Solar Concentrator Stagnation and Optimum Receiver Temperature

Stagnation temperature of a solar receiver at a concentration ratio and the operating temperature that maximises receiver-plus-Carnot efficiency.

Method: Receiver radiation balance with Carnot conversion

Input parameters

Unit system: SI

Parameter	Value	Unit
Concentration ratio	1,000.0	
Direct normal irradiance	0.90000	kW/m²
Receiver absorptance	95.000	%
Receiver emittance	85.000	%
Optical efficiency of the concentrator	80.000	%
Ambient (sink) temperature	25.000	°C

Calculated results

Parameter	Value	Unit
Stagnation temperature (radiation losses only)	1,668.0	°C
Receiver temperature for maximum system efficiency	787.32	°C
Receiver efficiency at T_opt	72.915	%
Receiver × Carnot efficiency at T_opt	52.415	%

Notes for this case

• Receiver: η_r = η_o[1 − εσ(T⁴ − T₀⁴)/(η_oαCG)]; stagnation where η_r = 0. The product with the Carnot factor 1 − T₀/T peaks at T_opt (golden-section search). Convection is neglected, so real optima are lower; the ideal cannot exceed the sun's 5,800 K.

Formula and method

$$\eta_r = \eta_o\left[1 - \frac{\varepsilon\sigma(T^4 - T_0^4)}{\eta_o \alpha C G}\right], \quad \eta_{sys} = \eta_r\left(1 - \frac{T_0}{T}\right)$$

Variables

C	Concentration ratio	-
G	Direct normal irradiance	W/m²
α	Receiver absorptance	-
ε	Receiver emittance	-
η_o	Optical efficiency of the concentrator	-
T_0	Ambient (sink) temperature	K
T_{stag}	Stagnation temperature (radiation losses only)	K
T_{opt}	Receiver temperature for maximum system efficiency	K
η_r	Receiver efficiency at T_opt	-
η_{sys}	Receiver × Carnot efficiency at T_opt	-

Method and standards

Concentrator thermodynamics.

Assumptions and limits

- Radiation losses only; ideal heat engine.

References

Receiver radiation balance with Carnot conversion

Report details

Report reference	FCC-R8JQ-EQSD (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Solar Concentrator Stagnation and Optimum Receiver Temperature
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 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/environmental/solar-thermal/solar-concentrator-receiver-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.