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19/ENG02/079
COMPUTER ENGINEERING
FLUID MECHANICS (CENG 214)

1. Pressure head at smaller end = 2.5m
Length of tube = 2.0m (TL)
Velocity of flow at lower end = $5ms^{-1}$ (v_1)
Velocity of flow at higher end = $2ms^{-1}$ (v_2)

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

=> Loss of head = $\frac{0.35(5-2)^2}{2 \times 9.81}$ = 0.16m

=> pressure head at higher end, $\frac{P_2}{w}$

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

$z_2 = 0$, $z_1 = 2.0m$ //

=> $2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{2^2}{2 \times 9.81} + 0.016$

= $5.775 = \frac{P_2}{w} + 0.364 =$

$\frac{P_2}{w} = 5.775 - 0.364 = 5.411m$ of liquid.

Pressure head at higher end = 5.411m //

12. Inlet diameter = 20cm = 0.2m
Throat diameter = 10cm = 0.1m
Pressure at inlet = 17.658N/cm² = 176.58KN/m
30cm of mercury
COD = 0.98

Solution:

Area of inlet = $A_1 = \frac{\pi}{4} \times 0.2^2 = 0.0314m^2$

Area of throat = $\frac{\pi}{4} \times 0.1^2 = 0.00785m^2$

=> $P_1/w = 176.58/9.8 = 18.01m$

Vacuum pressure at the throat
$P_2/w = -300mm = -0.3 \times 13.6 = -4.08$ of water

Differential head, $h = \frac{P_1}{w} = \frac{P_2}{w} = 18.01 - (-4.08) = 22.04m$

=> Rate of flow, Q
Using the relation, $Q = \frac{Cd \times A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

$\therefore Q = \frac{0.98 \times 0.0314 \times 0.00785}{\sqrt{(0.0314)^2 - (0.00785)^2}} \times \sqrt{2 \times 9.81 \times 22.04}$

$Q = \frac{0.00241}{0.00304} \times 20.82$

$Q = 0.165m^3/s$

$\therefore$ Discharge of water through venturimeter = $0.165m^3/s$

3. Orifice diameter A_o = 15cm = 0.15m^2

Pipe diameter = 30cm = 0.3m^2

Manometer reading = 0.5m of mercury

S.g of oil = 0.9 , C_d = 0.64

Solution:

Area of Orifice = $\frac{\pi}{4} \times 0.15^2 = 0.0177m^2 = A_o$

Area of pipe = $\frac{\pi}{4} \times 0.30^2 = 0.707m^2 = A_i$

Differential head, $h = y\left[\frac{S_{hL}}{S_o} - 1\right]$

$= 0.5\left[\frac{13.6}{0.9} - 1\right] = 7.06m$ of oil

=> Discharge Q

using the relation, $Q = C_d \times \frac{A_o \cdot A_i \sqrt{2gh}}{\sqrt{A_1^2 - A_o^2}}$

$Q = \frac{0.64 \times 0.707 \times 0.0177 \times \sqrt{2 \times 9.8 \times 7.06}}{\sqrt{(0.707)^2 - (0.0177)^2}}$

$= \frac{0.0942}{0.707} = 0.133m^3/s$

Rate of discharge = $0.133m^3/s$

4. Reading at manometer, y = 170mm = 0.17m
Sp of gravity of mercury, Shl = 15.6
Sp gravity of sea water, Sl = 1.026
Sp gravity

Find head(h) using the relation

$h = y\left[\frac{S_{hl}}{S_l} - 1\right]$

$h = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.05$

∴ speed of submarine

$v = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.08}$

$v = 6.38 m/s$

5. Actual flow rate = 0.05 m^3/min
pressure charge = 15bar
Speed of rotation = 1700 rev/min
Normal displacement = 10 cm^3/rev
Torque = 15Nm

Ideal flow rate = $28.3 \times 1 \times 10^{-5}$

$= 2.83 \times 10^{-4} m^3/sec$

i) Volumetric efficiency = $\frac{\text{Actual rate}}{\text{Ideal rate}} \times 100$

$= \frac{8.3 \times 10^{-4}}{2.83 \times 10^{-4}} \times 100 = 296\%$

ii) Fluid power = Q . ∂p

$= 8.3 \times 10^{-7} \times 15 \times 10^5$

= 1245 watts

iii) Shaft power = T . w
where T = torque
w = angular speed

T = 15Nm, w = 2πN for rps

$w = \frac{2\pi N}{60}$ for rpm

$w = 2 \times \frac{32}{7} \times 28.3 = 177.89 rad/s$

=> shaft power = 15 × 177.89
= 2668.35 watts

iv) Overall efficiency

$= \frac{\text{Fluid power}}{\text{shaft power}} \times 100$

$= \frac{1245}{2668.35} \times 100$

= 46.66%