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Biomedical Engineering
18/ENG08/1015
ENG 214 (Fluid mechanics) Assignment

1. Relative density = 0.8

Inlet diameter d_i = 150mm = 150×10^{-3} m

Throat " d_t = 75mm = 75×10^{-3} m

Q_{od} = 40L/secs = $0.04 m^3/secs$

C_d = 0.96

$z_2 - z_1$ = 150mm = 0.15m

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

$$= 0.0177 m^2$$

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

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

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

$$Q\sqrt{A_1^2 - A_2^2)} = C_d A_1 A_2 \sqrt{2gL}$$

$$\sqrt{2gh} = Q \frac{\sqrt{CA_1^2 - A_2^2}}{C_d A_1 A_2}$$

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

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

$$\frac{}{2g}$$

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

$$2 \times 9.81$$

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

$$2 \times 9.81$$

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

$$= 4.24\ m$$

Then

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

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

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

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

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

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

$$P_1 - P_2 = 4.39 \times w$$

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

$$P_1 - P_2 = 4.39 \times 7848$$

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

2. Inlet d, $D_1 = 300mm = 300 \times 10^{-3}\ m$ $A_1 = 0.07069\ m^2$

Throat d, $D_2 = 150mm = 150 \times 10^{-3}\ m$ $A_2 = 0.0177\ m^2$

Sp.L of moving = 13.6 $Cd = 0.98$

S.P of 0.6 = 0.9

Differential manometer = 250mm = 0.25m

$$h = \left(\frac{S.L}{S.p} - 1\right)$$

$$h = \left(\frac{13.6}{0.8} - 1\right) y$$

$$h = (14.11) \times 0.25$$

$h = 3.528\,m$

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

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

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

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

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

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

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

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

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

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

$$P_1 - P_2 = 3.828 \times \omega$$

Recall, $\omega = 9.81 \times 0.9$

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

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