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Course: Fluid Mechanics (Power)
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1 $V_1 = 5ms^{-1}$, $V_2 = 2ms^{-1}$

$P_{T_1} = 2.5m$, $P_{T_2} = ?$

$P_{T_1} = P_{T_2} = \frac{0.35(V_1 - V_2)^2}{2g}$

$\frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$

Recall

$P_{T_1} - P_{T_2} = 0.161$

$2.5 - P_{T_2} = 0.161$

$P_{T_2} = 2.5 + 0.161$

$P_{T_2} = 2.67m$

2 $d_1 = 20cm = 0.2m$, $C_d = 0.98$

$d_2 = 10cm = 0.1m$

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

$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times (0.1)^2}{4} = 7.85 \times 10^{-3}$

$P_1 = 17.658 N/cm^2 = \frac{17.658}{10^{-6}}$

$= 1.76 \times 10^7$

Specific gravity of Hg = 13.6

$\frac{P_1}{w} = \frac{P_1}{\rho_g} = \frac{17.658 \times 10^8}{1000 \times 9.81}$

$= 1.8 \times 10^8$

Vaccum pressure $= \frac{P_2}{w} = 300mmHg$

$P_1 = -4.08$

$h = 1.8 \times 10^{-4} \times 4.08$

$= 4.08m$

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

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

$= C_d$

$\frac{0.98 \times 0.0314 \times 7.815 \times 10^{-3} \sqrt{2 \times 9.81 \times 4.08}}{\sqrt{(0.0341)^2 - (7.85 \times 10^{-3})^2}}$

$= 0.07108$

3. $d_1 = 15 \times 10^{-2}m$

$d_2 = 30 \times 10^{-2}m$

$A_1 = \frac{\pi \times (15 \times 10^{-2})^2}{4} = 0.01767m^2$

$A_2 = \frac{\pi \times (30 \times 10^{-2})^2}{4} = 0.0707m^2$

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

S.g of oil = 0.9

$C_d = 0.64$

$Q = ?$

Sg of Hg = 13.6

$H = y\left[\frac{Sg\ of\ Hg}{Sg\ of\ oil} - 1\right]$

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

$H = 7.055m$

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

$0.64 \times 0.076 \times 0.01 \times \sqrt{2 \times 9.81 \times 7.08}$

$\sqrt{0.007^2 - 0.076^2}$

$Q = 0.137 m^3/s$

4 $y = 170mmHg = 170 \times 10^{-3} mHg$

S.g of Hg = 13.6

S.g of sea water = 1.026

$V = \sqrt{2gH}$

$V = \sqrt{2 \times 9.81 \times 7.08}$

$V = 6.39 m/s$

Recall $H = y \times \left[\frac{\text{S.g of Hg}}{\text{S.g of water}} + 1\right]$

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

$H = 2.08m$

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

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

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

$T = 15 N/m$ displacement $= 100 cm^3/rev$

$= 1 \times 10^{-6} m^3/rev$

i Volumetric Efficiency

$\frac{Q}{A} \times 100\%$

A(Ideal flow rate) = displacement $\times$ speed

$= 1 \times 10^{-6} \times 28.33$

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

Volumetric Efficiency $= \frac{8.33 \times 10^{-5}}{28.33 \times 10^{-4}} \times 100$

$= 29.4\% \simeq 30\%$

ii. Fluid Power $= Q \times \Delta P$

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

$= 124.95 watts$

iii Shaft power $= T \times w$

but $w = 2 \times \pi \times V$

$= 2 \times \pi \times 28.33$

$= 178 rad/sec$

$\therefore T \times w$

$= 15 \times 178 = 2670 watts$

iv Overal Efficiency

$\frac{\text{fluid power}}{\text{shaft power}} \times 100$

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

$= 4.68\%$

$\simeq 5\%$