18/ENG07/007
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Petroleum Engineering
Answers

(1)

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

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

Diameter at throat, $D_2 = 150mm = 0.5m$

$\therefore$ Area at throat, $A_2 = \frac{\pi}{4} \times 0.5^2 = 0.01767m^2$

~~Specific~~ Specific gravity of heavy liquid (mercury) in U-tube manometer, $S_L = 13.6$

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:

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

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

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

Using the relation

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

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

$$= \frac{0.001212}{0.0677} \times 8.32\ m$$

$$= 0.1489\ m^3/N$$

(2)

(11)

We know that

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

But, $Z_2 - Z_1 = 500\,mm$ or $0.3\,m$

$$\therefore \left(\frac{P_1}{w} - \frac{P_2}{w}\right) - 0.3 = 3.53 \quad \text{or} \quad \frac{P_1 - P_2}{w} = 3.83$$

$$P_1 - P_2 = (9.81 \times 0.9) \times 3.83$$

$$= \underline{33.8\,kN/m^3}$$

(2)

$$A_1 = \pi/4\, D_1^2 = \pi/4 \times 0.15^2 = 0.01767\,m^2$$

$$A_2 = \pi/4\, D_2^2 = \pi/4 \times 0.075^2 = 0.00442\,m^2$$

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

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

$$\therefore h = \left[\frac{0.04}{0.96 \times 0.004565 \times 4.429}\right]^2 = 4.247\,m$$

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

$$\text{or } 4.247 = \left(\frac{P_1 - P_2}{w}\right) + (Z_1 - Z_2)$$

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

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

$$= (0.8 \times 1000 \times 9.81)(4.247 + 0.15)\,N/m^2$$

$$= \underline{34.51\,kN/m^2}$$