Gear Train Ratio, Output Speed and Torque

Overall ratio of a gearbox with up to three reduction stages, the output speed, input and output torque and output power with the efficiency per stage.

Method: Gear train kinematics

Input parameters

Unit system: SI

Parameter	Value	Unit
Input speed	1,450.0	rpm
Input power	15.000	kW
Number of stages	2	
Ratio of stage 1 (driven teeth ÷ driving teeth)	4.0000	
Ratio of stage 2	3.5000	
Ratio of stage 3	1.0000	
Efficiency per stage	98.000	%

Calculated results

Parameter	Value	Unit
Overall ratio	14.000	
Output speed	103.57	rpm
Input torque	98.786	N·m
Output torque	1,328.2	N·m
Output power	14.406	kW
Overall efficiency	96.040	%

Formula and method

$$i = \prod_{k=1}^{N} i_k \quad \text{(only the first } N \text{ stages are used)}$$

$$n_2 = n_1 / i, \quad \eta = \eta_s^N$$

$$T_1 = \frac{P_1}{2\pi n_1}, \quad T_2 = \frac{P_1 \eta}{2\pi n_2}, \quad P_2 = P_1 \eta$$

Variables

n_1	input speed	rev/s
P_1	input power	W
N	number of stages	-
i_1	ratio of stage 1	-
i_2	ratio of stage 2	-
i_3	ratio of stage 3	-
η_s	efficiency per stage	-
i	overall ratio	-
n_2	output speed	rev/s
T_1	input torque	N·m

T_2	output torque	N·m
P_2	output power	W
η	overall efficiency	-

Method and standards

Stage ratios multiply; the overall efficiency is the stage efficiency raised to the number of stages. Output torque follows from output power over output angular speed.

Assumptions and limits

- Steady running; service factor and thermal rating are for the gearbox maker's selection.

References

- Gear train kinematics

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/mechanical/machine-design/gear-train-ratio

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.