Rankine Cycle Efficiency Calculator

Thermal efficiency, net work, back work ratio and specific steam consumption of a simple Rankine steam cycle with turbine and pump efficiencies (IAPWS-IF97).

Method: IAPWS R7-97(2012) IF97; first and second laws of thermodynamics

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet steam pressure (absolute)	66.000	bar
Inlet steam condition	Superheated at the temperature below	
Inlet steam temperature (superheated only)	485.00	°C
Condenser pressure (absolute)	10.000	kPa
Turbine isentropic efficiency	85.000	%
Feed pump isentropic efficiency	75.000	%

Calculated results

Parameter	Value	Unit
Cycle thermal efficiency	32.638	%
Net work per kg of steam	1,037.6	kJ/kg
Specific steam consumption (per kWh of net shaft work)	3.4696	kg/kWh
Turbine exhaust dryness (state 2)	89.523	%
Turbine work	1,046.5	kJ/kg
Pump work	8.8644	kJ/kg
Heat added in the boiler	3,179.1	kJ/kg
Back work ratio	0.84709	%

Formula and method

$$w_t = h_1 - h_2, \quad h_2 = h_1 - \eta_t \left[h_1 - h(p_2, s_1)\right] \qquad w_p = \frac{h(p_1, s_3) - h_3}{\eta_p}$$

$$q_{in} = h_1 - (h_3 + w_p) \qquad w_{net} = w_t - w_p \qquad \eta_{th} = \frac{w_{net}}{q_{in}} \qquad BWR = \frac{w_p}{w_t} \qquad SSC = \frac{1}{w_{net}}$$

Variables

p_1	boiler (turbine inlet) pressure, absolute	Pa
state	dry saturated or superheated steam	–
T_1	turbine inlet temperature	K
p_2	condenser pressure, absolute	Pa
η_t	turbine isentropic efficiency	–
η_p	pump isentropic efficiency	–
η_{th}	cycle thermal efficiency	–
w_{net}	net work per kg	J/kg
SSC	specific steam consumption, per unit of net shaft work (before generator losses)	kg/J
x_2	turbine exhaust dryness (state 2)	–

w_t	turbine work	J/kg
w_p	pump work	J/kg
q_{in}	heat added in the boiler	J/kg
BWR	back work ratio	–
$h_1\$, \$h_2$	turbine inlet and exhaust enthalpy	J/kg
$h_3\$, \$s_3$	saturated liquid enthalpy and entropy at the condenser	J/kg, J/(kg·K)
s_1	turbine inlet entropy	J/(kg·K)

Method and standards

Ideal Rankine cycle with isentropic efficiencies on the turbine and the pump; all states (including the compressed liquid after the pump) by FireCAD's IAPWS-IF97. Pressure drops and heat losses in pipes are neglected.

Assumptions and limits

- No reheat or feed heating; saturated liquid leaving the condenser; no pressure drops.
- States: 1 turbine inlet, 2 turbine exhaust, 3 condenser outlet (saturated liquid), then the pump outlet.
- SSC is per kWh of net shaft work; divide by the generator efficiency for steam per kWh of electricity.

References

• IAPWS R7-97(2012) IF97
• first and second laws of thermodynamics

Report details

Report reference	FCC-RKRK-4M7N (the same inputs always give the same reference)
Generated	17 November 2026, 19:50 UTC
Calculator	Rankine Cycle Efficiency Calculator
Method last reviewed	11 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/turbines-cycles/rankine-cycle-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.