Wind Rotor Torque Coefficient and Shaft Torque

Torque coefficient, shaft torque and power of a wind rotor from its power coefficient and tip speed ratio, showing why slow rotors give high torque.

Method: Rotor torque and power coefficients

Input parameters

Unit system: SI

Parameter	Value	Unit
Power coefficient	0.45000	
Tip speed ratio	8.0000	
Rotor diameter	120.00	m
Wind speed	9.0000	m/s
Air density	1.2250	kg/m³

Calculated results

Parameter	Value	Unit
Torque coefficient C_P/λ	0.056250	
Rotor torque	1,893.7	kN·m
Rotor power	2.2725	MW
Rotor speed	11.459	rpm

Notes for this case

• C_Q = Q/(½ρAU²R) = C_P/λ. Slow multi-blade rotors (λ ≈ 1) have high C_Q and starting torque for pumps; fast rotors have low C_Q and need a gearbox or large generator.

Formula and method

$$C_Q = \frac{C_P}{\lambda}, \quad Q = \frac{1}{2}\rho\pi R^3 U^2 C_Q$$

Variables

C_P	Power coefficient	-
λ	Tip speed ratio	-
D	Rotor diameter	m
U	Wind speed	m/s
ρ	Air density	kg/m³
C_Q	Torque coefficient C_P/λ	-
Q	Rotor torque	N·m
P	Rotor power	W
n	Rotor speed	rad/s

Method and standards

Rotor torque.

Assumptions and limits

- Steady flow.

References

Rotor torque and power coefficients

Report details

Report reference	FCC-CBY0-VR3D (the same inputs always give the same reference)
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Calculator	Wind Rotor Torque Coefficient and Shaft 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-torque-coefficient

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.