Motor Starting (Acceleration) Time

Time for a motor to run a load up to speed from the total moment of inertia and the average motor and load torques, with the stored kinetic energy.

Method: Newton's second law for rotation; J dω/dt = T_m − T_l

Input parameters

Unit system: SI

Parameter	Value	Unit
Total moment of inertia at the motor shaft	12.000	kg·m²
Final speed	1,480.0	rpm
Average motor torque during the start	700.00	N·m
Average load torque during the start	250.00	N·m

Calculated results

Parameter	Value	Unit
Average accelerating torque	450.00	N·m
Starting time	4.1329	s
Kinetic energy at full speed	144.12	kJ

Notes for this case

- Refer load inertia to the motor shaft by the square of the speed ratio. A long start heats the motor: compare with the maker's permitted starting time.

Formula and method

$$t_s = \frac{J\omega}{T_m - T_l}, \quad \omega = 2\pi N, \quad E_k = \frac{1}{2} J\omega^2$$

Variables

J	Total moment of inertia at the motor shaft	kg·m²
N	Final speed	1/s
T_m	Average motor torque during the start	N·m
T_l	Average load torque during the start	N·m
T_a	Average accelerating torque	N·m
t_s	Starting time	s
E_k	Kinetic energy at full speed	J

Method and standards

Constant average accelerating torque.

Assumptions and limits

- Average torques; no voltage dip. The average-torque method can be unconservative when the load curve approaches the motor curve near pull-up (fans): integrate over the torque–speed curves step by step in that case.

References

- Newton's second law for rotation
- J dω/dt = T_m − T_l

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/motor-starting-time

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Reopens the calculator with the inputs of this report.