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FLUID MECHANICS ASSIGNMENT

(1.) $L = 2.0m$ $V_1 = 5m/s$ $\frac{P_1}{w} = 2.5m$

$V_2 = 2m/s$ $h_L = \frac{0.35(V_1 - V_2)^2}{2g}$

$h_L = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.16m$

Applying Bernoullis equation

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

$Z_2 = 0$ $Z_1 = 2.0$

Sub into the equation

$\frac{P_2}{w} = 5.77 - 0.363 = 5.407m$

(2) $D_1 = 20cm$ $A_1 = \frac{\pi D_1^2}{4} = \frac{\pi \times 20^2}{4} = 314.16cm^2 = 3.14 \times 10^{-2}m$

$D_2 = 10cm$ $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi \times 10^2}{4} = 78.54cm^2 = 0.79 \times 10^{-3}m$

$P_1 = 17.658 N/cm^2$ $w = 9.81 \times 10^3$ $\frac{P_2}{w} = 0.3 \times 13.6 = -4.08$

$= 17.688 \times 10^4 N/m$

$\frac{P_1}{w} = \frac{17.688 \times 10^4}{9.81 \times 10^3} = 18m$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-~~0.03~~ 4.08) = ~~18.03m~~ 22.08$

$$Q_d = \frac{C_d A_1 A_2 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_1^2}} = \frac{0.98 \times 3.14 \times 10^{-2} \times 0.79 \times 10^{-2} \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(3.14 \times 10^{-2})^2 - (0.79 \times 10^{-2})^2}}$$

$= 2.4156 \times 10^{-4} \times 684.59 = 0.1653$

$Q_{actual} = 0.1653 m^3/s$

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3) Differential head $h_1 = y\left[\frac{S_{hL}}{S_0} - 1\right]$

$S_{hL} = 13.6 \quad y = 50 \times 10^{-2}$

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

$h = 50 \times 10^{-2} \times 14.11$

$= 7.055m$

$Q = \frac{C_d A_o A_p \sqrt{2gh}}{\sqrt{A_p^2 - A_o^2}}$

$= \frac{0.64 \times 0.01767 \times 0.07069 \times \sqrt{2 \times 9.81 \times 7.065}}{\sqrt{(0.07069^2) - (0.01767)^2}}$

$= \frac{7.994 \times 10^{-4} \times 11.763}{\sqrt{4.68 \times 10^{-3}}}$

$= 0.1374 m^3/s$

4 $y = 170mm\,Hg = 0.17m\,Hg$, $S.g\,Hg = 13.6$ $S.g_w = 1.026$

$\Delta h = y\left(\frac{S.g\,Hg}{S.g\,sw} - 1\right)$

$\Delta h = 0.17\left(\frac{13.6}{1026} - 1\right)$

$\Delta h = 2.08m$

$V = \sqrt{2g\Delta h} = \sqrt{2 \times 9.81 \times 2.08}$

$= 6.388 m/s$

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(5) $Q = 0.05 dm^3/mm = 8.33 \times 10^{-3} m^3/sec$

Speed of Rotation = 1700 Rev/min = 28.3 Rev/sec

Norminal Displacement = $10 cm^3/rev = 10^{-5} m^3/rev$

Torque Input = ~~78~~ 15Nm

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

Ideal flowrate = Norminal displacement × Speed Rotation

$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4} m/sec$

(a) Volumetric Efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100$

$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100 = 29.45\%$

(b) Fluid power $P_f = Q \times \Delta P$

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

$= 124.98$ watts

(c) Shaft power = $T \times \omega$

$\omega = 2 \times \pi \times$ speed of Rotation

$\omega = 2 \times \pi \times 28.3$

$\omega = 177.81$ rad/sec

∴ Shaft power = $15 \times 177.81 = 2667.2$ watts

(d) Overall efficiency = $\frac{\text{fluid power}}{\text{Shaft power}} \times 100$

$= \frac{124.98}{2667.2} \times 100 = 4.68\%$

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