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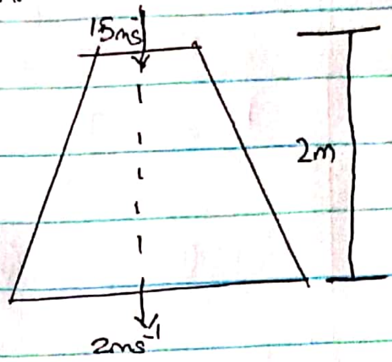
18/ENG05/048
Mechatronics ENG

Fluid Mehanics Assignment



1. Length of conical tube = 2m

$V_1 = 5 ms^{-1}$

$V_2 = 2 ms^{-1}$

Pressure head of smaller end = 2.5m

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

$= \frac{0.35(3)^2}{19.62} = 0.160m.$

Pressure at larger end $= \frac{P_2}{w}$

From Bernoulli's eqn for conical tube

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2 + h_L$$

$z_1 = 2m$ & $z_2 = 0m$

$25 + 1.27 + 2 = \frac{P_2}{w} + 0.203 + 0.160$

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

$\frac{P_2}{w} = 5.41m$

head at larger end = 5.41m

2. $d_1 = 0.2m$ (inlet)

$A_1 = \frac{3.142 \times (0.2)^2}{4} = 0.0314 m^2$

$d_2 = 0.1m$ (throat)

$A_2 = \frac{3.142 \times (0.1)^2}{4} = 7.86 \times 10^{-3} m^2$

Vacum pressure = 0.3m Hg

Q = ?

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

$$h_2 = \frac{P_2}{w} = -0.3m \text{ of mecury}$$
$$= -0.3 \times 13.6 = -4.08 \text{ of water}$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 + 4.08 = 22.08m$$

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

$$Q = \frac{0.98 \times 0.0314^2 \times (7.80 \times 10^{-3})^2 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.0314^2 - (7.80 \times 10^{-3})^2}}$$

$$Q = 4.085 \times 10^{5} m^3/s.$$

3 $d_0 = 15cm = 0.15m$

$d_1 = 0.30m$

$$A_0 = \frac{3.142 \times 0.15^2}{4} = 0.018m^2$$

$$A_1 = \frac{3.142 \times (0.30)^2}{4} = 0.071m^2$$

$C_d = 0.64$

S_g of oil $= 0.9$

$y = 0.5m$ Hg

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

~~h = 0.75~~ $h = 7.05m.$

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

$$= \frac{0.64 \times 0.018 \times 0.071 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.071^2 - 0.018^2}}$$

$$Q = 0.14 m^3/s.$$

4 Reading from manometer = 0.17m Hg
S.G of mecury = 13.6
S.G of Sea water = 1.026

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

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

$$h = 2.084m$$

$$V = \sqrt{2gh}$$

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

$$V = 6.39ms^{-1}$$

5 Actual Flow Rat = 5L/min
(a) P = 15 bar, Speed = 1700rpm
Displacment = 10cc/rev, Torque = 15 Nm

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

Theoretical flow = Disp × Speed
$ 10cm³/rev = 10×10^{-3} = 0.01 L/rev
Theretical flow = 0.01 × 1700 = 17L/min

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

(b) $$\text{Fluid power} = \frac{\text{Pressure} \times \text{actual flow}}{600}$$

$$= \frac{15 \times 5}{600} = 125 \text{ watts}$$

(c) $$\text{Shaft Power} = \frac{\text{Fluid power}}{\text{Efficiency of pump}}$$

$$= 125/0.294 = 425.17W$$

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Overall Efficiency = Volumetric Efficiency x Hydraulic efficiency

Hydraulic " = $\frac{\text{Theoretical Torque}}{\text{Actual torque}}$

Theoretical torque = $\frac{(\text{Disp} \times \text{Pressure})}{2 \times 3.142}$

= 2.39Nm.

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

Overall Efficiency = 0.294 x 0.160 x 100

= 4.7%.

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