Power per Tonne of Steam for Two Inlet Conditions

Turbine shaft work per tonne of steam for two inlet pressure–temperature pairs to the same exhaust pressure (IF97), and the gain from the higher conditions.

Method: Isentropic expansion with efficiency; IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet pressure A (absolute)	46.000	bar
Inlet temperature A	440.00	°C
Inlet pressure B (absolute)	111.00	bar
Inlet temperature B	540.00	°C
Exhaust pressure (absolute)	2.5000	bar
Isentropic efficiency	80.000	%

Calculated results

Parameter	Value	Unit
Shaft work per tonne, A	149.06	kWh/t
Shaft work per tonne, B	200.56	kWh/t
Gain of B over A	34.551	%

Notes for this case

- Higher inlet conditions also need more heat per tonne of steam; compare power per unit of fuel for the full picture.
- Shaft work: multiply by the gearbox and generator efficiencies for electrical output.

Formula and method

$$w = \eta_s [h(p_1, T_1) - h(p_e, s_1)]$$

Variables

p_A	Inlet pressure A (absolute)	Pa
T_A	Inlet temperature A	K
p_B	Inlet pressure B (absolute)	Pa
T_B	Inlet temperature B	K
p_e	Exhaust pressure (absolute)	Pa
η_s	Isentropic efficiency	-
w_A	Shaft work per tonne, A	J/kg
w_B	Shaft work per tonne, B	J/kg
$w_B/w_A - 1$	Gain of B over A	-

Method and standards

IF97 expansion.

Assumptions and limits

- Same efficiency.
- The work is turbine shaft work; gearbox and generator losses are not included.
- Wet exhaust (dryness below about 88 %) is flagged for each inlet.
- Each inlet must be superheated (or supercritical) steam; an inlet temperature at or below the saturation temperature is rejected.

References

- Isentropic expansion with efficiency; IAPWS-IF97

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/steam-inlet-conditions-power

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.