ENG

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Mechanical Engineering

Assignment

1) $Z_1 = 0$ $\qquad V_1 = 5m/s$

$Z_2 = 2.0m$ $\qquad V_2 = 2m/s$

The pressure, $h, \frac{P_1}{w} = 2.5m$

$\frac{P_2}{w} = ?$

$$h_f = 0.35\frac{(v_1 - v_2)^2}{2g}$$

$$= \frac{0.35(5-2)^2}{2\times9.81} = \frac{0.35\times9}{2\times9.81}$$

$$= 0.1606m$$

Applying Bernoulli's Equation

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + h_f$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 - \frac{V_2^2}{2g} - Z_2 - h_f$$

$$= 2.5 + \frac{5^2}{2\times9.81} + 0 - \frac{2^2}{2\times9.81} - 2 - 0.1606$$

$$= 2.5 + 1.274 - 0.204 - 0.1606 - 2.0$$

$$= 1.4094m$$

$$= 1.41m$$

$\therefore h_2, \frac{P_2}{w} = 1.41m$

$= 1.41m$

2) $d_1 = 20cm = \frac{20}{100} = 0.2m$, $\quad A_1 = \frac{\pi d^2}{4} = \frac{\pi(0.2)^2}{4} = 0.0314m^2$

$d_2 = 10cm = \frac{10}{100} = 0.1m$, $\quad A_2 = \frac{\pi d^2}{4} = \frac{\pi(0.1)^2}{4} = 0.00785m^2$

Scanned with CamScanner

$P_1 = 17.658\ N/cm^2 = 17.658 \times 10^4$

$= 176580\ N/m^2$

$P_2 = 30cm$ of Mercury

~~P_2~~ $= -0.3m$ of Hg

$= -0.3 \times 13.6$

$h_2 = -4.08$

$h_1 = \frac{P_1}{w} = \frac{176580}{1000 \times 9.81}$

$= 18m$

$\therefore h = h_1 - h_2$

$h = 18 - (-4.08) = 18 + 4.08$

$h = 22.08$

$\therefore Q = \frac{C_d\ A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

$= \frac{0.98 \times 0.0314 \times 0.00785 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.0314)^2 - (0.00786)^2}}$

$Q = \frac{0.00503}{0.0304}$

$\therefore \quad Q = 0.1654\ m^3/s$

3) Orifice diameter, $d_o = 15cm = 0.15m$

Pipe diameter, $d_1 = 30cm = 0.3m$

$A_o = \frac{\pi d_o^2}{4} = \frac{\pi (0.15)^2}{4}$

$= 0.01767m^2$ $\qquad C_d = 0.64$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (0.30)^2}{4}$

$= 0.070686m^2$

Differential head:

$y = 50cm$

$= 0.5m$

$h = \frac{p}{w} = y\left(\frac{S.G\ of\ mercury}{S.G\ of\ oil} - 1\right)$

$= 0.5\left(\frac{13.6}{0.9} - 1\right)$

$= 0.5(14.11) = 7.06m$

$\therefore h = 7.06m$

$\therefore Q = \frac{C_d \times A_1 A_2}{\sqrt{A_1^2 . A_0^2}} \times \sqrt{2gh}$

$= \frac{0.64 \times 0.01767 \times 0.07068}{\sqrt{(0.070686)^2 \times (0.01767)^2}} \times \sqrt{2 \times 9.81 \times 7.06}$

$= \frac{0.009407}{0.06844}$

$Q = 0.1374 m^3/s$

$Q = 0.137 m^3/s$

$Q = 0.137 m^3/s$

1 4) Difference of Hg (y)

$y = 170mm$

$y = \frac{170}{1000} = 0.17m$

S.G of mercury = 13.6

S.G of Sea Water = 1.026

$\therefore h = y\left(\frac{S.G\ of\ Hg}{S.G\ of\ seawater} - 1\right)$

$= y\left(\frac{13.6}{1.026} - 1\right)$

$= 0.17(12.255)$

$= 2.08m$

Velocity = ~~$\frac{\sqrt{2gAk}}{\sqrt{}}$~~ $\sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.08}$

$V = 6.39 m/s$

$\therefore$ Velocity $= 6.39 m/s$

5) Actual flow rate = $5 dm^3/min$

$= \frac{5 \times 10^{-3}}{60} m^3/sec$

=

Change in Pressure, δp = 15 bar

$= 15 \times 10^5 N/m^2$

Speed of rotation, N = 1700 rev/min

$= \frac{1700}{60} = 28.33$ rev/secs

Norminal Displacement = $10 cm^3/rev$

$= \frac{10}{10^6} m^3/rev$

$= 1 \times 10^{-5} m^3/rev$

Torque Input, T = 15 Nm

i) Volumetric Efficiency

$= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\%$

Actual flow rate = $8.33 \times 10^{-5} m^3/sec$

Ideal flow rate = speed of rotation x norminal displacement

$= 28.33 \times 1 \times 10^{-5}$

$= 2.833 \times 10^{-4}$

∴ Volumetric efficiency

$= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100\%$

$= 29.40\%$

ii) Fluid Power, $P_f = Q \times \delta p$

$= 8.33 \times 10^{-5} \times 15 \times 10^5$

= 124.95 watts

iii)

iii) Shaft Power = T·ω

$T = 15Nm$

$\omega = 2\pi N$ rad/s

$= 2 \times \frac{22}{7} \times 28.33$

$= 178.07$ rad/s

Shaft power = 15×178.07

$= 2671.11$ watts

∴ Overall efficiency

$= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100\%$

$= \frac{124.95}{2671.11} \times 100$

$= 4.678\%$

∴ The Overall efficiency is 4.68%,,