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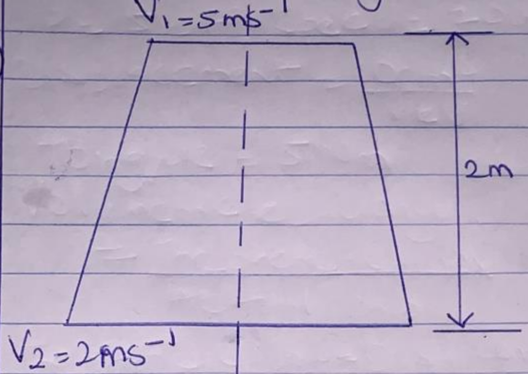
18/ENG08/023
BIOMEDICAL ENGINEERING
ENG235
FLUID MECHANICS

UGBECHIE VALENTINA
18/ENG08/023
Biomedical Engineering
ENG235 Assignment

1.)



$Z_1 = 2m$

$V_1 = 5ms^{-1}$

$V_2 = 2ms^{-1}$

$P_1 = 2.5m$

Loss of head (h_2)

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

$= \frac{0.35(5-2)^2}{2(9.8)}$

$h_2 = \frac{3.15}{19.6}$

$h_2 = 0.161m$

Applying Bernoulli's equation for conical tube

$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + h_2$

$Z_1 = 2m$

$Z_2 = 0m$

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

$2.5 + 1.27 + 2 = P_2/w + 0.203 + 0.16$

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

$\frac{P_2}{w} = 5.41 - 0.363$

$= 5.41m$

head at larger opening

$= 5.41m$

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

$A_1 = \frac{\pi d_1^2}{4} = \frac{3.14 \times (0.2)^2}{4}$

$= \frac{0.126}{4}$

$= 0.03142m^2$

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

$A_2 = \frac{\pi d_2^2}{4} = \frac{3.14(0.1)}{4}$

$= 0.00785m^2$

$Cd = 0.98$

$P_1 = 17.658 Ncm^{-2}$

$= 176580 Nm^{-2}$

Vacuum Pressure

$= 30cm Hg = 0.3m Hg$

$Q = ?$

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

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

$= (-0.3 \times 13.6) m H_2O$

$= -4.08 H_2O$

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

$= 22.08m$

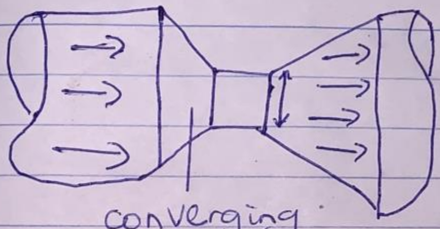
$Q = Cd A_1 - A_2 \sqrt{2gh}$

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

$$Q = \frac{2.42 \times 10^{-9} \times \sqrt{435.2}}{\sqrt{9.26 \times 10^{-9}}}$$

$$Q = \frac{5.037 \times 10^{-3}}{0.0309}$$

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



$Cd = 0.64$ $y = 0.5 mHg$

3) $do = 15 cm = 0.15 m$

$d_1 = 30 cm = 0.3 m$

$$A_0 = \frac{\pi (0.5)^2}{4} = 0.0177 m^2$$

$$A_1 = \frac{\pi (0.3)^2}{4} = 0.07 m^2$$

$$h = y\left(\frac{Jac}{Jo} - 1\right)$$

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

$h = 7.65 m$

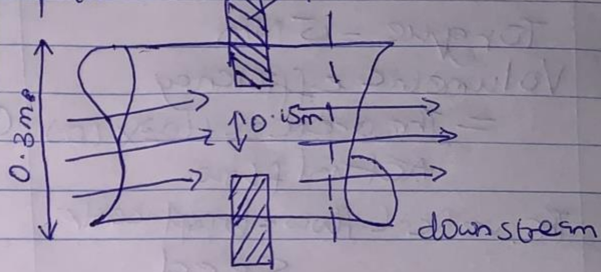
$$Q = \frac{Cd\, A_0 \times A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

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

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

$$Q = \frac{9.326 \times 10^{-3}}{0.069}$$

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



4) Reading from manometer
$= 170 mm Hg$
$= 0.17 mHg$

Specific gravity of Hg = 13.6
Specific gravity of water = 1.026

$$h = y\left(\frac{Jm}{Jw} - 1\right)$$

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

$h = 0.17 (12.26)$

$h = 2.084 m$

$V = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.084}$

$= \sqrt{40.89}$

$= 6.39 ms^{-1}$

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

$= 5\, l/min$

$P = 15$ bar, Speed $= 1700$ rpm

Displacement $= \frac{10\, cm^3}{rev}$

Torque $= 15$ Nm

Volumetric efficiency

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

Theoretical flow = Displacement × Speed

but $\frac{10\, cm^3}{rev} = 0.01\, L/rev$

Theoretical flow $= 0.01 \times 1700$

$= 17\, l/min$

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

$= 29.4\%$

5) Fluid Power = $\frac{\text{Pressure} \times \text{Actual flow}}{600}$

$= \frac{15 \times 15}{600}$

$= 1250$

c) Shaft Power = $\frac{\text{fluid Power}}{\text{Efficiency}}$

= Volumetric Efficiency × hydraulic Efficiency

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

Theoretical Torque

= Displacement × P ...

~~Hydrau~~

$= (10 \times \sqrt{5}) / (20 \cdot 3 \cdot 42)$

$\simeq 2.39$ Nm

Hydraulic Efficiency

$= \frac{2.39}{15}$

$= 0.16$

Overall Efficiency

$= 0.294 \times 0.16 \times 100$

$= 4.7\%$