Actuator Disc: Induction, Power and Thrust Coefficients

One-dimensional momentum theory of a wind turbine rotor: axial induction, power and thrust coefficients, disc and wake speeds, power, thrust and tower base moment.

Method: One-dimensional momentum (actuator disc) theory

Input parameters

Unit system: SI

Parameter	Value	Unit
Given	Axial induction factor a	
Axial induction factor (Betz optimum 1/3)	0.30000	
Thrust coefficient	0.84000	
Rotor diameter	120.00	m
Free-stream wind speed	9.0000	m/s
Air density	1.2250	kg/m³
Hub height (for tower base moment)	100.00	m

Calculated results

Parameter	Value	Unit
Axial induction factor	0.30000	
Power coefficient 4a(1 − a)²	0.58800	
Thrust coefficient 4a(1 − a)	0.84000	
Speed at the disc	6.3000	m/s
Far-wake speed	3.6000	m/s
Power extracted	2.9694	MW
Rotor thrust	471.33	kN
Tower base overturning moment from thrust	47,133	kN·m

Notes for this case

- Ideal actuator disc (no rotation, drag or tip losses): C_P,max = 16/27 at a = 1/3. Real rotors reach C_P of about 0.45–0.50.

Formula and method

$$C_P = 4a(1-a)^2, \quad C_T = 4a(1-a), \quad a = \frac{1-\sqrt{1-C_T}}{2}, \quad T = \frac{1}{2}\rho A U^2 C_T$$

Variables

given	Given	-
a	Axial induction factor (Betz optimum 1/3)	-
C_T	Thrust coefficient	-
D	Rotor diameter	m
U	Free-stream wind speed	m/s
ρ	Air density	kg/m³
H	Hub height (for tower base moment)	m
C_P	Power coefficient 4a(1 − a)²	-
U_d	Speed at the disc	m/s
U_w	Far-wake speed	m/s

P	Power extracted	W
T	Rotor thrust	N
M	Tower base overturning moment from thrust	N·m

Method and standards

Actuator disc momentum theory.

Assumptions and limits

- Steady, uniform, inviscid flow through an ideal disc.

References

One-dimensional momentum (actuator disc) theory

Report details

Report reference	FCC-DRTQ-2Z69 (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Actuator Disc: Induction, Power and Thrust Coefficients
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/actuator-disc-momentum-thrust

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.