Organic Rankine Cycle Power from Low-Grade Heat

Carnot limit and estimated ORC net power from a heat source's flow and temperatures and the cooling temperature, as a share of Carnot between mean temperatures.

Method: Carnot efficiency between the source's thermodynamic mean temperature $(T_1 - T_2)/\ln(T_1/T_2)$ and the cooling temperature (second law)

Input parameters

Unit system: SI

Parameter	Value	Unit
Heat source flow	36,000	kg/h
Source specific heat	1.1000	kJ/(kg·K)
Source in	300.00	°C
Source out	120.00	°C
Cooling (condensing) temperature	35.000	°C
Share of Carnot achieved	50.000	%

Calculated results

Parameter	Value	Unit
Heat taken from the source	1,980.0	kW
Mean source temperature	204.36	°C
Carnot efficiency between mean and cooling temperature	35.467	%
Estimated ORC efficiency	17.734	%
Estimated net power (the Carnot share covers all losses)	351.13	kW

Notes for this case

- Commercial ORC units reach 10–20 % net efficiency from 150–300 °C sources; ask the maker for a firm figure.

Formula and method

$$T_m = \frac{T_1 - T_2}{\ln(T_1/T_2)}, \quad \eta_C = 1 - \frac{T_c}{T_m}, \quad P = f\eta_C \dot{m} c_p (T_1 - T_2)$$

Variables

$\dot{m}$	Heat source flow	kg/s
c_p	Source specific heat	J/(kg·K)
T_1	Source in	K
T_2	Source out	K
T_c	Cooling (condensing) temperature	K
f	Share of Carnot achieved	-
Q	Heat taken from the source	W
T_m	Mean source temperature	K
η_C	Carnot efficiency between mean and cooling temperature	-
η	Estimated ORC efficiency	-
P	Estimated net power	W

Method and standards

Second-law estimate: Carnot efficiency between the source's thermodynamic mean temperature and the cooling temperature, times the share of Carnot you enter. That share stands for all real losses, pump and fan power included; nothing else is deducted.

Assumptions and limits

- Constant specific heat.
- The source outlet temperature is not checked against the acid dew point of a flue gas or the ORC evaporator pinch: choose it with both in mind.

References

• Carnot efficiency between the source's thermodynamic mean temperature $(T_1 - T_2)/\ln(T_1/T_2)$ and the cooling temperature (second law)

Report details

Report reference	FCC-E2DW-SHDK (the same inputs always give the same reference)
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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/hrsg-waste-heat/orc-power-potential

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.