ABIMBOLA OLUWAFEMI GIDEON

MATRIC NUMBER: 18/ENG05/002

DEPARTMENT: MECHATRONICS ENGINEERING

FLUID MECHANICS ASSIGNMENT

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Question 1

Data given

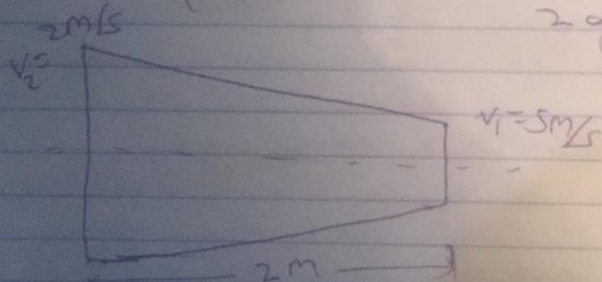
length of conical tube = 2.0m

velocity at smaller end = 5m/s = v_1

lower end velocity = 2m/s = v_2

Pressure head at the smaller end = 2.5m

loss of head = $\frac{0.35(v_1 - v_2)^2}{2g}$



loss of head = $\frac{0.35(5-2)^2}{2 \times 9.81} = \frac{0.35(3)^2}{19.62}$

H_L = loss of head = 0.161m.

Applying Bernoli's equation to find the pressure head at the lower end.

$$\frac{P_1}{w} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{v_2^2}{2g} + z_2 + H_L$$

$z_1 = 2m$, $z_2 = 0$

Pressure head at lower end $= \frac{P_2}{\omega}$
making $\frac{P_2}{\omega}$ the subject of formula

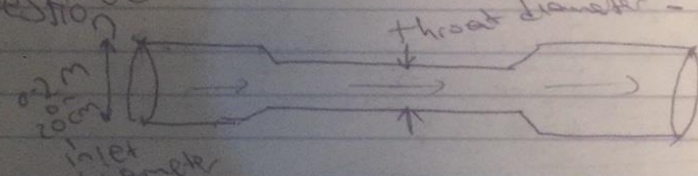
$$\frac{P^1}{\omega} + \frac{V_1^2}{2g} - \frac{V_2^2}{2g} + z_1 - z_2 - H_L = \frac{P_2}{\omega}$$

$$2.5 + \frac{5^2}{2\times9.81} - \frac{2^2}{2\times9.81} + 2 - 0 - 0.161 = \frac{P_2}{\omega}$$

$$2.5 + 1.27 - 0.204 + 2 - 0.161 = \frac{P_2}{\omega}$$

$$\frac{P_2}{\omega} = 5.41m$$ //

Question ②



$d_1 = 20cm = 0.2m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.2)^2}{4} = \frac{0.12568}{4} = 0.03142 m^2$ //

$d_2 = 10cm = 0.1m$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.1)^2}{4} = 0.007855 m^2$

Vacum pressure $= 300$ cm Hg $= 0.3$ m/Hg

$C_d = 0.96$

$P_1 = 0.17.658 N/cm^2 = \frac{17.658}{10^{-4}}$
$= 176580 N/m^2$

Discharge, $Q = ?$

$h_1 = \frac{P_1}{\rho g} = \frac{176580}{9.81 \times 1000} = \frac{176580}{9810} = 18\,m$

$h_2 = \frac{P_2}{w} = -0.3\,m\,Hg = -0.3 \times 13.6$

$= -4.08\,m$ of liquid (water)

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08)$
$= 22.08$

From bernolli's equation
Discharge, Q through venturimeter

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

$Q = \frac{0.98 \times 0.03142 \times 0.007855 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.03142^2 - 0.007855^2}}$

~~$Q = \frac{2.42 \times 10^{-4} \times \sqrt{433.21}}{\sqrt{9.87 \times 10^{-4} - 6.17 \times 10^{-5}}}$~~

~~$Q = 2.42 \times 10^{-4}$~~

$Q = \frac{2.42 \times 10^{-4} \times \sqrt{433.21}}{\sqrt{9.26 \times 10^{-4}}} = \frac{5.037 \times 10^{-3}}{0.0304}$

$Q = 0.166\,m^3/s$ //

Question 3

(3) Data given

$d_0 = 15\,cm = 0.15\,m$, $A_0 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4} = 0.0177\,m^2$

$d_1 = 30\,cm = 0.30\,m$, $A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.3)^2}{4} = 0.07\,m^2$

Cd = 0.64
Specific gravity of oil = 0.9

Pressure difference reading of differential manometer = $\frac{50cmHg}{100}$ = 0.5 mHg = y

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

h = 0.5 (14.1), h = 7.05m

Discharge, Q = ?

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

$$Q = \frac{0.64 \times 0.0177 \times 0.07 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.07^2 - 0.0177^2}}$$

$$Q = \frac{7.9296 \times 10^{-4} \times \sqrt{138.32}}{\sqrt{4.59 \times 10^{-3}}}$$

$$Q = \frac{9.326 \times 10^{-3}}{0.068} = 0.137 m^3/s$$

$Q = 0.137 m^3/s$

Question 4

Data given

Difference of mercury level is $\frac{170mm\,Hg}{1000}$ = 0.17m Hg. Specific gravity of mercury = 13.6. Specific gravity of sea water = 1.026.

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

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

$h = 0.17(12.26)$

$h = 2.0842m$

Velocity/speed of the submarine $= \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.0842} = \sqrt{40.89} = 6.39m/s$

∴ velocity of submarine $= 6.39m/s$ //

Question 5

Data given

Pressure Change = 15bar

[illegible]

Torque = 15Nm

Normal displacement $= 10cm^3/rev$
$= 10 \times 10^{-3} = 0.1l/rev$

Speed = 1700rpm

Flow rate $= ~~0.0~~ 5m^3/min = 5l/min$

Find

(i) Volumetric Efficiency $= \frac{\text{Theoritical Flow}}{\text{Actual flow}} \times 100$

Theoritical flow = Displacement X Speed
$= 0.01 \times 1700 = 17l/min$

Volumetric Efficiency $= \frac{5}{17} = 0.294$

$= 29.4\%$

(ii) Fluid power $= \frac{\text{Pressure} \times \text{Actual Flow}}{600}$

$= \frac{15 \times 5}{600} = 0.125\,kw = 125\,w$

(iii) Shaft power $= \frac{\text{Fluid power}}{\text{efficiency of pump}} = \frac{125}{0.294}$

$= 425.17\,w$ //

(iv) Overall efficiency = volumetric efficiency × hydraulic efficiency × 100

hydraulic efficiency $= \frac{\text{Theoritical torque}}{\text{Actual torque}}$

Theoritical torque $= \frac{\text{Displacement} \times \text{Pressure}}{20\pi}$

$\frac{10 \times 15}{20 \times 3.142} = 2.39\,Nm.$

Hydraulic efficiency $= \frac{2.39}{15} = 0.16$ //

overall efficiency $= 0.294 \times 0.16 \times 100$

$= 4.7\%$ //