Fan Compressibility Factor and Air Power

Compressibility factor relating isentropic to incompressible fan work for a pressure rise and inlet pressure, with air power and outlet-to-inlet volume ratio.

Method: Isentropic work ratio for fans

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet pressure (absolute)	101.33	kPa
Fan total pressure rise	1,019.7	mmWC
Isentropic exponent	1.4000	
Inlet volume flow	72,000	m³/h

Calculated results

Parameter	Value	Unit
Compressibility factor	0.96662	
Air power Q₁ΔpK_p	193.32	kW
Incompressible air power	200.00	kW
Outlet-to-inlet volume ratio (isentropic)	0.93498	

Notes for this case

• K_p = [κ/(κ − 1)][(1 + x)^((κ−1)/κ) − 1]/x with x = Δp/p₁: the ratio of isentropic to incompressible work. It matters above a few kPa (K_p ≈ 0.98 at 10 kPa) and is used in fan testing standards in a polytropic form.

Formula and method

$$K_p = \frac{\kappa}{\kappa - 1}\frac{(1+x)^{(\kappa-1)/\kappa} - 1}{x}, \quad x = \frac{\Delta p}{p_1}$$

Variables

p_1	Inlet pressure (absolute)	Pa
Δp	Fan total pressure rise	Pa
κ	Isentropic exponent	-
Q_1	Inlet volume flow	m³/s
K_p	Compressibility factor	-
P_u	Air power Q₁ΔpK_p	W
$Q_1 \Delta p$	Incompressible air power	W
Q_2/Q_1	Outlet-to-inlet volume ratio (isentropic)	-

Method and standards

Fan compressibility.

Assumptions and limits

- Ideal gas; isentropic reference.

References

Isentropic work ratio for fans

Report details

Report reference	FCC-CKE4-C3ZW (the same inputs always give the same reference)
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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/mechanical/fans/fan-compressibility-factor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.