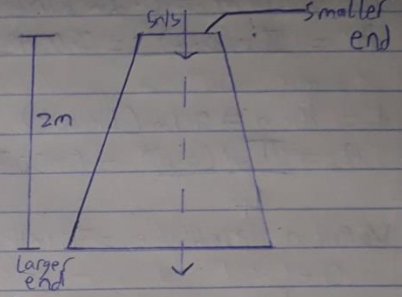
Ebitu, Ukpono Friday 18/ENG04/027

Fluid Mechanics Assignment — Elect Elect Engineering



1. Length of Conical tube = 2.0m

$V_1 = 5m/s$

$V_2 = 2m/s$

Pressure head of Smaller end = 2.5m

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

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

$h_L = 0.160m$

The pressure at larger end $= P^2/w$

Using Bernoulli's equation

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

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

$$2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{2^2}{2 \times 9.81} + 0 + 0.160$$

$$2.5 + 1.27 + 2 = \frac{P_2}{w} + 0.203 + 0.160$$

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

$\frac{P_2}{w}$ = ~~P.77~~ $\frac{P_2}{w} = 5.77 - 0.363$

head at ~~heo~~ Larger end $= \frac{P_2}{w} \Rightarrow 5.41m$

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

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

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

$A_2 = \frac{\pi \times (0.1)^2}{4} = 0.00785m^2$

Vacuum pressure $= 30cmHg \Rightarrow 0.3mHg$

$C_d = 0.98$

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

$= 176580 N/m^2$

$Q = ?$

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

$\Rightarrow 18m$

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

$\Rightarrow -0.3 \times 13.6 = -4.08m$ of water

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

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

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

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

$Q = \frac{5.04 \times 10^{-3}}{0.0304} = 0.1658 m^3/s$

3. $d_0 = 15cm \Rightarrow 0.15m$

$d_1 = 30cm \Rightarrow 0.30m$

$A_0 = \frac{\pi \times (0.15)^2}{4} = 0.0177m^2$

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

$C_d = 0.64$

S.g of oil = 0.9

Reading of differential manometer

$y \Rightarrow 50cmHg$

$\Rightarrow 0.5mHg$

$h = y\left(\frac{\text{S.g of mercury}}{\text{S.g of oil}} - 1\right) = 0.5\left(\frac{13.6}{0.9} - 1\right)$

$h = 7.05m$

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

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

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

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

4. Reading from differential manometer = 170 mmHg = 0.17 mHg

Specific gravity of mercury = 13.6

" " " sea water = 1.026

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

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

$$h = 0.17(12.26)$$

$$h = 2.084 m$$

$$V = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.084} = \sqrt{40.89}$$

$$= 6.39 m/s$$

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

(a) P = 15bar. Speed = 1700rpm Displacement = 10cc/rev

Torque = 15Nm , Volumetric Efficiency = $\frac{\text{Theoritical flow}}{\text{Actual flow}} \times 100$

Theoretical Flow ⇒ Displacement × speed

but $10cm^3/rev = 10 \times 10^{-3}$ ⇒ 0.01 L/rev

Theoretical flow = 0.01 × 1700 ⇒ 17L/min

Volumetric efficiency = $\frac{5}{17} \times 100$ = 0.294 × 100

= 29.4%

b Fluid power ⇒ $\frac{\text{pressure} \times \text{Actual flow}}{600}$

= $\frac{15 \times 5}{600}$ = 0.125Kw ⇒ 1.25W

C. Shaft power = $\frac{\text{Fluid power}}{\text{efficiency of pump}}$ = $\frac{125}{0.294}$ = 425.17W

General/overall Efficiency

= Volumetric eff. × hydraulic/mechanical effi

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

Theoretical torque = $\frac{\text{Displacement} \times \text{pressure}}{20\pi}$ = $\frac{10 \times 15}{20 \times 3.142}$

= 2.39Nm

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

overal efficiency = 0.294 × 0.160 × 100 = 4.7%