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

$= \frac{8.33\times10^{-5}}{2.83\times10^{-4}} \times 100 = 29.45\%$

(b) Fluid power, $PF = Q \times \Delta p$

$= 8.33\times10^{-5} \times 15\times10^{5} = 124.95$ watts

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

$w = 2\times\pi\times28.3 = 177.81$ rad/sec

$\therefore$ shaft power $= 15\times177.81 = 2667.2$ watts

(d) Overall efficiency = $\frac{\text{Fluid power}}{\text{shaft power}} \times 100$

$= \frac{124.95}{2667.5} \times 100 = 4.68\%$

MEZI HANNAH CHIBUIKE

18/ENG05/031

MECHATRONICS ENGINEERING

-4.687×10^{-3}

① $L = 2.0m$, $V_1 = 5 m/s$

$V_2 = 2 m/s$

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

P at small head $= 2.5m$

$\frac{P_2}{w} = \frac{P_1}{w} + \frac{(V_1^2 + V_2^2)}{2g} + (z_1 - z_2)h$

$= 2.5 + \frac{(5^2 - 2^2)}{2\times9.81} + 2 - (0.35\times2)$

$= 2.5 + 5^2$

$= 2.5 + 1.07 + 2 - 0.16055$

$P_2 = 5.40$ bar

② Throat diameter $= 0.1m$

Inlet diameter $= 0.2m$

$Cd = 0.98$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi\times0.2^2}{4} = 0.0314 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi\times0.1^2}{4} = 7.85\times10^{-3} m^2$

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

$\frac{P_1}{w} = \frac{1.705\times10^{-2}}{9.81} = 1.799\times10^{-3}$

$\frac{P_2}{w} = 0.3\times13.6 = -4.08$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 1.799\times10^{-3} - (-4.08)$

$= 4.082m$

$\therefore Q = \frac{0.98\times0.0314\times7.85\times10^{-3}}{\sqrt{(0.0314)^2 - (7.85\times10^{-3})^2}} \times \sqrt{2\times9.81\times4.08018}$

$Q = \frac{0.00241}{0.0304} \times 8.947$

$Q = 0.00709 m^3/s$

③ $D_1 = 0.15m$, $D_2 = 0.3m$

④ $S.G = 0.9$, $Cd = 0.64$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi\times0.15^2}{4} = 0.0176 m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi\times0.3^2}{4} = 0.07069 m^2$

$h = 0.5\left[\frac{13.6}{0.9} - 1\right] = 7.05m$

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

$= \frac{0.64\times0.0176\times0.07069}{\sqrt{(0.0176)^2 - (0.07069)^2}} \times \sqrt{2\times9.81\times7.05}$

$= \frac{7.9625\times10^{-4}}{0.06846} \times 11.761$

$Q = 0.1368 m^3/s$

④ $y = 170mm\,Hg = 0.17m\,Hg$

$S.G\,Hg = 13.6$, $S.G\,sw = 1.026$

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

$\Delta h = 0.17\left(\frac{13.6}{1.026} - 1\right)$

$\Delta h = 2.08m$

$V = \sqrt{2g\Delta h}$

$V = \sqrt{2\times9.81\times2.08}$

$V = 6.388 m/s$

⑤ $Q = 0.05 dm^3/mm = 8.33\times10^{-5} m^3/s$

speed of rotation $= 1700 rev/min$

$= 28.3 rev/s$

Nominal displacement $= 10cm^3/rev = 10^{-5} m^3/rev$

Torque Input $= 15Nm$

pressure change $= 15 bar = 15\times10^5 N/m^2$

Ideal flowrate = Nominal displacement $\times$ speed rotation

$= 28.3\times10^{-5} = 2.83\times10^{-4} m^3/s$