Steam Turbine Isentropic Efficiency

Isentropic (internal) efficiency of a steam turbine from measured inlet and exhaust pressures and temperatures, with the actual and isentropic enthalpy drops (IAPWS-IF97).

Method: ASME PTC 6 (enthalpy-drop efficiency concept)

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet steam pressure (absolute)	45.000	bar
Inlet steam condition	Superheated at the temperature below	
Inlet steam temperature (superheated only)	400.00	°C
Exhaust pressure (absolute)	400.00	kPa
Measured exhaust temperature (superheated exhaust)	200.00	°C

Calculated results

Parameter	Value	Unit
Isentropic efficiency	63.099	%
Actual enthalpy drop	344.57	kJ/kg
Isentropic enthalpy drop	546.07	kJ/kg
Exhaust enthalpy	2,861.0	kJ/kg
Isentropic exhaust enthalpy	2,659.5	kJ/kg

Formula and method

$$\eta_i = \frac{h_1 - h_2}{h_1 - h_{2s}} \qquad h_{2s} = h(p_2, s_1) \qquad h_2 = h(p_2, T_2)$$

Variables

p_1	inlet pressure, absolute	Pa
state	dry saturated or superheated inlet	–
T_1	inlet temperature (superheated)	K
p_2	exhaust pressure, absolute	Pa
T_2	measured exhaust temperature	K
η_i	isentropic efficiency	–
$h_1 - h_2$	actual enthalpy drop	J/kg
$h_1 - h_{2s}$	isentropic enthalpy drop	J/kg
h_2	exhaust enthalpy	J/kg
h_{2s}	isentropic exhaust enthalpy	J/kg
s_1	inlet entropy	J/(kg·K)

Method and standards

Isentropic efficiency as the ratio of actual to isentropic enthalpy drop, the enthalpy-drop method used in turbine performance testing (ASME PTC 6 uses the same idea for its sections). Enthalpies and entropies from FireCAD's IAPWS-IF97.

Assumptions and limits

- Exhaust superheated (vapour) for a measured temperature to fix its state; supercritical exhaust is not accepted (not reached at exhaust pressures in practice); steady flow; heat loss from the casing neglected.

- An efficiency outside 0–100 % is rejected as a reading error.

References

ASME PTC 6 (enthalpy-drop efficiency concept)

Report details

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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/boilers-power-plant/steam-turbines/turbine-isentropic-efficiency

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Reopens the calculator with the inputs of this report.