Turbine Flow at Changed Pressures (Stodola Ellipse Law)

Steam flow a turbine stage group passes at new inlet and outlet pressures and inlet temperature, from a design point, by Stodola's ellipse law (IF97).

Method: Stodola's ellipse (cone) law ṁ ∝ √((p_in² − p_out²)/(p_in v_in)); specific volumes from IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Design flow	100.00	t/h
Design inlet pressure (absolute)	87.000	bar
Design inlet temperature	515.00	°C
Design outlet pressure (absolute)	2.5000	bar
New inlet pressure (absolute)	80.000	bar
New inlet temperature	510.00	°C
New outlet pressure (absolute)	2.5000	bar

Calculated results

Parameter	Value	Unit
Flow at the new conditions	92.055	t/h
Flow ratio	92.055	%

Notes for this case

- Applies to a group of stages without control-valve throttling between the pressures used; nozzle-governed first stages need the valve points.

Formula and method

$$\frac{\dot{m}}{\dot{m}_0} = \sqrt{\frac{p_{in}^2 - p_{out}^2}{p_{in,0}^2 - p_{out,0}^2}} \sqrt{\frac{p_{in,0} v_{in,0}}{p_{in} v_{in}}}$$

Variables

$\dot{m}_0$	Design flow	kg/s
$p_{in,0}$	Design inlet pressure (absolute)	Pa
$T_{in,0}$	Design inlet temperature	K
$p_{out,0}$	Design outlet pressure (absolute)	Pa
p_{in}	New inlet pressure (absolute)	Pa
T_{in}	New inlet temperature	K
p_{out}	New outlet pressure (absolute)	Pa
$\dot{m}$	Flow at the new conditions	kg/s
$\dot{m}/\dot{m}_0$	Flow ratio	-

Method and standards

Stodola's ellipse (cone) law for a group of turbine stages: with fixed geometry the flow is proportional to √((p_in² − p_out²)/(p_in v_in)), so the flow at new conditions follows from a known design point. Inlet specific volumes from FireCAD's IAPWS-IF97.

Assumptions and limits

- Fixed stage geometry.
- Both inlet states must be superheated (or supercritical) steam; a liquid inlet state is rejected.

References

Stodola's ellipse (cone) law ṁ ∝ √((p_in² − p_out²)/(p_in v_in)); specific volumes from IAPWS-IF97

Report details

Report reference	FCC-10AV-H6ND (the same inputs always give the same reference)
Generated	23 November 2026, 17:43 UTC
Calculator	Turbine Flow at Changed Pressures (Stodola Ellipse Law)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	2 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/boilers-power-plant/steam-turbines/stodola-ellipse-law

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.