Induction Motor Power Flow, Rotor Loss and Torque

Air-gap power, rotor copper loss, mechanical power, output, efficiency and torque of an induction motor from stator input, losses and slip.

Method: Induction machine power flow P_g : P_cu : P_m = 1 : s : (1 − s) (textbook)

Input parameters

Unit system: SI

Parameter	Value	Unit
Stator input power	50.000	kW
Stator losses (copper and iron)	2.0000	kW
Slip	3.0000	%
Friction and windage loss	0.50000	kW
Synchronous speed	1,500.0	rpm

Calculated results

Parameter	Value	Unit
Air-gap (rotor input) power	48.000	kW
Rotor copper loss s P_g	1.4400	kW
Mechanical power developed (1 − s) P_g	46.560	kW
Shaft output	46.060	kW
Efficiency	92.120	%
Torque developed P_g / ω_s	305.58	N·m
Shaft torque	302.30	N·m

Formula and method

$$P_g = P_{in} - P_s, \quad P_{cu,r} = sP_g, \quad P_m = (1-s)P_g$$

$$T_d = \frac{P_g}{2\pi N_s}, \quad \eta = \frac{P_m - P_{fw}}{P_{in}}$$

Variables

P_{in}	Stator input power	W
P_s	Stator losses (copper and iron)	W
S	Slip	-
P_{fw}	Friction and windage loss	W
N_s	Synchronous speed	1/s
P_g	Air-gap (rotor input) power	W
$P_{cu,r}$	Rotor copper loss s P_g	W
P_m	Mechanical power developed (1 − s) P_g	W
P_{out}	Shaft output	W
η	Efficiency	-
T_d	Torque developed P_g / ω_s	N·m
T_{sh}	Shaft torque	N·m

Method and standards

Power stages of the induction motor.

Assumptions and limits

- Steady running.
- There is no separate stray-load-loss input (IEC 60034-2-1): add stray load losses to the stator losses P_s (or to P_fw) so they are counted.

References

- Induction machine power flow P_g : P_cu : P_m = 1 : s : (1 − s) (textbook)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/motors/induction-motor-power-flow

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Reopens the calculator with the inputs of this report.