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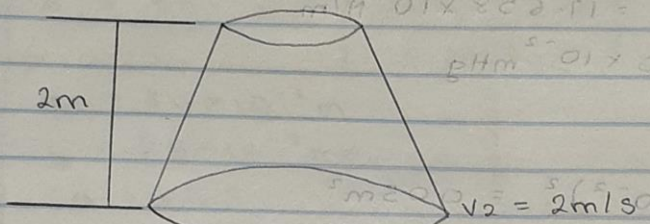
DEPARTMENT: MECHANICAL ENGINEERING
COURSE: FLUID MECHANICS
ASSIGNMENT

(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

$\frac{P_1}{w} = ?$

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

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

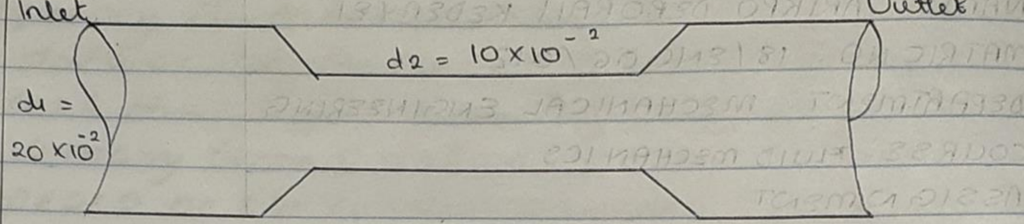
$$\frac{P_2}{w} = 2.5 + \left[\frac{5^2 - 2^2}{2\times 9.81}\right] + \left[2 - \frac{0.35(5-2)^2}{2\times 9.81}\right]$$

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

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

Therefore; the pressure head at the lower end is equal to 5.409m.

(2)



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

$P_2 = 30 cm Hg = 30 \times 10^{-2} mHg$

$Cd = 0.98$

$Q = ?$

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

$A_2 = \frac{\pi \times (10 \times 10^{-2})^2}{4} = 7.85 \times 10^{-3} m^2$

$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08 mHg$ (Vacuum Pressure)

$\frac{P_2}{w} = 4.08$

$\frac{P_1}{w} = \frac{17.685 \times 10^4}{9.81 \times 10^3} = 18$

$h = \frac{P_1}{w} - \frac{P_2}{w}$

$= 18 - (-4.08)$

$= 22.08$

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

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

$Q = 0.166 m^3/s$

(3) $D = 15 \times 10^{-2} m$

$A_o = \frac{\pi \times (15 \times 10^{-2})^2}{4} = 0.01767 m^2$

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

$H = 50 \times 10^{-2} \left[\frac{13.6}{0.9} - 1 \right] = 7.055 m$

$d_1 = 30 \times 10^{-2} m$

$y = 50 \times 10^{-2} mHg$

$Cd = 0.64$

S.G of oil = 0.9

$H = y \left[\frac{Sh_1}{nSo} - 1 \right]$

$Cd = 0.64$

$Q = ?$

$SH_1 = 13.6$

$S_o = 0.9$

$Q = \frac{Cd\, A_o A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_o^2}}$

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

$Q = 0.137 m^3/s$

(4) $y = 170 mm\,Hg = 170 \times 10^{-3} m\,Hg$

S.g of mercury = 13.6 Hg

S.g of sea water = 1.026

$H = y \times \frac{SH_1}{S_0} - 1$

$H = 170 \times 10^{-3} \times \left[\frac{13.6}{1.026} - 1\right]$

$H = 2.08 m$

$V = \sqrt{2gh}$

$V = \sqrt{2 \times 9.81 \times 2.08}$

$V = 6.39 m/s$

(5) Actual flowrate (Q) = $0.005 m^3$ 5 dm^3/min

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

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

$V = 1700 rev/min = 28.33 rev/sec$

$T = 15 N/m$

Normal displacement = $10 cm^3/rev = 1 \times 10^{-5} m^3/rev$

(i) VOLUMETRIC EFFICIENCY =>

$\frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$

$= 29.4\%$

Actual flowrate / Ideal flowrate × 100%

Ideal flowrate = displacement × Speed

$Q = 1 \times 10^{-5} \times 28.33 = 2.833 \times 10^{-4} m^3/sec$

(ii) FLUID POWER =>

$(Q \times \Delta P)$

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

= 124.95 watts

(iii) SHAFT POWER =>

$T \times W$

$W = 2 \times \pi \times V$

$\omega = 2 \times \pi \times 28.33 = 178$ rad/sec

Shaft power $= T \times \omega$

$= 15 \times 178$

$= 2670$ watts

④ **OVERALL EFFICIENCY =>**

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

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

$$= 4.68\%$$