Reheat Rankine Cycle Efficiency Calculator

Thermal efficiency, net work and exhaust dryness of a Rankine cycle with one reheat, from main and reheat steam conditions and the condenser pressure (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)	150.00	bar
Main steam temperature	535.00	°C
Reheat pressure (absolute)	35.000	bar
Reheat temperature	535.00	°C
Condenser pressure (absolute)	10.000	kPa
Turbine isentropic efficiency (each section)	88.000	%
Feed pump isentropic efficiency	80.000	%

Calculated results

Parameter	Value	Unit
Cycle thermal efficiency	38.813	%
Net work per kg of steam	1,431.1	kJ/kg
Specific steam consumption	2.5155	kg/kWh
Turbine exhaust dryness	94.314	%
Heat added (boiler and reheater)	3,687.2	kJ/kg
Back work ratio	1.3014	%

Formula and method

$$h_2 = h_1 - \eta_t\,[h_1 - h(p_{rh}, s_1)] \qquad h_4 = h_3 - \eta_t\,[h_3 - h(p_2, s_3)]\,,\ h_3 = h(p_{rh}, T_{rh})$$

$$w_{net} = (h_1 - h_2) + (h_3 - h_4) - w_p \qquad q_{in} = (h_1 - h_6) + (h_3 - h_2) \qquad \eta_{th} = \frac{w_{net}}{q_{in}}$$

Variables

p_1	main steam pressure, absolute	Pa
T_1	main steam temperature	K
p_{rh}	reheat pressure, absolute	Pa
T_{rh}	reheat temperature	K
p_2	condenser pressure, absolute	Pa
η_t	turbine isentropic efficiency, each section	–
η_p	pump isentropic efficiency	–
η_{th}	cycle thermal efficiency	–
w_{net}	net work per kg	J/kg
SSC	specific steam consumption	kg/J
x_4	turbine exhaust dryness	–
q_{in}	heat added in boiler and reheater	J/kg
BWR	back work ratio	–
w_p	pump work	J/kg

$h_1\$, \$h_2\$, \$h_3\$, \$h_4$	main steam, HP exhaust, reheat outlet, LP exhaust enthalpies	J/kg
h_6	feedwater enthalpy after the pump	J/kg
$s_1\$, \$s_3$	entropy at main steam and reheat outlet	J/(kg·K)

Method and standards

Rankine cycle with one reheat; isentropic efficiencies on both turbine sections and the pump; states by FireCAD's IAPWS-IF97. Reheater pressure drop neglected.

Assumptions and limits

- One reheat, no feed heating, no pressure drops; saturated liquid from the condenser.
- Main steam must be superheated: unlike the simple and regenerative cycle pages there is no dry-saturated option.
- The reheat outlet enthalpy must be at least the HP exhaust enthalpy; a negative reheater duty is rejected.

References

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

Report details

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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/reheat-cycle-efficiency

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Reopens the calculator with the inputs of this report.