Axial Fan Velocity Triangles and Blade Angles

Axial velocity, blade speed, required swirl and the inlet and outlet relative flow angles at the mean radius of an axial fan, with the de Haller ratio.

Method: Euler turbomachine equation for axial fans

Input parameters

Unit system: SI

Parameter	Value	Unit
Tip diameter	1.2000	m
Hub diameter	0.50000	m
Speed	1,480.0	rpm
Volume flow	54,000	m³/h
Total pressure rise	61.183	mmWC
Gas density	1.2000	kg/m³
Hydraulic efficiency	85.000	%

Calculated results

Parameter	Value	Unit
Axial velocity	16.049	m/s
Blade speed at mean radius	71.234	m/s
Swirl added	8.2578	m/s
Inlet relative flow angle (from the plane of rotation)	12.697	°
Outlet relative flow angle	14.297	°
de Haller ratio (keep above about 0.7)	0.89002	

Notes for this case

• Euler: Δp_t = η_hρuΔc_u at the root-mean-square radius, no inlet swirl. β measured from the plane of rotation; the blade turns the flow from β_1 to β_2. A de Haller ratio below about 0.7 means too much diffusion: separation and stall.

Formula and method

$$\Delta p_t = \eta_h \rho u \Delta c_u, \quad \tan\beta_1 = \frac{c_a}{u}, \quad \tan\beta_2 = \frac{c_a}{u - \Delta c_u}$$

Variables

D_t	Tip diameter	m
D_h	Hub diameter	m
n	Speed	rad/s
Q	Volume flow	m³/s
Δp_t	Total pressure rise	Pa
ρ	Gas density	kg/m³
η_h	Hydraulic efficiency	-
c_a	Axial velocity	m/s
u_m	Blade speed at mean radius	m/s
Δc_u	Swirl added	m/s
β_1	Inlet relative flow angle (from the plane of rotation)	rad

β_2	Outlet relative flow angle	rad
w_2/w_1	de Haller ratio (keep above about 0.7)	-

Method and standards

Axial fan triangles.

Assumptions and limits

- No inlet swirl; mean-radius design.

References

Euler turbomachine equation for axial fans

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/mechanical/fans/axial-fan-velocity-triangles

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.