NJOKU VICTORY 18/ENG04/068
ELECT-ELECT FLUID MECHANICS ENG214

1) Actual rate = $10 dm^3/min = 0.01 m^3/min \times 1.67 \times 10^{-4} m^3/s$
Pressure = 12 bar = $12 \times 10^5 N/m^2$
Speed = 1600 rev/min = 25 rev/s
nominal displacement = $10 cm^3/rev = 1 \times 10^{-5} m^3/rev$
Torque = 12.5 Nm
Volumetric efficiency = $\frac{\text{actual flowrate}}{\text{ideal flowrate}} \times 100\%$
ideal flowrate = $1 \times 10^{-5} \times 25 = 2.5 \times 10^{-4} m^3/s$
Volumetric efficiency = $\frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100\%$
Volumetric efficiency = 66.8%
Fluid power = actual rate x pressure
Fluid power = $1.67 \times 10^{-4} \times 12 \times 10^5$
Fluid power = 200.4 watts
Shaft power = Torque x angular speed
Angular speed = $2 \times \pi \times$ speed = $2 \times \pi \times 25 = 157.08 rad/s$
Shaft power = 12.5×157.08
Shaft power = 1963.5 watts
Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft Power}} \times 100\%$
Overall efficiency = $\frac{200.4}{1963.5} \times 100\%$
Overall efficiency = 10.21%

3) Nominal displacement = 50cm³/rev = 5 × 10⁻⁵ m³/rev
Pressure = 100 bar = 100 × 10⁵ N/m²
Shaft power = 15KW = 15 × 10³ W
Actual flow rate = 35dm³/min = 0.035m³/min = 5.83 × 10⁻⁴ m³/s
Speed = 850 rev/min = 14.17 rev/s
Volumetric efficiency = $\frac{\text{Actual rate}}{\text{Ideal rate}} \times 100\%$
ideal rate = nominal displacement × speed
ideal flowrate = 5 × 10⁻⁵ × 14.17
ideal flow rate = 7.085 × 10⁻⁴ m³/s
Volumetric efficiency = $\frac{\text{actual flowrate}}{\text{ideal flowrate}} \times 100\%$
$= \frac{5.83 \times 10^{-4}}{7.085 \times 10^{-4}} \times 100$
Volumetric efficiency = 82.3%
Overall efficiency = $\frac{\text{fluid power}}{\text{shaft power}} \times 100$
Fluid power = actual rate × pressure
$= 5.83 \times 10^{-4} \times 100 \times 10^5 = 5830$ watts
Overall efficiency = $\frac{5830}{15 \times 10^3} \times 100$
Overall efficiency = 38.87%

4) $Z = 24000\,cm = 240\,m$

Volumetric flow rate $= 13\,ltr = 0.013\,m^3/s$

Jet velocity $= 66\,m/s$ ∴ $P = 0,\ z = 0$

$$\text{Power} = \frac{P \times Q \cdot V^2}{2}$$

$$\text{Power} = \frac{1000 \times 0.013 \times (66)^2}{2}$$

Power $= 28314$ watts

Power supplied from reservoir

$P = 0,\ V = 0$

$P = \rho g Q z$

Power $= 1000 \times 9.81 \times 0.013 \times 240$

Power supplied from reservoir $= 30607.2$ watts

Power loss in transmission = Power of reservoir − Power of jet

Power loss in transmission $= 30607.2 - 28314$

Power Loss $= 2293.2$ watts

Head loss in pipeline

$$h = \frac{\text{Power Loss in transmission}}{\rho g Q}$$

$$h = \frac{2293.2}{1000 \times 9.81 \times 0.013} = 17.952\,m$$

$$\text{Efficiency} = \frac{\text{Power of Jet}}{\text{Power of reservoir}} \times 100\%$$

$$\text{Efficiency} = \frac{28314}{30607.2} \times 100$$

Efficiency $= 92.5\%$

2) Rate = 35 dm^3/min = 0.035 m^3/min = 5.83×10^{-4} m^3/s

Pressure = 100 bar = 100×10^5 N/m^2

Overall efficiency = 87%

Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}} \times 100\%$

Fluid power = actual flowrate × pressure

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

Fluid power = 5830 watts

Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}} \times 100\%$

$87 = \frac{5830}{\text{Shaft power}} \times 100$

$0.87 = \frac{5830}{\text{Shaft power}}$

Shaft power × 0.87 = 5830

Shaft power = $\frac{5830}{0.87}$ = 6701.15 Watts