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COMPUTER ENGINEERING

FLUID MECHANICS

1) Length = 2.0m, $v_1 = 5m/s$; $v_2 = 2m/s$

$P_1/w = 2.5m$ of liquid

loss of head, $h_f = \frac{0.35(v_1-v_2)^2}{2g} = \frac{0.35(5-2)^2}{2\times 9.81} = 0.161m$

applying bernoulli's equation at ends (1) and (2)

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

$$2.5 + \frac{25}{2\times 9.81} + 2 = \frac{P_2}{w} + \frac{4}{2\times 9.81} + 0 + 0.161$$

$$\frac{P_2}{w} = 5.77 - 0.204 = 5.6m - 0.161m = 5.4m$$

Pressure head at lower end i.e large end is 5.4m

$P_2 = 5.4 \times 9810 \times 10^{-5} = 0.53bar$

2) Inlet diameter $(D_1) = 20cm = 0.2m$

Inlet ~~diameter~~ area $(A_1) = \frac{\pi \times 0.2^2}{4} = 0.0314m^2$

Throat diameter $(D_2) = 10cm = 0.1m$

Throat area $(A_2) = \frac{\pi \times 0.1^2}{4} = 0.0079m^2$

$P_1 = 17.658N/cm^2 = 176580N/m^2 = 176.580kPa$

Pressure head $= \frac{P_1}{w} = \frac{176.580}{9.81} = 18m$

throat pressure head $= \frac{P_2}{w} = -30cm$ of mercury

$= -0.3 \times 13.6 = -4.08m$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08) = 22.08m$

$C_d = 0.98$

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

$$Q = 0.98 \times \frac{0.0314 \times 0.0079}{\sqrt{(0.0314)^2 - (0.0079)^2}} \times \sqrt{2 \times 9.81 \times 22.08}$$

$Q = 0.166 m^3/s$

3) Orifice diameter = 15cm = 0.15m = D_o

Area of Orifice = $\frac{\pi \times 0.15^2}{4} = 0.0176 m^2 = A_o$

Pipe diameter = 30cm = 0.30m = D_1

Pipe Area = $\frac{\pi \times 0.3^2}{4} = 0.071 m^2 = A_1$

manometer reading = 50cm of mercury = 0.5m of mercury

$C_d = 0.64$

S.P gravity of oil = 0.9

$$h = y\left[\frac{S_{HL}}{S_o} - 1\right]$$

$$h = 0.5\left[\left(\frac{13.6}{0.9}\right) - 1\right]; \quad h = 7.06m \text{ of oil}$$

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

$$Q = 0.64 \times \frac{0.0176 \times 0.071}{\sqrt{0.071^2 - 0.0176^2}} \times \sqrt{2 \times 9.81 \times 7.06}$$

$Q = 0.137 m^3/s$

4) axis = 15m below Surface

$y = 170mm = 0.17m$ of mercury

Sp. gravity of Hg = 13.6

Sp. gravity of water = 1.026

$$h = y\left(\frac{S_{HL}}{S_L} - 1\right) = 0.17\left(\frac{13.6}{1.026} - 1\right) = 2.08m$$

Speed of sub marine = $\sqrt{2gh}$

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

$= 6.38 m/s$

5) Rate of pump delivery $= 0.05\ m^3/min = 8.33 \times 10^{-4}\ m^3/s$

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

Speed in rotation $= 1700$ rev/min $= 28.33$ rev/sec

Normal displacement $= 10 cm^3/rev = 1 \times 10^{-5}\ m^3/rev$

Torque input $= 15 Nm$

i) Volumetric efficiency $= \frac{\text{actual flow rate}}{\text{Ideal flow rate}} \times 100$

Ideal flow rate = normal displacement × speed

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

$= 2.833 \times 10^{-4}\ m^3/s$

Volumetric efficiency $= \frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}} \times 100$

$= 294.03\%$

ii) Fluid Power = Actual flowrate × pressure

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

$= 1249.5 W$

$= 1.2495 kW$

iii) Shaft power = Torque input × angular speed

Torque input $= 15 Nm$

Angular speed $= \omega = \frac{2\pi N}{60} = 2 \times \frac{22}{7} \times 28.33$

$= 178.07 W$

iv) Overall efficiency $= \frac{\text{fluid power}}{\text{Shaft power}} \times 100$

$= \frac{1249.5}{178.07} \times 100$

$= 702\%$

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FLUID M

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