AFE BABALOLA UNIVERSITY ADO-EKITI, EKITI STATE

Fluid Mechanics (ENG235) Assignment

SUBMITTED BY:

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MECHATRONICS ENGINEERING

18/ENG05/056

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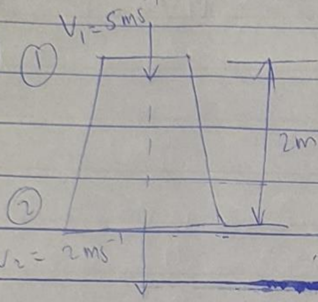
Mechatronics Engineering
ENG235 Assignment

1.)



$Z_1 = 2m$
$V_1 = 5ms^{-1}$
$V_2 = 2ms^{-1}$
$P_1 = 2.5m$

Loss of head $(h_L) = 0.35 (V_1 - V_2)^2 / 2g$

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

$h_L \simeq 0.16m$

Applying Bernoulli's equation for conical tube

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

$Z_1 = 2m$, $Z_2 = 0m$

$$2.5 + \frac{5^2}{2(9.81)} + 2 = \frac{P_2}{w} + \frac{2^2}{2(9.81)} + 0 + 0.16$$

$\Rightarrow 2.5 + 1.27 + 2 = \frac{P_2}{w} + 0.203 + 0.16$

$\Rightarrow 5.77 = \frac{P_2}{w} + 0.363$

$\frac{P_2}{w} = 5.77 - 0.363$

$= 5.41m$

head at larger opening $= 5.41m$

2.) $d_1 = 20cm = 0.2m$ (inlet)

$A_1 = \frac{\pi d_1^2}{4} \simeq 0.03142m^2$

$d_2 = 10cm = 0.1m$ (throat)

$A_2 = \frac{\pi d_2^2}{4} \simeq 0.00785 m^2$

$C_d = 0.98$

$P_1 = 17.658 Ncm^{-2} = 176580 Nm^{-2}$

Vacuum Pressure $= 30cmHg = 0.3mHg$

$Q = ?$

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

$h_2 = \frac{P_2}{\rho w} = -0.3mHg$

$= (-0.3 \times 13.6) mH_2O$

$= -4.08 mH_2O$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08)$

$= 22.08m$

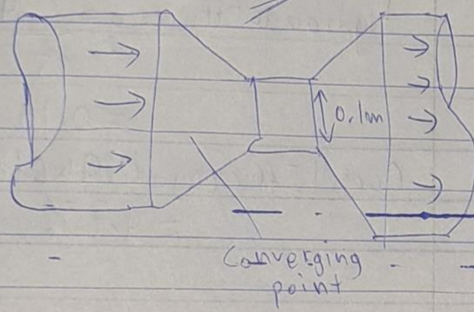
$Q = C_d A_1 \cdot A_2 \sqrt{2gh} / \sqrt{A_1^2 - A_2^2}$

$$Q = \frac{0.98 \times 0.03142 \times 0.00785 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.03142^2 - 0.00785^2}}$$

$$Q = \frac{2.42\times10^{-4}\times\sqrt{433.21}}{\sqrt{9.26\times10^{-4}}}$$

$$Q = \frac{5.037\times10^{-3}}{0.0304}$$

$$Q = 0.166\,m^3 s^{-1}$$



3) $d_0 = 15cm = 0.15m$

$d_1 = 30cm = 0.3m$

$A_0 = \pi(0.15)^2/4 = 0.0177m^2$

$A_1 = \pi(0.3)^2/4 = 0.07m^2$

$Cd = 0.64$

$y = 0.5mHg$

$$h = y\left(\frac{S_{ac}}{S_o} - 1\right) = 0.5\left(\frac{13.6}{0.9} - 1\right)$$

$h = 7.65m$

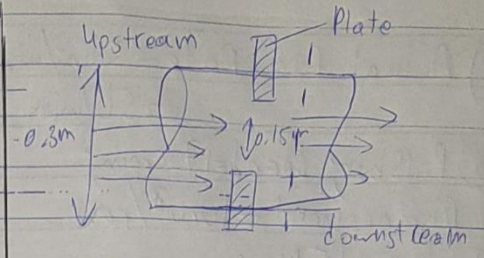
$$Q = \frac{C_d A_0 \times A_1\sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

$$Q = \frac{0.64\times0.0177\times0.07\times\sqrt{2\times9.81\times7.05}}{\sqrt{0.07^2 - 0.0177^2}}$$

$$Q = \frac{7.9296\times10^{-4}\times\sqrt{138.32}}{\sqrt{4.59\times10^{-3}}}$$

$Q = 9.326\times10^{-3}/0.068$

$= 0.137\,m^3 s^{-1}$



4.) Reading from manometer

$= 170mmHg$

$= 0.17mHg$

Specific gravity of Hg = 13.6

Specific gravity of sea water = 1.026

$$h = y\left(\frac{S_m}{S_L} - 1\right)$$

$$h = 0.17\left(\frac{13.6}{1.026} - 1\right)$$

$h = 0.17(12.26)$

$h = 2.084m$

$V = \sqrt{2gh} = \sqrt{2\times9.81\times2.084}$

$= \sqrt{40.89}$

$= 6.39\,m s^{-1}$

5.) Actual flow Rate = $5 dm^3/min$
$= 5 l/min$

(a) P = 15bar; Speed = 1700rpm;
Displacement = $10 cm^3/rev$
Torque = 15 Nm;

Volumetric efficiency = $\frac{\text{Theoretical Flow} \times 100}{\text{Actual flow}}$

Theoretical flow = Displacement × speed
but $10 cm^3/rev$ = 0.01L/rev
Theoretical flow = 0.01 × 1700 = 17L/min

Volumetric efficiency = $\frac{5}{17} \times 100$
$\simeq 29.4\%$

(b) Fluid Power = $\frac{\text{Pressure} \times \text{Actual Flow}}{600}$
$= \frac{15 \times 5}{600}$
$\simeq 125 W$

(c) Shaft Power = $\frac{\text{Fluid Power}}{\text{Efficiency of Pump}}$
$= \frac{125}{0.294}$
$\simeq 425.17 W$

General/Overall Efficiency
= Volumetric Efficiency × Hydraulic Efficiency

Hydraulic Efficiency = $\frac{\text{Theoretical Torque}}{\text{Actual Torque}}$

Theoretical Torque
$= \frac{\text{Displacement} \times \text{Pressure}}{2\pi}$
$\Rightarrow (10 \times \sqrt{15}) / (20 \times 3.42)$
$\simeq 2.39 Nm$

Hydraulic Efficiency = $\frac{2.39}{15}$
$= 0.16$

Overall Efficiency = 0.294 × 0.16 × 100
= 4.7%