Olayinka Samuel
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Fluid mechanics
CHM ENG

Flowrate (Q) = 10 dm^3/min
Pressure change (ΔP) = 12 bar
Speed (N) = 1500 rpm
Normal displacement = 10 cm^3/rev
Torque Input (T) = 12.5 Nm

(i) Ideal flow rate = Normal displacement × speed
= 10 cm^3/rev × 1500 rpm
= 15000 cm^3/min = 15 dm^3/min
Volumetric efficiency = Actual flow / ideal flow
= 10/15 = 0.667 / 66.67%

(ii) $Q = \frac{10 \times 10^{-3}}{60} m^3/sec = 16.7 \times 10^{-5} m^3/sec$

$\Delta P = 12 \times 10^5 N/m^2$
Fluid Power = $\Delta P \times Q = 16.7 \times 10^{-05} m^3/sec \times 12 \times 10^5 Nm^2$ =
200 watts
Shaft Power = $\frac{2\pi NT}{60} = \frac{2\pi \times 1500 \times 12.5}{60}$
= 1963.5 watt
= 0.102 or 10.2%

Summary: Here we can see that shaft power almost 10 times of fluid power. Fluid power can be either increase by the change in pressure or discharge

Flowrate (Q) = 35 dm^3/min
Pressure change = 100 bar
Overall Efficiency = 87%
Shaft Power = $\frac{2\pi NT}{60}$

fluid = $\Delta P \times Q$
$Q = \frac{35 \times 10^{-3}}{60}$ m^3/sec
$= 58.3 \times 10^{-5}$ m^3/sec $\Delta P = 100 \times 10^5 N/m^2$
$= 58.3 \times 10^{-5} \times 100 \times 10^5$
$= 5830$ watts
Overall. efficiency = $\frac{\text{fluid power}}{\text{shaft power}}$

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

Shaft Power = $\frac{5830}{0.87}$ = 6701.14 watts

Normmal displacement = 50 cm^3 Cre
Pressure Charge (ΔP) = 100 bar
Sheft power 15 kilowatts = 15000
Overall eff = ??
Volumentric - efficiency = ??
flow rate (Q) ~~efficiency~~ = 35 dm^3/min
Speed (N) = 850 rpm

Ideal flow rate = Nominal displacement × speed
= 50 cm^3/r × 850 rpm
= 42500 cm^3/min = 42.5 dm^3/min

Volumentric efficiency = Actual flow / Real flow

$35/42.5 = 0.8235$ or 82.35%

$Q = \frac{35 \times 10^{-3}}{60} m^3/sec = 58.3 \times 10^{-5} m^3/sec$

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

Fluid power $= AP \times Q = 58.3 \times 10^{-3} m^3/sec \times 100 \times 10^5$

$= 5830$ watts

Shaft power $= \frac{2\pi N T}{60}$ 15000 watts

Overall eff $= \frac{\text{fluid}}{\text{Shaft Power}} = \frac{5830}{15000} = 0.3886$ or 38.86%

$Z_1 = 30000cm = 300m$

$Q_1 = 220$ litres/s $= (220 \times 10^{-3}) m^3/s$

$V_2 = 7m/s$

Power of Jet $\rho g Q H$

where $\rho = 0.89 \times 1000 = 890 kg/m^3$

$g = 9.81 m/s^2$

$Q = (220 \times 10^{-3}) m^3/s$

$H = Z_2 + \frac{P}{\rho g} + \frac{V^2}{2g}$

$H = 0 + \frac{0}{\rho g} + \frac{(7)^2}{2 \times 9.81}$

$H = 49/19.62 = 2.497$

Power $= 810 \times 9.81 \times 220 \times 10^{-3} \times 2.497$

$= 4797.1$ watts

Power Supplied from reservoir

$H = Z_1 + \frac{P}{\rho g} + \frac{V^2}{2g} = 300 + \frac{Q}{\rho g} + \frac{Q}{2g}$

$= 300$

35%
see

×10⁵

86%

Power = 820 × 9.81 × 220 × 10^{-3} × 300
= 576239.4 kg m/sec

(iii) Head used to overcome the loss
= power loss / $\rho g Q$
= (576239.4 − 4797.1) / 100 × 9.81 × 220 × 10^{-3}
= 571442.3 / 2158.2
= 264.7772681

(iv) Efficiency = $\frac{\text{Power of Jet}}{\text{Power of reservoir}}$ × 100
= $\frac{4797.1}{576239.4}$ × 100
= 0.8324838 6%

Power = $\frac{\text{workdone}}{\text{Time}}$
= workdone = $\frac{mgh}{time}$

v = velocity of stream
ρ = density of water (1000 kg/m³))
m = ρ . × v
v = $\sqrt{2gh}$ = $\sqrt{2 \times 9.8 \times 20}$
= 19.7989 m/s

P = $\pi r^2 v g h$

Power = $\frac{1000 kg}{m^3}$ π $\left(\frac{10 \times 10^{-2}}{2}\right)$ × 19.7989 m/s × 9.8 m/s² × 20 m

= 1000 × π × 2.5 × 10^{-3} × 19.7989 × 9.8 × 20
= 30478.03 w
Power = 30478.03 w

Diameter $(D_1) = 0.3m$

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

$A_1 = 0.070685 m^2$

Throat diameter $(D_2) = 0.2m$

$A_2 = \frac{\pi}{4} \times (0.2)^2$

$A_2 = 0.031416 m^2$, coefficient of discharge $(C_d) = 0.96$

Specific weight of gas $(\gamma) = 19.62 \ N/m^3$

density of gas $(S_g) = \frac{19.62}{9.81}$

$S_g = 2 kg/m^3$

Piezometric head diff $(h) = x\left(\frac{S_m}{S_g} - 1\right)$

$= 0.06 \times \left(\frac{100}{2} - 1\right)$

$h = 2.94m$

Volume flow rate $(Q) = C_d \frac{A_1 \cdot A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$= \frac{0.96 \times 0.070685 \times 0.031416 \sqrt{2 \times 9.81 \times 2.94}}{\sqrt{(0.070685)^2 - (0.031416)^2}}$

$Q = 0.81599 \ m^3/s$