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18/ENG04/059
Electrical Engineering
ENG 214 - Fluid mechanics

1) Given Sp of gravity 0.8, $D_1 = 150mm = 0.15m$
$D_2 = 95mm = 0.095m$, $Z_2 - Z_1 = 150mm = 0.15m$
$Q = 40lit/sec = 0.04m^3/s$, $cd = 0.96$
Pressure difference $(P_1 - P_2)$

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

$$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.095}{4} = 0.00442m^2$$

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

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

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

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

$$h = 4.247m$$

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

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

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

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

$$(4.247 + 0.15)P_g = P_1 - P_2$$

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

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

2) $D_1 = 300mm = 03m$

$D_2 = 150mm = 0.15m$

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

$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0177m^2$

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

Specific gravity of liquid (oil) $S_p = 0.9$

$y = 250mm = 0.25m$

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

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

$= 3.53m$

2i&) Discharge of oil Q

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

$Q = \frac{0.98 \times 0.07 \times 0.0177}{\sqrt{0.07^2 - 0.0177^2}} \times \sqrt{2 \times 9.81 \times 3.53}$

$Q = 0.149 m^3/s$

$Z_2 - Z_1 = 300mm = 0.3m$

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

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

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

$P_1 - P_2 = 3.83w$

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

$P_1 - P_2 = 33.8 kN/m^2$