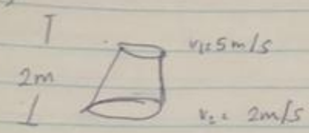
Nwachukwu Marshall
18/ENG05/036
Mechatronics

1)



$P_1 = \frac{P_1}{w} = 2.5cm$

$H_o = \frac{0.35(v_1 - v_2)^2}{2g}$

$$\frac{P_1}{w} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{v_2^2}{2g} + z_2 + H_2 = 0$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{v_1^2 - v_2^2}{2g} + (z_1 - z_2) - \frac{0.35(v_1 - v_2)^2}{2g}$$

$$\frac{P_2}{w} = 2.5 + \frac{5^2 - 2^2}{2(9.81)} + 2 - \frac{0.35(5 - 2)^2}{2(9.81)}$$

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

$$\frac{P_2}{w} = 5.409m \text{ of liquid}$$

2) $d_1 = 20cm = 0.2m$, $d_2 = 10cm = 0.1m$

$P_1 = 17.658 N/cm^2 = 176580 N/m^2$, $P_2 = 0.30cm\ Hg = -0.3m\ Hg$

$A_1 = \frac{\pi(0.2)^2}{4} = 0.031m^2$

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

$$h = \frac{P_1}{w} - \frac{P_2}{w} = \frac{176580}{(1000 \times 9.81)} = (0.3 \times 13.6)$$

$h = 18 + 4.08 = 22.08m$

$Cd = 0.98$

$$Q = \frac{Cd \cdot A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.98 \times 0.031 \times 1.85 \times 10^{-1} \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.031^2 - (1.85 \times 10^{-3})^2}}$$

b) Fluid Power, $P_f = Q \times \Delta P$

$= 8.33 \times 10^{-3} \times 15 \times 10^{3} = 124.95$ watts

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

$\omega = 2 \times \pi \times$ speed of rotation $= 2 \times \pi \times 28.3$

$= 177.81$ rad/sec

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

d) Overall Efficiency $= \dfrac{\text{Fluid power}}{\text{Shaft power}} \times 100$

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

$= 4.68\%$

[illegible]

3. $A_2 = \frac{\pi (0.1[illegible])^2}{4} = 0.0[illegible] m^2$, $A_1 = \frac{\pi (0.[illegible])^2}{4} = 0.0[illegible] m^2$

$y = [illegible] mmHg = 0.[illegible] mHg$, $S_g = 0.9$, $C_d = 0.9[illegible]$

$h = y \left[\frac{S_{Hg}}{S_{oil}} - 1 \right] = 0.[illegible] \left[\frac{13.6}{0.9} - 1 \right]$

$h = 7.[illegible] m$

$Q = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.9[illegible] \times 0.0[illegible] \times 0.0[illegible] \times \sqrt{2 \times 9.81 \times 7.[illegible]}}{\sqrt{0.0[illegible]^2 - 0.0[illegible]^2}}$

$= \frac{7.4175 \times 10^{-3}}{0.0[illegible]} = 0.1[illegible] m^3/sec$

4. $y = 170 mmHg = 0.17 mHg$, $S_{g Hg} = 13.6$, $S_{g sd} = 1.026$

$\Delta h = y \left[\frac{S_{g Hg}}{S_{g sd}} - 1 \right] = 0.17 \left[\frac{13.6}{1.026} - 1 \right]$

$\Delta h = 2.08 m$

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

$v = 6.388 m/s$

5. $Q = 0.05 m^3/min = 8.33 \times 10^{-4} m^3/sec$

Speed of rotation = 1700 Rev/min = 28.3 rev/sec

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

Torque input = 15 Nm

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

Ideal flow rate = Nominal displacement × Speed of rotation

$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4} m^3/sec$

a. Volumetric efficiency = $\frac{\text{Actual flowrate}}{\text{Total flowrate}} \times 100$

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