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

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

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

$= \frac{0.35(5-2)^2}{2 \times 9.81} = \frac{0.35 \times 9}{2 \times 9.81}$

$= 0.1606m$

Applying Bernoulli's Equation

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

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

$= 2.5 + \frac{5^2}{2 \times 9.81} + 0 - \frac{2^2}{2 \times 9.81} - 2.0 - 0.1606$

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

$= 1.4094m$

$= 1.41m$

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

$= 1.41m$

No. 2

2 $d_1 = 20\,cm$

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

$d_2 = 10\,cm$

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

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

$= 0.0314\,m^2$

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

$= 0.00785\,m^2$

$P_1 = 17.658\,N/cm^2$

$= 17.658 \times 10^4$

$= 176580\,N/m^2$

$P_2 =$ 30cm of Mercury

$= -0.3m$ of Hg.

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

$h_2 = -4.08\,m$

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

$= \frac{176580}{1000 \times 9.81}$

$= 18\,m$

$\therefore h = h_1 - h_2$

$h = 18 - (-4.08)$

$= 18 + 4.08$

$= 22.08.$

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

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

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

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

$Q = 0.1654 m^3/s$

No. 3

3 Orifice diameter, $d_0 = 15 cm$
$= 0.15 m$

Pipe diamet, $d_1 = 30 cm$, $Cd = 0.64$
$= 0.3 m$

$A_0 = \frac{\pi d_0^2}{4} = \frac{\pi (0.15)^2}{4}$

$= 0.01767 m^2$

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

$= 0.070686 m^2$

Differential head;
$y = 50 cm$
$= 0.5 m$

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

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

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

$\therefore h = 7.06 m$

$\therefore Q = \frac{Cd \times A_1 A_0}{\sqrt{A_1^2 - A_0^2}} \cdot \sqrt{2gh}$

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

$= \frac{0.009407}{0.06844}$

$Q = 0.1374 m^3/s$

$Q = 0.137 m^3/s$

$Q = 0.137 m^3/s$

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

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

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

$= 0.17\,(12.255)$

$= 2.08\,m.$

velocity $= \sqrt{2g\Delta h}$

$= \sqrt{2gh}$

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

$V = 6.39\,m/s$

Actual flow rate = 0.05 m³/min

$= \frac{0.05}{60}$ m³/sec

$= 8.33 \times 10^{-4}$ m³/sec

Change in pressure, δp = 15 bar

$= 15 \times 10^5$ N/m²

Speed of rotation, N = 1700 rev/min

$= \frac{1700}{60}$

= 28.33 rev/secs

Norminal displacement = 10cm³/rev

$= \frac{10}{10^6}$ m³/rev

$= 1 \times 10^{-5}$ m³/rev.

Torque input, T = 15Nm

i) Volumetric efficiency

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

Actual flowrate = 8.33×10^{-4} m³/sec

Ideal flowrate = speed of rotation × Normal disp

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

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

∴ Volumetric Efficiency

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

$= 2.9403 \times 100\%$

$= 294.03\%$

ii) fluid Power, P_F = $Q \times \delta P$

$= 8.33 \times 10^{-4} \times 15 \times 10^5$

= 1249.5 Watts

iii) Shaft power = T. ω

T = 15 Nm

ω = 2πN rad/s

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

= 178.07 rad/s

∴ Shaft power = 15 × 178.07

= 2671.11 watts.

iv) Overall efficiency = $\frac{\text{Fluid power}}{\text{shaft power}} \times 100\%$

= $\frac{1249.5}{2671.11} \times 100\%$

= 0.468 × 100%

= 46.8%

∴ The overall efficiency is ~~46.8%~~ 46.8%