[illegible]

[illegible]

[illegible]

1. Real flow rate = 10 dm³/min

$T = 12.5 \, Nm$

$= \frac{10 \times 10^{-3}}{60} = 1.67 \times 10^{-4} \, m^3/s$

$P = 12 \times 10^{5} \, N/m^2$

Speed = 1500 rev/min = $\frac{1500 \, rev}{60}$ = 25 rev/sec

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

Ideal flow rate = nominal × speed

$= 1 \times 10^{-5} \, m^3/rev \times 25 \, rev/sec$

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

i. Volumetric efficiency = $\frac{\text{Real flow rate}}{\text{ideal flow rate}} \times 100$

$= \frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100\%$

$= 66.8\%$

ii. fluid power = $Q \, dp$

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

$= 200.4$ watts

iii. Shaft power = $T\omega$

$\omega = 2\pi N$

$= 2 \times \pi \times 25$

$= 157.08$

Shaft power = 12.5×157.08

$= 1963.5$ watts

iv. Overall efficiency

$\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$

$\frac{200.4}{1963.5} \times 100\% = 10.21\%$

2. Pump delivery = 35 dm³/min

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

$P = 100 \, bar = 100 \times 10^{5} \, Nm^{-2}$

Overall efficiency = 87%

fluid power = $100 \times 10^{5} \, Nm^{-2} \times 5.83 \times 10^{-4}$

$= 5830$ watts

Recall

Overall efficiency = $\frac{\text{fluid power}}{\text{shaft power}}$

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

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

$= 6701.149$ watts

3. Nominal displacement of 50 cm³/rev

$= 50 \times 10^{-6} \, m^3/rev$

Pressure = 100 bar = $100 \times 10^{5} \, N/m^2$

Shaft power = 15000 watts

actual flow rate = $\frac{35 \times 10^{-3} \, m^3}{60}$

$= 5.63 \times 10^{-4}$

Speed = 14.17 rev/s

ideal flowrate = $50 \times 10^{-6} \, m^3/rev \times 14.17 \, rev/s$

$= 7.085 \times 10^{-4} \, m^3/s$

i. Volumetric efficiency = $\frac{5.83 \times 10^{-4}}{7.085 \times 10^{-4}}$

$= 82.29\%$

ii. fluid power = $Q \, dp$

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

$= 5830$ watts

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

$= 38.867\%$

4) Volumetric flow rate

$Q = 13$ litres/sec

$= 0.013 \, m^3/sec$

Velocity = 66 m/sec

Bernoulli's formula

$P = \rho g Q \left(\frac{P}{\rho g} + \frac{v^2}{2g} + z\right)$

$P = QP + \frac{\rho Q v^2}{2} + \rho g Q z$

Pressure head = 0

$z = 0$

$P = \frac{\rho Q v^2}{2}$

5) Sg oil = 0.89

$z = 30{,}000 \, cm = 300 \, m$

$Q = 0.22 \, m^3/sec$

$v = 1 \, m/sec$

i. $P = \rho Q v^2/2$

$Sg = 0.89$

$Sg = \frac{x}{1000}$

$x = 890$

$P = \frac{890 \times 0.22 \times 1^2}{2}$

$P = 479.1$ watts

ii) $P = \rho g Q z$

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

$= 576.2394 \, kW$

iii) Power loss

= power reservoir − power of jet

$= (576239.4 - 4.7971) \, kW$

$= 571.4423 \, kW$

Head used to overcome losses

$= \frac{571.4423}{890 \times 9.81 \times 0.22}$

$= 294.51$

6. $P = \rho g Q z$

$u = 0$

$v^2 = \sqrt{u^2 + 2gh}$

$v^2 = u^2 - 2gh$

$v = \sqrt{0^2 + 2 \times 9.81 \times 20}$

$v = \sqrt{392.4}$

$v = 19.81 \, m/s$

$Q = VA$

$= 19.81 \times 7.85 \times 10^{-3}$

$= 0.1556 \, m^3/s$

Then $P = \rho g Q z$

$= 1000 \times 9.81 \times 0.156 \times 20$

$= 30.5 \, kW$