Name: Adjugah Uvietobore Joshua
Department: 18/ENG05/007 / Mechatronics Engineering
Matric Number

(1) $\frac{P_1}{w} = 2.5m$; $V_1 = 5m/s$; $V_2 = 2m/s$; $Z_1 = 2m$

Heat loss, $H_1 = \frac{0.35(V_1 - V_2)^2}{2g}$

$H_1 = \frac{0.35(5-2)^2}{2\times9.81} = 0.16m$

$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + H_1$

$2.5 + 1.27 + 2 = \frac{P_2}{w} + 0.203 + 0 + 0.16$

$\frac{P_2}{w} = 2.5 + 1.27 + 2 - 0.203 - 0.16$

$= 5.07m$

(2) Inlet: $d_1 = 20cm = 0.2m$

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

$P_1 = 17.658 N/cm^2 = 176580 N/m^2$

$d_2 = 10cm = 0.1m$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times (0.1)^2}{4} = 0.00785m^2$

$h = \frac{P_1}{w} - \frac{P_2}{w}$ where $P_1 = 176580 N/m^2$; $w = 9.81 \times 1000 = 9810$

$\frac{P_2}{w} = 30cm Hg = \frac{30 \times -13.6}{1000} = -4.08$

$$\frac{P_1}{\omega} = \frac{176580}{9810} = 18$$

$$\frac{P_1}{\omega} - \frac{P_2}{\omega} = 18 - (-4.08) = 22.08$$

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

$$= 0.98 \times 0.0314 \times 0.00785 \sqrt{\frac{2 \times 9.81 \times 22.08}{(0.0314)^2 - (0.00785)^2}}$$

$$= 0.1653 m^3/s$$

(3) $d_o = 15cm = 0.15m$ $A_o = \pi \times \frac{(0.15)^2}{4} = 0.01767 m^2$

$d_p = 30cm = 0.3m$ $A_p = \pi \times \frac{(0.3)^2}{4} = 0.07069 m^2$

S.g of oil $= 0.9$; $C_d = 0.64$; Reading of Differential $= 50cm\,Hg$

Differential head, $h_1 = y\left[\frac{S_{hl}}{S_{g\,of\,oil}} - 1\right]$

$S_{hl} = 13.6$

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

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

$h = 0.5 \times 14.11 = 7.055m$

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

$$= \frac{0.64 \times 0.1767 \times 0.07069 \times \sqrt{2 \times 9.8}}{\sqrt{(0.07069)^2 - (0.1767)^2}}$$

$$= 0.1374 m^3/s$$

(4) $y = 170\,mmHg = 0.17\,mHg$

s.g of Mercury = 13.6

s.g of Sw = 1.026

$\Delta h = y\left(\frac{s.g\,Hg}{s.g\,Sw} - 1\right)$; $\Delta h = 0.17\left(\frac{13.6}{1.026} - 1\right)$

$= 2.08$

$V = \sqrt{2g\Delta h} = \sqrt{2 \times 9.81 \times 2.08} = 6.388\,m/s$

(5) $Q = 0.05\,dm^3/mm$

$\Rightarrow 8.33 \times 10^{-5}\,m^3/Sec$

speed of rotation $= 1700\,Rev/min$

$\Rightarrow 28.3\,Rev/sec$

Nominal displacement $= 10\,cm^3/rev$

$\Rightarrow 10^{-5}\,m^3/rev$

Torque input $= 15\,Nm$

Pressure change $= 15\,Bar$

$\Rightarrow 15 \times 10^5\,N/m^2$

Ideal flow rate = Nominal displacement × Speed Rotation

(a) ~~Volumetric Efficiency~~

$= \frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100$

~~2.8×7.055~~

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

(b) Fluid Power:

$P_F = Q \times \Delta P$

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

$= 124.95\,W$

(c) ~~Shaft Power~~

$= T \times \omega$

$\therefore \omega = 2 \times \pi \times \text{Speed}$

$= 2 \times \pi \times 28.3 = 177.81\,Rad/Sec$

$\Rightarrow = T \times \omega$

$= 15 \times 177.81$

$= 2667.2\,W$

(d) Overall efficiency

$= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

$= \frac{124.95}{2667.2} \times 100$

$= 4.68\%$