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Online Assignment.

1. Flow rate = $10 dm^3/min$ = $0.01 m^3/min$

$Q_{actual} = 1.67 \times 10^{-4} m^3/sec$

Speed = 1500 rev/min

= 25 rev/sec

Torque = 12.5 Nm

dP = 12 bar = $12 \times 10^5 N/m^2$

Nominal displacement = $10 cm^3/rev$

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

Ideal flow rate = nominal displacement x speed

$= 25 \times 1 \times 10^{-5}$

$= 2.5 \times 10^{-4} m^3/sec$

i.) Vol. efficiency = $\frac{\text{actual flow rate}}{\text{Ideal flow rate}} \times 100 = \frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100$

= 66.8%

ii.) Fluid power = $Q \cdot dp$

$= 1.67 \times 10^{-4} \times 12 \times 10^5$

= 200.4 Nm/sec

iii.) Shaft power = $\gamma \omega_c$
└ angular speed

$\omega_c = 2\pi N$ └ speed of rotation ~~nominal displacement~~

$= 2 \times 22/7 \times 25 = 157.14$ rads/sec

∴ shaft power = 12.5×157.14

= 1964.25 W

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

$= \frac{200.4}{1964.25} \times 100$

$= \underline{10.2\%}$

2. $dp = 100 \times 10^5 \, N/m^2$

$Q = 35 \, dm^3/min$

$= \frac{0.035}{60} = 5.83 \times 10^{-4} \, m^3/sec$

Fluid power $= Q \cdot dP$

$= 5.83 \times 10^{-4} \times 100 \times 10^5$

$= 5830 W$

Shaft power $= \frac{\text{fluid power}}{\text{overall efficiency}} \times 100$

$= \frac{5830}{87} \times 100$

$= \underline{6701.15 W}$

3. Nominal displacement $= 50 cm^3/rev = 5 \times 10^{-5} \, m^3/rev$

$dP = 100 \times 10^5 \, N/m^2$

Shaft power $= 15 kW$

Actual flow rate $[Q_a] = \frac{0.035}{60} = \underline{5.83 \times 10^{-4} \, m^3/sec}$

$P_F = Q \cdot dP$

$5.83 \times 10^{-4} \times 100 \times 10^5$

$= \underline{5830 W}$

Overall efficiency $= \frac{5830}{15000} \times 100$

$= \underline{38.87\%}$

Ideal flow rate = nominal displacement × speed

$5 \times 10^{-5} \times \frac{850}{60} = 7.08 \times 10^{-4} \, m^3/sec$

Vol. efficiency = $\frac{\text{actual flow rate}}{\text{ideal flow rate}} \times 100$

$= \frac{5.83 \times 10^{-4}}{7.08 \times 10^{-4}} \times 100$

$= \underline{82.34\%}$

4. $Z_2 = 240m$

$Q = 0.013\ m^3/sec$

$V_{jet} = 66m/sec$; $P = 0$ and $Z_1 = 0$ — $\rho = 1000kg/m^3$ for water

Power $= \underset{\downarrow 0}{PQ} + \frac{\rho Q V^2}{2} + \rho g \underset{\downarrow 0}{Q z_1}$

$= \frac{\rho Q V^2}{2} = \frac{1000 \times 13 \times 10^{-3} \times (66)^2}{2}$

$P = \underline{28.314\ kW}$

ii) Power supplied from reservoir

Since reservoir operates at atmospheric pressure ; $P = 0$, $V = 0$

$P = 0 \cdot Q + \rho Q 0^2 + \rho g Q z_2$

$P = \rho g Q z = 1000 \times 9.81 \times 0.013 \times 240$

$= \underline{30.61\ kW}$

iii) Power loss in transmission = Reservoir power − Jet power

$= 30.61 - 28.314$

$= 2.296kW$

Head Loss (H) $= \frac{\text{power Loss}}{\rho g Q} = \frac{2.296 \times 10^3}{1000 \times 9.81 \times 0.013}$

$= \underline{18\ m}$

iv.) $\Sigma = \frac{\text{power of jet}}{\text{Power of reservoir}} \times 100$

$= \frac{28314}{30610} \times 100$

$= \underline{92.45\%}$

6. $h_1 = 20m$

$d = 10cm = 0.1m$

$r = 0.05m$

$g = 9.81 m/s^2$

Using conservation of energy;

$\frac{1}{2} mv^2 = mgh$

~~$v = \sqrt{9.81 \times 20}$~~

$v = \sqrt{9.81 \times 20 \times 2}$

$= \sqrt{392.4}$

$v = 19.81 m/s$ at the base

$\rho = 1000 kg/m^3$

$Q_{base} = \pi r^2 v$

$= \frac{22}{7} \times 0.05^2 \times 19.81$

$= 0.156 m^3/sec$

$\therefore$ 155.6 kg of water leaves the fountain every sec

$P = \frac{W}{t} = mg\frac{h}{t}$

$= \frac{\rho \pi r^2 v g h}{t} = 155.6 \times 9.81 \times 20$

$= 30528.72 W$

$= \underline{30.53 kW}$

7. $Cd = 0.96$

$d_1 = 0.3m$

$d_2 = 0.2m$

$\rho g = $ ~~16~~ $19.62\ N/m^2$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.0707\ m^2$

$A_2 = \frac{\pi \times 0.2^2}{4} = 0.0314\ m^2$

$Q = U_1 A_1 = U_2 A_2$

$U_1 = \frac{Q}{0.0707}$ $\qquad U_2 = \frac{Q}{0.0314}$

For manometer;

$P_1 + \rho_g g z = P_2 + \rho_g g (z_2 - R_1) + \rho_u g R_2$

$P_1 - P_2 = 19.62\ (z_2 - z_1) + 587.423$

For venturimeter;

$P_1 - P_2 = 19.62 (z_2 - z_1) + 0.803 u_2^2$

Combining:

$0.803\ u_2^2 = 587.423$

$U_{2ideal} = 27.047 m/s$

$Q_{ideal} = 27.047 \times \pi \left(\frac{0.2}{2}\right)^2 = 0.85 m^3/s$

$Q_{actual} = Cd \cdot Q_{ideal}$

$= 0.96 \times 0.85$

$= 0.816 m^3/sec$

9. $d_1 = 300mm = 0.3m$

$A_1 = \pi/4 \times 0.3^2 = 0.0707\ m^2$

$P_1 = 400 KN/m^2$

Height above datum, $Z_1 = 10m$

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$d_2 = 0.15m$

$A_2 = \frac{\pi \times 0.15^2}{4} = 0.01767 \, m^2$

height of lower end above datum, $Z_2 = 6m$

$Q = 40 \, l/sec = \frac{40 \times 10^3}{10^6}$

$= 0.04 m^3/s$

$Q = A_1 V_1 = A_2 V_2$

$V_1 = \frac{Q}{A_1} = 0.566 m/s$

$V_2 = \frac{0.04}{0.01767} = 2.264 m/s$

Using Bernoulli's eqn:

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

$$\frac{P_2}{W} = \frac{400}{9.81} + \frac{1}{2 \times 9.81}(0.566^2 - 2.264^2) + (10-6)$$

$$\frac{P_2}{W} = 44.525m$$

$P_2 = 44.525 \times 9.81 = 436.8 kN/m^2$

10. Manometer reading (y) = 170mmHg = 0.17m Hg

Specific gravity of heavier liquid (mercury) = 13.6

Sg of sea water (S_w) = 1.026

$$h = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$= 2.08$

Velocity of the submarine

$V = \sqrt{2gh}$

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

$= 6.39 m/s$

5. $Z_2 = 300m$

$\rho_{oil} = S_g \times \rho_{water} = 0.89 \times 1000$

$= 890 \, kg/m^3$

$Q = 220 \, L/sec = 0.22 \, m^3/s$

$V_{jet} = 7 \, m/sec$; $P = 0$; $Z_1 = 0$

Power of jet = $PQ + \frac{\rho Q V^2}{2} + \rho g Q Z_1$

$$P = \frac{\rho Q V^2}{2} = \frac{890 \times 0.22 \times (7)^2}{2}$$

$= 4797.1 \, W$

$= \underline{4.7971 \, kW}$

ii.) Power supplied from reservoir

$P = 0$; $V = 0$

$P = \rho g Q Z$

$= 890 \times 9.81 \times 0.22 \times 300$

$= \underline{576.239 \, kW}$

iii.) Power Loss in transmission $= 576.239 - 4.7971$

$\approx \underline{571.442 \, kW}$

Head Loss $(h) = \frac{\text{power loss}}{\rho g Q} = \frac{571442}{890 \times 9.81 \times 0.22}$

$= \underline{297.50 \, m}$

iv.) Efficiency $= \frac{4797.1}{576239} \times 100$

$= \underline{0.83\%}$