Ocean Thermal Energy Conversion (OTEC) Net Power

Gross power, seawater pumping power and net output of a closed-cycle OTEC plant from warm and cold seawater temperatures and flows, pinches and cycle quality.

Method: Closed-cycle OTEC energy balance with exchanger pinches

Input parameters

Unit system: SI

Parameter	Value	Unit
Warm surface water temperature	26.000	°C
Cold deep water temperature	5.0000	°C
Warm water flow	18,000	m³/h
Cold water flow	18,000	m³/h
Warm water temperature drop	3.0000	K
Pinch in each heat exchanger	2.0000	K
Cycle efficiency as a fraction of Carnot	75.000	%
Warm-water pumping head	3.0000	m
Cold-water pumping head (pipe friction and density)	5.0000	m
Pump and motor efficiency	80.000	%
Seawater density	1,025.0	kg/m³
Seawater specific heat	3.9900	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Heat taken from warm water	61.346	MW
Cold water temperature rise	2.9152	K
Working fluid evaporating temperature	21.000	°C
Working fluid condensing temperature	9.9152	°C
Cycle efficiency	2.8263	%
Gross power	1,733.8	kW
Seawater pumping power	502.59	kW
Net power	1,231.2	kW
Carnot efficiency of the seawater temperatures	7.0199	%

Notes for this case

• Closed cycle: evaporating at T_w − ΔT_w − δ and condensing at T_c + ΔT_c + δ, with the cold-water rise from the heat rejected; cycle efficiency is the chosen fraction of the Carnot value between those temperatures. Pumping power ρg(Q_wH_w + Q_cH_c)/η_p typically takes 20–40 % of the gross output.

Formula and method

$$T_e = T_w - \Delta T_w - \delta, \quad T_k = T_c + \Delta T_c + \delta, \quad \eta = f\left(1 - \frac{T_k}{T_e}\right), \quad P_n = \eta \rho c Q_w \Delta T_w - \frac{\rho g (Q_w H_w + Q_c H_c)}{\eta_p}$$

Variables

T_w	Warm surface water temperature	K
T_c	Cold deep water temperature	K

Q_w	Warm water flow	m³/s
Q_c	Cold water flow	m³/s
ΔT_w	Warm water temperature drop	K
δ	Pinch in each heat exchanger	K
f	Cycle efficiency as a fraction of Carnot	-
H_w	Warm-water pumping head	m
H_c	Cold-water pumping head (pipe friction and density)	m
η_p	Pump and motor efficiency	-
ρ	Seawater density	kg/m³
c	Seawater specific heat	J/(kg·K)
$\dot{Q}_{in}$	Heat taken from warm water	W
ΔT_c	Cold water temperature rise	K
T_e	Working fluid evaporating temperature	K
T_k	Working fluid condensing temperature	K
η	Cycle efficiency	-
P_g	Gross power	W
P_p	Seawater pumping power	W
P_n	Net power	W
$\Delta T/T_w$	Carnot efficiency of the seawater temperatures	-

Method and standards

OTEC energy balance.

Assumptions and limits

- Steady state; constant seawater properties; cycle quality entered.

References

Closed-cycle OTEC energy balance with exchanger pinches

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

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Reopens the calculator with the inputs of this report.