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

1. Pressure head at smaller end = 2.5m
Length of tube = 2.0m (T)
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
300m of mercury
COD = 0.98

Solution:

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

Area at 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, $Q = \frac{Cd \times A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

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

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

$Q = 0.165m^3/s$

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

3. Diameter of pipe = 30cm

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (30)^2}{4} = 706.8 \text{ cm}^2$$

Diameter of orifice, $d_2 = 15$ cm

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (15)^2}{4} = 176.72 \text{ cm}$$

Specific gravity of oil = 0.9 ($S_o$)

" " " mercury = 13.6 ($S_{mg}$)

Differential manometer reading = 50cm of mercury ($x$)

Cod = 0.64

Differential head; $h = x\left(\frac{S_{mg}}{S_o} - 1\right)$

$$h = 50\left(\frac{13.6}{0.9} - 1\right)$$

$h = 705.56$ cm of oil

$\therefore$ Flow of oil = $Q = \frac{C_d \sqrt{2gh} \cdot A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$

$$Q = \frac{0.64 \times \sqrt{2 \times 9.81 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)^2}}$$

$Q = 137443.29 \text{ cm}^3/s$

$Q = 137.44$ lit/s

Scanned with CamScanner

4.) The difference of mercury, $x = 170mm = 170 \times 10^{-3} = 0.17m$

specific gravity of mercury, $S_g = 13.6$

Spec ✓ ✓ sea water, $S_o = 1.026$

Speed $v = \sqrt{2gh}$

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

$= 2.084m$

$v = \sqrt{2 \times 9.81 \times 2.0834} = 6.393 m/s$ //

$V = 23.07 km/hr$ //

5) i) Volumetric Efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate × speed.

$= 10 cm^3/rev \times 1700 rev/min$

$= 17000 \ cm^3/min$

- Ideal flow rate = $\frac{17000}{1000000} = 0.017 m^3/min$
- Actual flow rate = $0.05 m^3/min$

Volumetric ~~Efficiency~~ = $\frac{0.05}{0.077} = 2.94\% = 294\%$ //

ii) Fluid power = $P \times Q$

$P = 15 \times 10^5 N/m^2$

$Q = 0.05 m^3/mm = \frac{0.05}{60} = 8.33 \times 10^{-4} m/s$

Fluid power = $15 \times 10^5 \times 8.33 \times 10^{-4}$

$= 1249.5$ watts //

iii) Shaft power = $\frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.35$ watts//

iv) Overall efficiency = $\frac{\text{Fluid Power}}{\text{Shaft Power}}$

$\therefore \frac{1249.5}{2670.35} = 0.468$

Overall efficiency = $0.468 \times 100 = 46.8\%$//