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19/ENG07/025.
Petroleum Engineering.
Fluid Mechanics (EPH 214).

(1) Given Sp of gravity 0.8, $D_1 = 150mm = 0.15m$.
$D_2 = 75mm = 0.075m$. $Z_2 - Z_1 = 150mm = 0.15m$
$Q = 40 lit/sec = 0.04 m^3/s$, $C_d = 0.96$.

Pressure difference $(P_1 - P_2)$.

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

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

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

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

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

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

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

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

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

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

$$P_1 - P_2 = 34.51 kN/m^2$$

2) Diameter of inlet $D_1 = 300mm = 0.3m$.

Area of inlet $D_1 = \frac{\pi \times (D_1)^2}{4} = \frac{\pi \times (0.3)^2}{4} = 0.07m^2$.

Diameter of throat $D_2 = 150mm = 0.15m$.

Area of inlet $D_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times (0.45)^2}{4} = 0.01767m^2$.

Specific gravity of heavy liquid (mercury) in tube.

Reading the diff. manometer, $y = 250mm = 0.25m$

The differential "h" is given by;

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

$$= y\left[\frac{S_m}{S_p} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right] = 3.53m \text{ of oil.}$$

(a) Discharge of oil.

Using the relation,

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

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

$$Q = 0.1489 m^3/s.$$

(b) Pressure difference $P_1 - P_2$,

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

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

$$z_2 - z_1 = 300mm = 0.3m.$$

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

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

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

$$P_1 - P_2 = 3.83w.$$

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

$$= 33.8 \text{ kN/m}^2.$$