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COURSE: FLUID MECHANICS - EMG 214
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(1) ASSIGNMENT.

$D_1 = 300mm = 0.3m$

$A_1 = \pi/4 \times 0.3^2 = 0.07m^2$

$D_2 = 150mm = 0.15m$

$A_2 = \pi/4 \times 0.15^2 = 0.017667m^2$

$= 0.02m^2$

Specific gravity of oil = 0.9 = S_p

Specific gravity of manometric fluid = 13.6 = S_m

Manometer reading $y = 250mm = 0.25m$

Differential 'h' $= \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right) = y\left[\frac{S_m}{S_p} - 1\right]$

$= 0.25\left[\frac{13.6}{0.9} - 1\right]$

$= 3.53m$ of oil

(i) Discharge of oil, Q

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

$= 0.98 \times \frac{(0.07 \times 0.02)}{\sqrt{0.07^2 - 0.02^2}} \times \sqrt{2 \times 9.81 \times 3.53}$

$= 0.17m^3/s.$

(ii) Pressure difference between the entrance section & the throat section.

Recall: $\left(P_1/w - P_2/w\right) + (z_1 - z_2) = 3.53$

$z_1 - z_2 = 300mm = 0.3m$ [datum head difference]

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

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

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

Pressure difference $= 33.8 kN/m^2.$

(2) Data Relative density of fluid = 0.8

Inlet diameter, D_1 = 150mm = 0.15m

Throat diameter, D_2 = 75mm = 0.075m

$z_2 - z_1$ = 150mm = 0.15m

flow rate, Q = 40 litres/sec = $\frac{40}{1000}$ = $0.04 m^3/s$

Cd = 0.96.

$A_1 = \pi/4 \times 0.15^2 = 0.018 m^2$

$A_2 = \pi/4 \times 0.075^2 = 0.004 m^2$

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

$$0.04 = 0.96 \times \frac{(0.018 \times 0.004)}{\sqrt{0.018^2 - 0.004^2}} \times \sqrt{2 \times 9.81} \times \sqrt{h}$$

$$0.04 = 0.96 \times (4.00 \times 10^{-3}) \times 4.429 \times \sqrt{h}$$

$$\sqrt{h} = \frac{0.04}{0.96 \times 4.00 \times 10^{-3} \times 4.429}$$

$\sqrt{h} = 2.30581$

$h = (2.30581)^2 = 5.3m$

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

$5.31 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (z_1 - z_2)$

$5.31 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) - 0.15$

$5.31 + 0.15 = P_1/w - P_2/w$

$5.46 = \frac{P_1 - P_2}{w}$

$P_1 - P_2 = 5.46 \times (0.8 \times 1000 \times 9.81)$

$P_1 - P_2 = 42.85 \times 10^3 N/m^2$