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DEPARTMENT: MECHANICAL ENGINEERING
COURSE: FLUID MECHANICS
ASSIGNMENT NO 2

(1) Relative density = 0.8

Inlet diameter $d_1 = 150mm = 150 \times 10^{-3} m$

Throat diameter $d_2 = 75mm = 75 \times 10^{-3} m$

Actual flowrate $Q_{act} = 40L/secs = 0.04m^3/secs$

$Cd = 0.96$

$Z_2 - Z_1 = 150mm = 0.15m$

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

$$= 0.0177m^2$$

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

$$= 4.419 \times 10^{-3} m^2$$

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

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

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

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

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

$$h = \frac{\left(\frac{0.04\sqrt{(0.0177)^2 - (4.419 \times 10^{-3})^2}}{0.96 \times 0.0177 \times 4.419 \times 10^{-3}}\right)^2}{2 \times 9.81}$$

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

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

$= 4.24 m$

Then;

$$h = \left(\frac{P_1}{w_1} + z_1\right) - \left(\frac{P_2}{w_2} + z_2\right)$$

$$h = \left(\frac{P_1}{w_1} - \frac{P_2}{w_2}\right) + (z_1 - z_2)$$

$$4.24 = \frac{P_1 - P_2}{w} + (z_1 - z_2)$$

$$\frac{P_1 - P_2}{w} = 4.24 + (z_2 - z_1)$$

$$\frac{P_1 - P_2}{w} = (4.24 + 0.15)$$

$$\frac{P_1 - P_2}{w} = 4.39$$

$P_1 - P_2 = 4.39 \times w$

$P_1 - P_2 = 4.39 \times (0.8 \times 9.81 \times 1000)$

$P_1 - P_2 = 4.39 \times 7848$

$P_1 - P_2 = 34452.72\ N/m^2$

(2) Inlet d ; $d_1 = 300 mm = 300 \times 10^{-3} m$

Throat diameter $d_2 = 150 mm = 150 \times 10^{-3} m$

$A_1 = 0.07069 m^2$

$A_2 = 0.0177 m^2$

$C_d = 0.98$

Sh of mercury = 13.6

S.P of oil = 0.9

Differential manometer = 250 mm = 0.25 m

$$h.\left[\frac{s.l}{Sp} - 1\right]$$

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

$h = (14.11) \times 0.25$

$h = 3.528m$

(i) The discharge of oil =

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

$$Q = \frac{0.98 \times 0.07069 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.528}}{\sqrt{(0.07069^2) - (0.0177^2)}}$$

$$Q = \frac{0.0102}{0.0689}$$

$Q = 0.149 m^3/s$

(ii) The pressure difference between the entrance section and the throat section.

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

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

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

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

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

$$\frac{P_1 - P_2}{W} = 3.828$$

$P_1 - P_2 = 3.828 \times W$

Recall, $W = 9.81 \times 0.9$

$P_1 - P_2 = 3.828 \times 9.81 \times 0.9$

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