
$$= 34.51\ kN/m^2 //$$