ELECT/ELECT

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SINGLE CASH

1 Actual rate = 10 dm^3/min = 0.01 m^3/min
= 1.67×10^{-4} m^3/s
Pressure = 12 bar = 12×10^5 N/m^2
Speed = 1500 rev/min = 25 rev/s
Nominal displacement = 10 cm^3/rev = 1×10^{-5} m^3/rev
Torque = 12.5 Nm
Volumetric efficiency = $\frac{\text{actual flowrate}}{\text{ideal flowrate}} \times 100\%$

Ideal flowrate = displacement × speed
ideal flowrate = $1 \times 10^{-5} \times 25$ = 2.5×10^{-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 × pressure
Fluid power = $1.67 \times 10^{-4} \times 12 \times 10^5$
Fluid power = 200.4 watts
Shaft power = Torque × angular speed
Angular speed = $2 \times \pi \times$ speed
= $2 \times \pi \times 25$ = 157.08 rad
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%

(2) Rate = 35 dm^3/m = 0.035 m^3/min = 5.83×10^{-4} m^3/s
Pressure = 100 bar × 10^5 N/m^2
Overall efficiency = 87%
Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}} \times 100$
Fluid power = actual flow rate × pressure
= $5.83 \times 10^{-4} \times 100 \times 10^5$
Fluid power = 5830 watts

SINGLE CASH

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

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

~~0.87~~ Shaft power = 6701.15 watts

3 Nominal displacement = 50 cm^3/rev = 5×10^{-5} m^3/rev
Pressure = 100 bar = 100×10^5 N/m^2
Shaft power = 15 kW = 15×10^3 W
Actual flowrate = 35 dm^3/min = 0.035 m^3/min =
5.83×10^{-4} m^3/s
Speed = 850 rev/m = 14.17 rev/s
Volumetric efficiency = $\frac{\text{Actual rate}}{\text{ideal flowrate}} \times 100$
~~ideal rate~~ =
Ideal flowrate = 7.085×10^{-4} m^3/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 = 82.29%
~~overall efficiency =~~
Fluid power = actual rate × pressure
= $5.83 \times 10^{-4} \times 100 \times 10^5$
Fluid power = 5830 watts
overall efficiency = $\frac{5830}{15 \times 10^3} \times 100$
= 38.87%

4 Z = 24,000 cm = 240 m
volumetric flow rate = 13 l/s = 0.013 m^3/s
jet velocity = 66 m/s P = 0, Z = 0
power = ~~$\frac{\rho \times Q}{2}$~~ v^2
power = $\frac{1000 \times 0.013 \times (66)^2}{2}$

Power = 28314 watts
Power supplied
P = 0, v = v
P = $\rho g Q_2$

SINGLE CASH

Power = 1000 × 9.81 × 0.013 × 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 = $\frac{2293.2}{1000 \times 9.81 \times 0.013}$
Efficiency = $\frac{\text{Power of jet}}{\text{Power of reservoir}} \times 100$
Efficiency = $\frac{28314}{30607.2} \times 100$
Efficiency = 92.5%

5 Specific gravity of oil = 0.89
Z = 30,000 cm = 300 m
Q = 220 liters = ~~0.022~~ 0.22 m^3/s
Velocity = 7 m/s
(i) Power of jet = $\frac{\rho \times Q \times v^2}{2}$

= 4797.1 watts
(ii) Power supplied from
P = $\rho g Q_2$
P = 576234.4 watts

(iii) Head loss in pipe = $\frac{\text{Power loss in transmission}}{\rho g Q}$

= 571442.3

Efficiency = 0.83%