Wind Rotor Speed, Tip Speed Ratio, Gearbox Ratio and Torque

Rotor speed and blade tip speed from the tip speed ratio, the gearbox ratio for a given generator speed, and the low-speed shaft torque at a given power.

Method: Rotor kinematics and shaft torque

Input parameters

Unit system: SI

Parameter	Value	Unit
Rotor diameter	120.00	m
Wind speed	9.0000	m/s
Tip speed ratio ΩR/U	8.0000	
Generator speed	1,500.0	rpm
Rotor (shaft) power	3.5000	MW

Calculated results

Parameter	Value	Unit
Rotor speed	11.459	rpm
Blade tip speed	72.000	m/s
Gearbox ratio n_g/n	130.90	
Low-speed shaft torque	2,916.7	kN·m
Once-per-revolution frequency	0.19099	Hz

Notes for this case

- λ = ΩR/U. Modern three-bladed rotors run at λ ≈ 7–9; tip speeds are kept below about 80–90 m/s for noise and erosion.

Formula and method

$$\Omega = \frac{\lambda U}{R}, \quad V_{tip} = \lambda U, \quad i = \frac{n_g}{n}, \quad Q = \frac{P}{\Omega}$$

Variables

D	Rotor diameter	m
U	Wind speed	m/s
λ	Tip speed ratio ΩR/U	-
n_g	Generator speed	rad/s
P	Rotor (shaft) power	W
n	Rotor speed	rad/s
V_{tip}	Blade tip speed	m/s
i	Gearbox ratio n_g/n	-
Q	Low-speed shaft torque	N·m
f_{1P}	Once-per-revolution frequency	1/s

Method and standards

Rotor kinematics.

Assumptions and limits

- Steady operation.

References

Rotor kinematics and shaft torque

Report details

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Calculator	Wind Rotor Speed, Tip Speed Ratio, Gearbox Ratio and Torque
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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/environmental/wind-power/wind-rotor-tip-speed-ratio

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.