LAW-ADUE EMMANUEL

19/ENG05/069

MECHATRONICS <200 Lvl>

ENG214 ASSGN

Q1 $V_1 = 5ms^{-1}$, $V_2 = 2ms^{-1}$

$P_{T1} = 2.5m$, $P_{T2} = ?$

$$P_{T1} - P_{T2} = \frac{0.35\,(V_1 - V_2)^2}{2g}$$

$$= \frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$$

Since $P_{T1} - P_{T2} = 0.161$;

$2.5 - P_{T2} = 0.161$

$P_{T2} = 2.5 + 0.161$

$P_{T2} = 2.67m$

∴ Pressure head at lower end $= 2.67m$ ///

Q2 Inlet diameter, $d_1 = 20cm = 0.2m$

Throat diameter, $d_2 = 10cm = 0.1m$

$P_1 = 17.658 N/cm^2$

$= 176,580 N/m^2$

$P_2 = 30cmHg = 0.3mHg$

$Cd = 0.98$

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Specific gravity of mercury = 13.6

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

$\Rightarrow \frac{P_1}{\omega} = \frac{176580}{1000 \times 9.81} = 18$

$\Rightarrow$ Vacuum pressure $= 0.3 \times 13.6$

$= 4.08$

$\therefore h = 18$

$= 18 - 4.08 = 13.92$

Area, $A_1 = \frac{\pi d_1^2}{4} = \frac{3.142 \times 0.2^2}{4} = 0.03142 m^2$

Area, $A_2 = \frac{\pi d_2^2}{4} = \frac{3.142 \times 0.1^2}{4} = 0.007855 m^2$

Discharge of water, $Q_{act} = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$$\therefore Q_{act} = \frac{0.98 \times 0.0314 \times 0.00786 \times \sqrt{2 \times 9.81 \times 13.92}}{\sqrt{0.0314^2 - 0.00786^2}}$$

$$Q_{act} = 0.131 \quad ///$$

Q3 Orifice diameter, d_2 = 15 cm = 0.15 m

Pipe diameter, d_1 = 30 cm = 0.30 m

$$A_1 = \frac{\pi d_2^2}{4} = \frac{3.142 \times 0.15^2}{4} = 0.0177 m^2$$

$$A_2 = \frac{\pi d_1^2}{4} = \frac{3.142 \times 0.30^2}{4} = 0.0707 m^2$$

y = 50 cmHg = 0.5 mHg

C_d = 0.64

$$h = \frac{\text{SG of Hg} - \text{SG of oil}}{\text{SG of oil}} \times y$$

$$= \frac{13.6 - 0.9}{0.9} \times 0.5$$

$$= 7.06 m$$

Rate of flow, $Q_{act} = \frac{C_d A_2 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$$Q_{act} = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.06}}{\sqrt{0.0177^2 + 0.0707^2}}$$

Q_{act} = 0.138 ///

Q4 Velocity of the submarine, $V = \sqrt{2gH}$

$$H = y\left(\frac{\text{SG of mercury} - \text{SG of water}}{\text{SG of water}}\right)$$

$$H = 0.17\left(\frac{13.6 - 1.026}{1.026}\right)$$

$$= 0.17 \times 12.26$$

$$= 2.0842 m$$

$$V = \sqrt{2 \times 9.81 \times 2.0842}$$

$$= 6.39 ms^{-1}$$

$\therefore$ the speed of the sub-marine $= 6.39 ms^{-1}$ ///

9 − 1) + 0.914 = 0

Q5 Actual flow rate = 0.05 m^3/min ;

Q = 0.05 m^3 / 60secs

= 8.33×10^{-4} m^3/sec

Speed = 1700 rev/min

= 1700 rev/ 60sec

= 28.33 rev/sec

Normal displacement = 10 cm^3/rev

= 1×10^{-5} m^3/rev

Pressure = 15 bar (P)

= 15×10^5 N/m^2

Ideal flow rate = $28.33 \times 1 \times 10^{-5}$

=

* Volumetric Efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100$

= $\frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}}$

= 2.940 %

* Fluid power = $Q \times P$

$= 8.33 \times 10^{-4} \times 15 \times 10^5$

$= 1249.5$ Nm/s or Watts

* Shaft power = $\tau \cdot \omega$

<Torque input X angular speed>

$\tau = 15$ Nm

$\omega = 2\pi \times$ Speed

$= 2 \times \frac{22}{7} \times 28.33 = 178.026$

$= (15 \times 178.026)$ Watts

$= 2670.39$ Watts

* Overall Efficiency ; $\frac{\text{fluid power}}{\text{Shaft power}} \times 100$

$= \frac{1249.5}{2670.39} \times 100$

$= 46.79\ \%$