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18/ENG04/006
Electrical Engineering.
Fluid Mechanics

1) Relative Density = 0.8
Inlet diameter $d_1 = 150mm = 150 \times 10^{-3} m$
$d_2 = 75mm = 75 \times 10^{-3} m$
$Q = 40L/secs = 0.04 m^3/secs$
$Cd = 0.96$
$Z_2 - Z_1 = 150mm = 0.15m$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times (150 \times 10^{-3})^2}{4}$
$= 0.177 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times (75 \times 10^{-3})^2}{4}$
$= 4.419 \times 10^{-3} m^2$

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

$\therefore Q\sqrt{(A_1^2 - A_2^2)} = Cd A_1 A_2 \sqrt{2gh}$

$\sqrt{2gh} = \left(\frac{Q\sqrt{(A_1^2 - A_2^2)}}{Cd A_1 A_2 \sqrt{2g}}\right)^2$

$h = \left(\frac{Q\sqrt{A_1^2 - A_2^2}}{Cd A_1 A_2}\right)^2 \frac{}{2g}$

$$h = \left(\frac{(0.04\sqrt{(0.0177)^2 - (4.419 \times 10^{-3})^2})^2}{0.76 \times 0.0177 \times 4.419 \times 10^{-3}} \right)^2 \Big/ 2 \times 9.81$$

Differential manometer = 250mm = 0.25m

$$h = \left[\frac{S_h}{S_p} - 1\right] y$$

$$h = \left[\frac{13.6}{0.8} - 1\right] y$$

$$h = (16.11) \times 0.25$$

$$h = 3.528m$$

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

$$Q = \frac{0.98 \times 0.01069 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.528}}{\sqrt{(0.01069^2 - 0.0177^2)}}$$

$$Q = \frac{0.0102}{0.689}$$

$$Q = 0.149 m^3/s$$

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

$$3.528 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) - (Z_1 - Z_2)$$

$$3.528 + (Z_2 - Z_1) = \left(\frac{P_1}{w} - \frac{P_2}{w}\right)$$

Recall, $Z_2 - Z_1 = 300mm = 0.3m$

$(3.528 + 0.3) = \left(\frac{P_1 - P_2}{w}\right)$

$\left(\frac{P_1 - P_2}{w}\right) = 3.828$

$P_1 - P_2 = 3.828 \times w$

Recall $w = 9.81 \times 0.7$

$P_1 - P_2 = 3.828 \times 9.81 \times 0.7$

$P_1 - P_2 = 33.79\ KN/m^2$

$$h = \left(\frac{6.855799 \times 10^{-4}}{\frac{7.50876 \times 10^{-5}}{2 \times 9.81}}\right)$$

$\frac{(9.130)^2}{2 \times 9.81} = \frac{83.3569}{19.62}$

$= 4.24m$

Then

$h = \left(\frac{P_1}{w_1} + Z_1\right) - \left(P_2/w_2 + Z_2\right)$

$h = \left(\frac{P_1}{w_1} - \frac{P_2}{w_2}\right) + (Z_1 - Z_2)$

$4.24 = \frac{P_1 - P_2}{w} + (Z_1 - Z_2)$

$\frac{P_1 - P_2}{w} = 4.24 + (Z_2 - Z_1)$

$= 4.24 + 0.15$

$= 4.39$

$P_1 - P_2 = 4.39 \times w$

$= 4.39 \times (0.8 \times 9.81 \times 1000)$

$= 4.39 \times 7848$

$= 34452.72 N/m^2$

$(3.528 + 03) = \left(\frac{P_1 - P_2}{w}\right)$

$\left(\frac{P_1 - P_2}{w}\right) = 3.828$

$P_1 - P_2 = 3828 \times w$

Recall $w = 9.81 \times 0.9$

$P_1 - P_2 = 3.828 \times 9.81 \times 0.7$

$P_1 - P_2 = 33.79\ KN/m^2$

$h = \left(\frac{6.855799 \times 10^{-4}}{\frac{1.50876 \times 10^{5}}{2 \times 9.81}}\right)$

$\frac{(9.130)^2}{2 \times 9.81} = \frac{83.3569}{19.62}$

$= 4.24m$

Then

$h = \left(\frac{P_1}{w_1} + Z_1\right) - \left(P_2/w_2 + Z_2\right)$

$h = \left(\frac{P_1}{w_1} - \frac{P_2}{w_2}\right) \pm (Z_1 - Z_2)$

$4.24 = \frac{P_1 - P_2}{w} \pm (Z_1 - Z_2)$

$\frac{P_1 - P_2}{w} = 4.24 + (Z_2 - Z_1)$

$= 4.24 + 0.15$

$= 4.39$

$P_1 - P_2 = 4.39 \times w$

$= 4.39 \times (0.8 \times 9.81 \times 1000)$

$= 4.39 \times 7848$

$= 34452.72 N/m^2$