Centrifugal Fan Euler Pressure with Stodola Slip

Theoretical and actual pressure rise of a centrifugal fan impeller from its outlet diameter, width, blade angle and number, speed and flow, including Stodola slip.

Method: Euler equation with Stodola slip

Input parameters

Unit system: SI

Parameter	Value	Unit
Impeller outlet diameter	0.90000	m
Outlet width	0.15000	m
Outlet blade angle from the tangent (90° radial)	40.000	°
Number of blades	12.000	
Speed	1,480.0	rpm
Volume flow	21,600	m³/h
Gas density	1.2000	kg/m³
Hydraulic efficiency	85.000	%

Calculated results

Parameter	Value	Unit
Tip speed	69.743	m/s
Meridional (radial) velocity at outlet	14.147	m/s
Slip factor	0.83172	
Absolute swirl velocity with slip	41.147	m/s
Euler pressure with slip	351.16	mmWC
Estimated total pressure rise	298.48	mmWC
Pressure coefficient Δp/(ρu₂²)	0.50148	

Notes for this case

• Euler: Δp = ρu₂c_u2 with no inlet swirl; c_u2 = u₂ − c_m2 cot β₂ − Δc_slip, Stodola slip Δc = πu₂ sin β₂/z. Backward-curved blades (β₂ < 90°) give rising-then-falling curves and high efficiency; forward-curved (β₂ > 90°) give high pressure from small, slow wheels.

Formula and method

$$\Delta p_{th} = \rho u_2 c_{u2}, \quad c_{u2} = u_2 - c_{m2}\cot\beta_2 - \frac{\pi u_2 \sin\beta_2}{z}$$

Variables

D_2	Impeller outlet diameter	m
b_2	Outlet width	m
β_2	Outlet blade angle from the tangent (90° radial)	rad
z	Number of blades	-
n	Speed	rad/s
Q	Volume flow	m³/s
ρ	Gas density	kg/m³
η_h	Hydraulic efficiency	-
u_2	Tip speed	m/s

c_{m2}	Meridional (radial) velocity at outlet	m/s
σ	Slip factor	-
c_{u2}	Absolute swirl velocity with slip	m/s
Δp_{th}	Euler pressure with slip	Pa
Δp	Estimated total pressure rise	Pa
ψ	Pressure coefficient Δp/(ρu₂²)	-

Method and standards

Centrifugal impeller pressure.

Assumptions and limits

- No inlet swirl; uniform outlet flow.

References

Euler equation with Stodola slip

Report details

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This calculator online

https://calc.firecad.com/mechanical/fans/centrifugal-fan-euler-pressure

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Reopens the calculator with the inputs of this report.