18/ENG04/008

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Course Title: Fluid mechanics

Assignment

1) $Z_1 = 0$

$Z_2 = 2.0m.$

$V_1 = 5m/s$

$V_2 = 2m/s$

The Pressure, $h_1 \frac{P_1}{w} = 2.5m.$

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

$$h_f = 0.35\frac{(V_1 - V_2)^2}{2g}$$

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

$$= 0.1606m.$$

Applying Bernoulli's Equation.

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

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

$$= 2.5 + \frac{5^2}{2\times9.81} + 0 - \frac{2^2}{2\times9.81} - 2.0 - 0.1606$$

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

$$= 1.4094m$$

$$= 1.41m$$

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

$= 1.41m$

NO 2

2 $d_1 = 20cm$

$= \frac{20}{100} = 0.2m.$

$d_2 = 10cm$

$= \frac{10}{100} = 0.1m$

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi(0.2)^2}{4}$$

$$= 0.0314m^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi(0.1)^2}{4}$$

$$= 0.00785m^2$$

$P_1 = 17.658 N/cm^2$

$= 17.658\times10^4$

$= 176580 N/m^2$

$P_2 =$ 30cm of Mercury

$= -0.3m$ of Hg.

$= -0.3m$ of Hg $\times 13.6$

$h_2 = -4.08m$

For $h_1 = \frac{P_1}{w}$

$$= \frac{176580}{1000\times9.81}$$

$$= 18m$$

$\therefore h = h_1 - h_2$

$h = 18 - (-4.08)$

$= 18 + 4.08$

$= 22.08.$

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

$$= \frac{0.98\times0.0314\times0.00785\times\sqrt{2\times9.81\times22.08}}{\sqrt{(0.0314)^2 - (0.00786)^2}}$$

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

$$Q = 0.1654 m^3/s$$

$Q = 0.1654 \, m^3/s$

No. 3

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

Pipe diameter, $d_1 = 30$ cm , $C_d = 0.64$
$= 0.3$ m

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

$= 0.01767 \, m^2$

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

$= 0.070686 \, m^2$

Differential head:

$y = 50$ cm
$= 0.5$ m.

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

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

$= 0.5(12.6)$ $0.5(14.11)$
$= 6.3$ $= 7.06$ m

$\therefore h = 7.06$ m

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

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

$= \frac{0.009407}{0.06844}$

$Q = 0.1374 \, m^3/s$

$Q = 0.137 \, m^3/s$

$Q = 0.137 \, m^3/s$

No. 4

Difference of Hg (y)

$y = 170$ mm
$= \frac{170}{1000}$

$y = 0.17$ m.

S.G of mercury $= 13.6$

S.G of sea water $= 1.026$

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

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

$= 0.17(12.255)$

$= 2.08$ m.

velocity $= \sqrt{2g\Delta h}$
$= \sqrt{2gh}$
$= \sqrt{2 \times 9.81 \times 2.08}$

$V = 6.39$ m/s

Actual flow rate $= 5\,dm^3/min$

$= \frac{5\times10^{-3}}{60}\ m^3/sec$

$= 8.33\times10^{-5}\ m^3/s$

Change in pressure, $\delta p = 15$ bar

$= 15\times10^5\ N/m^2$

Speed of rotation, $N = 1700$ rev/min

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

Normal displacement $= 10\,cm^3/rev$

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

$= 1\times10^{-5}\ m^3/rev$

Torque input, $T = 15\,Nm$

i) Volumetric Efficiency

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

Actual flow rate $= 8.33\times10^{-5}\ m^3/sec$

∴

Ideal flow rate = Speed of rotation × normal disp

$= 28.33 \times 1\times10^{-5}$

$= 2.833\times10^{-4}$

∴ Volumetric efficiency

$= \frac{8.33\times10^{-5}}{2.833\times10^{-4}} \times 100\%$

$= 29.40\%$

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

$= 8.33\times10^{-5} \times 15\times10^5$

$= 124.95$ Watts.

iii) Shaft power $= T \cdot \omega$

$T = 15\,Nm$

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

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

$= 178.07$ rad/s

∴

Shaft Power $= 15 \times 178.07$

$= 2671.11$ 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%