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1) $Q = 10 dm^3/min = \frac{10}{1000 \times 60}$

$= 1.667 \times 10^{-4} m^3/s$

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

speed of Rotation $= 1500 rev/min$

$= 1500/60 = 12 rev/s$

Nominal displacement $= 10 cm^3/rev$

$= 10/1000000$

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

Torque input $= 12.5 NM$

a) Volumetric efficiency $= Q/$ideal flow rate

Ideal flow rate = Nominal displacement × speed

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

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

= Volumetric Efficiency $= \frac{1.667 \times 10^{-4}}{2.5 \times 10^{-4}}$

$= 0.6668 \times 100\%$

$= 66.68\%$

(ii) Fluid power $= Q \times \Delta P$

$= 1.667 \times 10^{-4} \times 12 \times 10^{-3}$

$= 200.04 W$

(iii) Shaft power $= 2\pi T \times$ speed

$= 2 \times 3.14 \times 12.5 \times 25$

$= 1963.50 W$

(iv) Overall Efficiency $= \frac{\text{Fluid power}}{\text{Shaft power}}$

$= \frac{200.04}{1963.80}$

$= 0.102 \times 100$

$= 10.2\%$

2) $Q = 35 dm^3/min = \frac{35 \times 0.001}{60}$

$= 5.83 \times 10^{-4} m^3/s$

$\Delta P = 100 bar = 100 \times 10^5 N/m^2$

Overall Efficiency $= 87\%$

Shaft power $= \frac{\text{fluid power}}{\text{Overall Efficiency}}$

$= \frac{Q \times \Delta P}{87 \div 100}$

$= \frac{5.83 \times 10^{-4} \times 100 \times 10^5}{0.87}$

$= \frac{5830}{0.87}$

$= 6701.15 W$

3) $Q = 35 dm^3/min = \frac{35 \times 0.001}{60}$

$= 5.83 \times 10^{-4} m^3/s$

$\Delta P = 100 bar = 100 \times 10^5 N/m^2$

Shaft power $= 15 KW$

speed of rotation $= 880 rev/min$

$= 850$

$= 14.167 revs$

(i) Volumetric Efficiency $= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = nominal displacement × speed

$= 50 cm^3/rev \times 14.167$

$= 5 \times 10^{-3} \times 14.167$

$= 7.035 \times 10^{-4} m^3/s$

∴ Volumetric Efficiency $= \frac{5.85 \times 10^{-4}}{7.0835 \times 10^{-4}}$

$= 0.823 \times 100\%$

$= 82.3\%$

(ii) Overall Efficiency = fluid Power / shaft power

$= \frac{Q \times \Delta P}{\text{shaft Power}}$

$= \frac{5.83 \times 10^{-4} \times (150 \times 10^5)}{(15 \times 10^2)}$

$\frac{5830}{15000}$

$= 0.3887 \times 100\%$

$= 38.87\%$

NO. (iv)

Difference of Mercury level,

$x = 170mm = 0.17 M$

Speed of submarine = ?

Sgravity of mercury = 13.6

S-gravity of sea water = 1.026

Differential head, $h = x \left\{\frac{Sg}{S0} - 1\right\}$

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

$= 2.0834$ m of water

Velocity/Speed of submarine

$V = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.0834}$

$= 6.393$ m/s

NO. 7

Specific weight $= 19.62 N/m^3$

$Cd = 0.96$

$d_1 = 0.3 m$

$d_2 = 0.2 M$

Calculate Q.

$V_1 = Q/0.0707 \quad V_2 = Q/0.0314$

for the Manometer;

$P_1 + S_0 g Z = P_2 + S_w g(Z_2 - R_2) + (S_0 g R_f$

$P_1 - P_2 \Rightarrow 19.62(Z_2 - Z_1) + 587.423 .(1)$

for the Venturimeter

$\frac{P_1}{S_w g} + \frac{V_1^2}{2g} + Z_1 \Rightarrow \frac{P_2}{S_w g} + \frac{V_2^2}{2g} + Z_2$

$P - P_2 = 19.62(Z_2 - Z_1) + 0.803 V_2^2 - (2)$

Combining (1) & (2) we get

$0.803 V_2^2 = 587.423$

V_2 ideal $= 27.047 m/s$

$Q_{ideal} = 27.047 \times \pi \times \left(\frac{0.2}{2}\right)^2$

$= 0.85 m^2/s$

$Q = Cd\ Q_{ideal} = 0.96 \times 085 = 0.816 m^3/s$

(NO 6)

Power = Workdone / Time

Workdone = mgh / time

V = Velocity of Stream

ρ = density of water ($1000 kg/m^3$)

$\dot{m} = \rho \times V$

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 20}$

$= 19.798 M$

$P \Rightarrow \rho \pi r^2 V g h$

Power $= 1000 \frac{kg}{m^2} \times \left(\frac{10 \times 10^{-2}}{2}\right) \times 19.7989 \frac{m}{s} \times 9.8 \frac{m}{s^2} \times 20$

$\Rightarrow 30478.03 W$

Power $\Rightarrow 30.5 KW$

No. 8

$d_1 = 0.152m \Rightarrow A_1 = \frac{\pi}{4}(0.152)^2$
$= 0.01814 m^2$

$d_2 = 0.076m \Rightarrow A_2 = \frac{\pi}{4}(0.076)^2$
$= 0.00464 m^2$

$\rho = 0.8 \times 1000 = 800 kg/m^3$

$cd = 0.97$

Apply Benoulli :-

$$\frac{P}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

(a) $P_1 = P_2$

$$\frac{V_1^2}{2g} + Z_1 = \frac{V_2^2}{2g} + Z^2$$

By Continuity

$Q = V_1 A_1 = V_2 A_2$

$V_2 = V_1 \cdot \frac{A_1}{A_2}$

$$\frac{V_1^2}{2g} + 0.314 = \frac{16(U_1^2)}{2g}$$

$$U_1 = \sqrt{\frac{0.314 \times 2 \times 9.81}{15}} = 1.0934 m/s$$

$Q = Cd A_1 V_1 = 0.37 \times 0.01814 \times (1.0937)$

$Q = 0.0172 m^3/s$

(b) $P_1 - P_2 = 15170$

$\rightarrow \frac{P_1 - P_2}{\rho g} = \frac{U_2^2 - U_1^2}{2g} - 0.914$

$$\frac{15170}{800 \times 9.81} = \frac{Q^2[(220 \times 43)^2 - (55.19)^2]}{2 \times 9.81}$$

$- 0.914;$

$\Rightarrow Q = 0.035 m^3/s.$

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At Section 1

$D_1 = 300 mm = 0.3 m$

$Area = \frac{\pi}{4} \times (0.3)^2$
$= 0.07068 m^2$

Pressure. $P_1 = 400 kN/m^2$

Height of upper end above the datum $(Z) = 10m$

$\Rightarrow$ At Section 2;

$P_2 = 180M = 0.15M,$

$Area = \frac{\pi}{4}(0.15)^2$

$a_2 = 0.01767 m^2$

Height of lower end of datum $(Z_2) = 6m$

$\Rightarrow$ Rate of flow

$Q = 40 Lt/sec = 0.04 m^3/sec$

$\Rightarrow$ As the flow Continous

$Q = A_1 V_1 = A_2 V_2$ Continuity Equation)

$V_1 = Q/A_1 = \frac{0.04}{0.07068} = 0.5658 m/s$

$V_2 = Q/A_2 = \frac{0.04}{0.01767} = 2.2635 m/s$

$\rightarrow$ Apply Bernoulli's equation at Section

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

$$\frac{P_2}{\rho g} = \frac{P_1}{\rho g} + \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2)$$

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