Solar Collector Stagnation (No-Flow) Temperature

Plate temperature a flat-plate collector reaches with no flow, from absorbed radiation and Klein's top loss coefficient solved together with the plate temperature.

Method: Stagnation energy balance with Klein's top-loss equation

Input parameters

Unit system: SI

Parameter	Value	Unit
Radiation on the collector	1,050.0	W/m²
Transmittance–absorptance product	80.000	%
Number of glass covers	1.0000	
Plate emittance (selective 0.1, black paint 0.95)	12.000	%
Glass emittance	88.000	%
Collector slope	40.000	°
Ambient temperature	35.000	°C
Wind heat transfer coefficient	8.0000	W/(m²·K)
Back insulation conductivity	0.040000	W/(m·K)
Back insulation thickness	50.000	mm
Edge loss coefficient	0.30000	W/(m²·K)
Boiling point of the collector fluid at system pressure	140.00	°C

Calculated results

Parameter	Value	Unit
Stagnation plate temperature	189.28	°C
Loss coefficient at that temperature	5.4446	W/(m²·K)
Top loss coefficient	4.3446	W/(m²·K)
Absorbed radiation	840.00	W/m²
Margin to boiling (negative = boils)	-49.282	K

Notes for this case

- No-flow balance S = U_L(T_p − T_a) with U_L from Klein's top-loss equation, which rises with plate temperature, plus back and edge losses.
- The fluid would boil in the collector at stagnation: provide pressure relief, a drain-back or overheat protection.

Formula and method

$$G_T(\tau\alpha) = U_L(T_p)\,(T_p - T_a), \quad U_L = U_t(T_p) + \frac{k_b}{L_b} + U_e$$

Variables

G_T	Radiation on the collector	W/m²
$(\tau\alpha)$	Transmittance–absorptance product	-
N	Number of glass covers	-
ε_p	Plate emittance (selective 0.1, black paint 0.95)	-
ε_g	Glass emittance	-
β	Collector slope	rad

T_a	Ambient temperature	K
h_w	Wind heat transfer coefficient	W/(m²·K)
k_b	Back insulation conductivity	W/(m·K)
L_b	Back insulation thickness	m
U_e	Edge loss coefficient	W/(m²·K)
T_{boil}	Boiling point of the collector fluid at system pressure	K
$T_{p,stag}$	Stagnation plate temperature	K
U_L	Loss coefficient at that temperature	W/(m²·K)
U_t	Top loss coefficient	W/(m²·K)
S	Absorbed radiation	W/m²
$T_{boil} - T_{p,stag}$	Margin to boiling (negative = boils)	K

Method and standards

No-flow energy balance with a temperature-dependent loss coefficient.

Assumptions and limits

- Steady state, clear sky, Klein's correlation range.

References

Stagnation energy balance with Klein's top-loss equation

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/environmental/solar-thermal/collector-stagnation-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.