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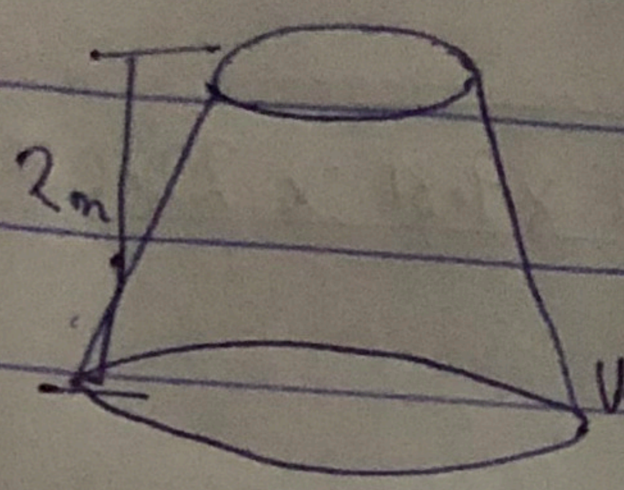
Matric : ~~Mechanical Engineering~~ 18/ENG 06/066
Department : Mechanical Engineering

1.



$P_{T_1} = \frac{P_1}{w} = 2.5m$

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

Using Bernell's equation $\frac{P_2}{w} = ?$

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

$$\frac{P_2}{w} = \frac{P_1}{w} + \left[\frac{V_1^2 - V_2^2}{2g}\right] + \left[Z_1 - Z_2\right] - H_L$$

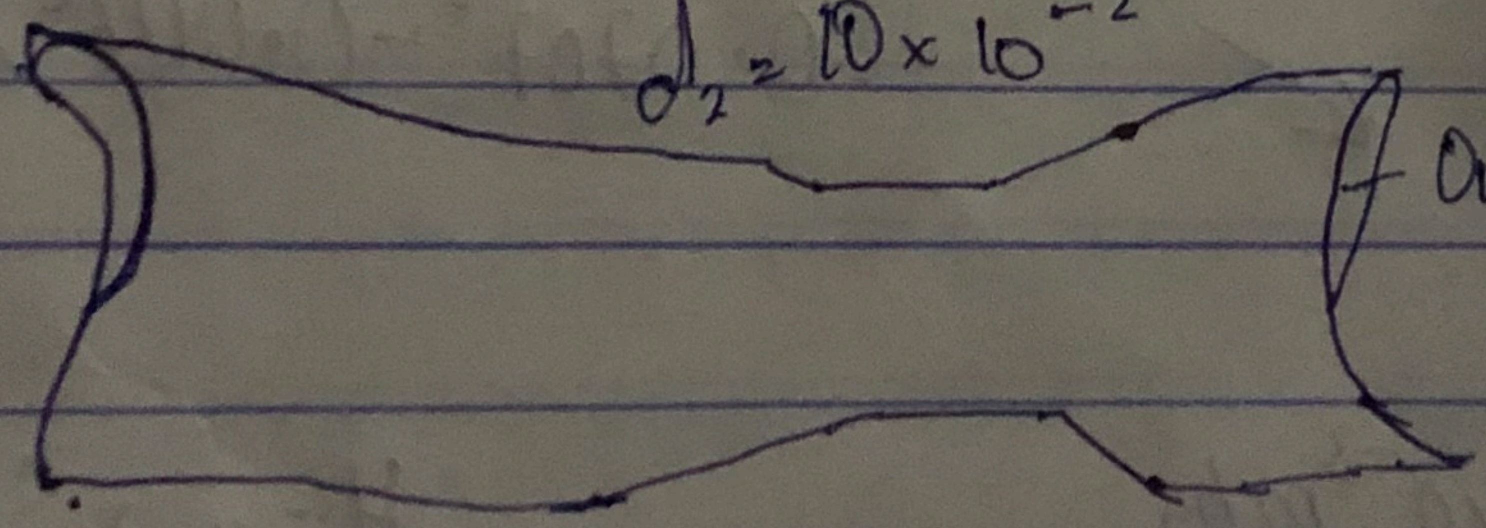
$$\frac{P_2}{w} = 2.5 + \left[\frac{5^2 - 2^2}{2 \times 9.81}\right] + 2 - \frac{0.35(5-2)^2}{2 \times 9.81}$$

$$\frac{P_2}{w} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409m$$

∴ The Pressure head at the lower end is 5.409m

2.) Inlet



$P_1 = 17.658 N/cm^3 = 17.658 \times 10^4 N/m^2$ $Cd = 0.98$

$P_2 = 30cm\ Hg = 30 \times 10^{-2} m\ Hg$ $Q = ?$

$A_1 = \frac{\pi \times (20 \times 10^{-2})^2}{4} = 0.03m^2$ $A_2 = \frac{\pi \times (10 \times 10^{-2})^2}{4}$

$= 7.85 \times 10^{-3} m^2$

$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08 m\ Hg$

$\frac{P_2}{w} = -4.08$ (Since Vaccum pressure)

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

$$\frac{P_1}{w} = \frac{17.05\,8 \times 10^4}{9.81 \times 10^3} = 18$$

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

$$Q = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.03^2 - (7.85 \times 10^{-3})^2}}$$

$$Q = 0.166\ m^3/s$$

3.) $A_0 = 15 \times 10^{-2} m$ $\quad d_1 = 30 \times 10^{-2} m$ $\quad C.d = 0.64$

$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4}$ $\quad y = 50 \times 10^{-2} mHg$ $\quad Q = ?$

$0.01767 m^2$ $\quad$ S.G of Oil $= 0.9$ $\quad S_H = 13.6$

$H = y \left[\frac{S_m}{S_0} - 1\right]$ $\quad S_0 = 0.9$

$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4} = 0.0707 m^2$

$$H = 50 \times 10^{-2} \left(\frac{13.6}{0.9} - 1\right)$$

$H = 7.055 m$

$$Q = \frac{C_d A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}} = \frac{0.64 \times 0.0176 \times 0.0707 \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.0707^2 - 0.0176^2)}}$$

$Q = 0.137 m^3/s$

4.) $y = 170 mmhg = 170 \times 10^{-3} mhg$ $\quad H = y \times \frac{S_m}{S_0} - 1$

S.g of mecury $= 13.0hg$

S.g of Sea water $= 1.026$ $\quad H = 170 \times 10^{-3} \times \left(\frac{13.6}{1.026} - 1\right)$

$V = \sqrt{2gH}$

$V = \sqrt{2 \times 9.81 \times 2.08}$ $\quad H = 208 m$

$V = 6.39 m/s$

5.) Actual flow rate $Q = 0.03 m^3$ $\quad 5 dm^3/min$

$= 8.33 \times 10^{-5} m^3/sec$

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

$V = 1700$ rev/min $= 28.33$ rev/sec
$Q = 15$ l/m · Normal displacement $= 10 cm^3/rev = 1 \times 10^{-5} m^3/rev$

i.) Volumetric · Efficiency

$\frac{\text{Actual flow rate}}{\text{Total flowrate}} \times 100\%$

Total flow rate = displacement × speed

$Q = 1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4} m^3/sec$

Volumetric Efficiency $= \frac{8.33 \times 10^{-3}}{2.833 \times 10^{-4}} \times 100$

$= 29.4\%$

ii.) fluid power $(Q \times \Delta P)$

$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95$ watts

iii.) Shaft power $= T \times \omega$

$\omega = 2 \times \pi \times V$

$\omega = 2 \times \pi \times 28.33 = 178.$ watt/sec.

Shaft power $= T \times \omega$

$= 15 \times 178$

$= 2670$ watts

iv.) Overall Efficiency

$\frac{\text{fluid power}}{\text{Shaft power}} \times 100\%$

$= \frac{124.95}{2670} \times 100$

$= 4.68\%$