Multistage Turbine: Stage Efficiency and Reheat Factor

Overall internal efficiency and reheat factor of a multistage steam turbine with equal stage pressure ratios and stage efficiency (IF97 expansion).

Method: Stage-by-stage expansion with IAPWS-IF97; reheat factor RF = Σ Δh_s; stage / Δh_s; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet pressure (absolute)	40.000	bar
Inlet temperature	400.00	°C
Exhaust pressure (absolute)	2.0000	bar
Number of stages	8.0000	
Stage efficiency	75.000	%

Calculated results

Parameter	Value	Unit
Sum of stage isentropic drops	683.83	kJ/kg
Overall isentropic drop	648.04	kJ/kg
Reheat factor	1.0552	
Overall internal efficiency η_s × RF	79.142	%
Exhaust enthalpy	2,701.5	kJ/kg

Notes for this case

- The losses of each stage reheat the steam, so later stages have more isentropic drop available: RF > 1.

Formula and method

$$RF = \frac{\sum \Delta h_{s,i}}{\Delta h_{s,overall}}, \quad \eta_o = \eta_s \cdot RF$$

Variables

p_1	Inlet pressure (absolute)	Pa
T_1	Inlet temperature	K
p_2	Exhaust pressure (absolute)	Pa
n	Number of stages	-
η_s	Stage efficiency	-
$\Sigma\Delta h_{s,i}$	Sum of stage isentropic drops	J/kg
Δh_s	Overall isentropic drop	J/kg
RF	Reheat factor	-
η_o	Overall internal efficiency η_s × RF	-
h_2	Exhaust enthalpy	J/kg

Method and standards

The expansion is split into n stages with equal pressure ratios; each stage expands at the stage efficiency from the actual state left by the previous stage. The reheat factor is the sum of the stage isentropic drops over the overall isentropic drop, the classical definition in steam turbine texts. States from FireCAD's IAPWS-IF97.

Assumptions and limits

- Equal stage pressure ratios and efficiencies.

- Wet exhaust (dryness below about 88 %) is flagged.
- The inlet must be superheated or supercritical steam; a liquid inlet is rejected.

References

• Stage-by-stage expansion with IAPWS-IF97; reheat factor RF = Σ Δh_s
• stage / Δh_s
• overall (steam turbine texts)

Report details

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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/turbines-cycles/turbine-stage-reheat-factor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.