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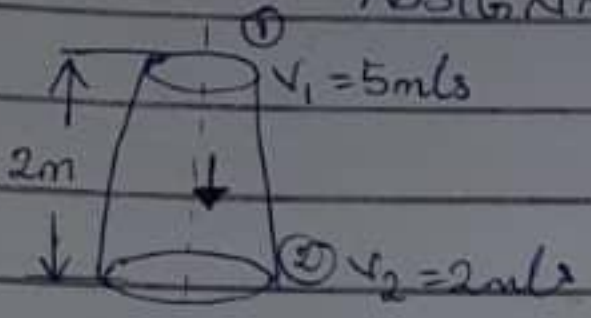
DEPARTMENT: 18/ENG05/049

MATRIC. NO.: MECHATRONICS

COURSE CODE: ENG 214

ASSIGNMENT

1.



$$P_T = \frac{P_1}{W} = 2.5m$$

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

$$\frac{P_1}{W} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{W} + \frac{V_2^2}{2g} + z_2 + H_L$$

$$\frac{P_2}{W} = \frac{P_1}{W} + \frac{V_1^2 - V_2^2}{2g} + (z_1 - z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

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

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

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

2. $d_1 = 20cm$, $d_2 = 10cm$, $P_1 = 17.658 N/cm^2 = 176,580 N/m^2$

$d_1 = 0.2m$, $d_2 = 0.1m$, $P_2 = -0.3cm\ Hg = -0.3m\ Hg$

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

$$A_1 = 0.031m^2$$

$$A_2 = \frac{\pi(0.1)^2}{4}$$

$$A_1 = 7.85 \times 10^{-3} m^2$$

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

$$h = \frac{176,580}{(1000 \times 9.81)} - (-0.3 \times 13.6)$$

$$h = 18 + 4.08$$

$$h = 22.08m$$

$$C_d = 0.98$$

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

$$Q = \frac{0.98 \times 0.031 \times 7.85 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.031^2 - (7.85 \times 10^{-3})^2}}$$

$$Q = \frac{4.95 \times 10^{-3}}{0.0299}$$

$$Q = 0.166 m^3/sec$$

3. $A_o = \frac{\pi (0.15)^2}{4} = 0.0177m^2$, $A_1 = \frac{\pi (0.30)^2}{4} = 0.0707m^2$

$y = 50cm\,Hg = 0.5m\,Hg$, $S.g_{oil} = 0.9$, $C_d = 0.64$

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$$h = y\left(\frac{S.g_{Hg}}{S.g_{oil}} - 1\right)$$

$$h = 0.5\left(\frac{13.6}{0.9} - 1\right)$$

$$h = 7.05m$$

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

$$Q = \frac{0.64 \times 0.0707 \times 0.177 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$Q = \frac{8.01 \times 10^{-4} \times 11.76}{0.0684}$$

$$Q = 0.1378\ m^3/sec$$

4. $y = 170mmHg = 0.17mHg$, $S.g_{Hg} = 13.6$, $S.g_{sw} = 1.026$

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

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

$$\Delta h = 2.08m$$

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

$$V = \sqrt{2 \times 9.81 \times 2.08}$$

$$V = 6.388 m/s$$

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

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

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

Torque Input $= 15 Nm$

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

- Ideal Flowrate = Nominal displacement x Speed Rotation

$= 10^{-5} \times 28.3$

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

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

Volumetric Efficiency $= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$

$= 29.45\%$

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

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

$= 124.95$ 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 $= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

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

$= 4.68\%$