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MECHATRONICSS ENGINEERING

MATRIC NO: 18/ENG05/002

FLUID MECHANICS ASSIGNMENT

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Mechatronics Engineering
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Question 1

Data given

Specific gravity = 0.8

$D_1 = 150mm = 0.15m$

$D_2 = 75mm = 0.075m$

$Z_1 - Z_2 = 150mm = 0.15m$

$Q_{actual} = 40 \text{ litres/s} = 0.04 m^3/s$

$C_d = 0.96$

$P_1 - P_2 = ?$

Solution

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767 m^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.075)^2}{4} = 0.00442 m^2$$

$$Q_{actual} = \frac{C_d A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

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

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

$$h = \left(\frac{0.04}{0.96 \times 0.004565 \times 4.429}\right)^2 \quad h = 4.247m$$

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

$$4.247 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (Z_1 - Z_2)$$

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

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

$$P_1 - P_2 = 7848 \times 4.397 = 34507.7 N/m^2$$

$$P_1 - P_2 = 34507.7 N/m^2$$

Question 2

Data given

$D_1 = 300mm = 0.3m$

$D_2 = 150mm = 0.15m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.3)^2}{4} = 0.07m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767m^2$

Specific gravity of heavy fluid (mercury) $S_{hl} = 13.6$.

Specific gravity of oil $= 0.9 = S_p$

Reading of differential manometer,

$y = 250mm = 0.25m$.

$h = y\left(\frac{S_{hl}}{S_p} - 1\right)$, $h = 0.25\left(\frac{13.6}{0.9} - 1\right)$

$h = 3.53m$ of oil.

(i) Discharge of oil

$Q_{actual} = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$.

$Q = 0.98 \times \frac{0.07 \times 0.01767}{\sqrt{0.07^2 - 0.01767^2}} \times \sqrt{2 \times 9.81 \times 3.53}$

$= \frac{0.001212}{0.0677} \times 8.32 = 0.1489 m^3/s$

$\therefore$ Q, Discharge of oil $= 0.1489 m^3/s$.

(ii) $P_1 - P_2 = ?$

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

$Z_1 - Z_2 = 300mm = 0.3m$

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

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

$P_1 - P_2 = \rho g (3.53 + 0.3)$

QUESTION 2 SOLUTION CONTINUATION

Question

Solution Continuation

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

$P_1 - P_2 = 8.829 \times 3.83$

$P_1 - P_2 = 33.82 KN/m^2$

∴ Pressure difference between the entrance section and throat section is $33.82 KN/m^2$