Thermoelectric Generator Power and Efficiency

Current, power, heat input and efficiency of a thermoelectric generator from couple Seebeck coefficient, resistance, thermal conductance and temperatures.

Method: Thermoelectric couple model

Input parameters

Unit system: SI

Parameter	Value	Unit
Hot-side temperature	250.00	°C
Cold-side temperature	50.000	°C
Seebeck coefficient per couple (V/K)	400.00	µV/K
Electrical resistance per couple	0.004000	Ω
Thermal conductance per couple	1.2000e-05	kW/K
Couples	127.00	
Load-to-internal resistance ratio (0 for optimum √(1 + ZT̄))	0	

Calculated results

Parameter	Value	Unit
Figure of merit at mean temperature	1.4105	
Load ratio used	1.5526	
Current	7.8352	A
Load voltage	6.1797	V
Electrical power	0.048419	kW
Heat drawn from the hot side	0.49744	kW
Efficiency	9.7338	%
Carnot efficiency	38.230	%

Notes for this case

• Couple model with constant properties: I = SΔT/[R(1 + m)], P = nI²mR, Q_h = n(KΔT + SIT_h − ½I²R). Best efficiency at m = √(1 + ZT̄); best power at m = 1. Bismuth telluride reaches ZT about 1, giving roughly 5–10 % for a 200 K difference.

Formula and method

$$I = \frac{S\Delta T}{R(1+m)}, \quad P = nI^2mR, \quad \dot{Q}_h = n\left(K\Delta T + SIT_h - \frac{1}{2}I^2R\right), \quad Z = \frac{S^2}{RK}$$

Variables

T_h	Hot-side temperature	K
T_c	Cold-side temperature	K
S	Seebeck coefficient per couple (V/K)	V/K
R	Electrical resistance per couple	Ω
K	Thermal conductance per couple	W/K
n	Couples	-
m	Load-to-internal resistance ratio (0 for optimum √(1 + ZT̄))	-
$Z\bar{T}$	Figure of merit at mean temperature	-
I	Current	A

V	Load voltage	V
P	Electrical power	W
$\dot{Q}_h$	Heat drawn from the hot side	W
η	Efficiency	-
η_C	Carnot efficiency	-

Method and standards

Thermoelectric generation.

Assumptions and limits

- Constant properties; no contact resistance.

References

Thermoelectric couple model

Report details

Report reference	FCC-J5DY-5RTE (the same inputs always give the same reference)
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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/electrical/electronics/thermoelectric-generator

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Reopens the calculator with the inputs of this report.