Gas Turbine Inlet Evaporative Cooling: Power Gain and Water

Compressor inlet temperature after an evaporative cooler or fogger from dry bulb, humidity and effectiveness, with the output gain and water used.

Input parameters

Unit system: SI

Parameter	Value	Unit
Ambient dry bulb	40.000	°C
Relative humidity	30.000	%
Ambient pressure	101.33	kPa
Cooler effectiveness (fogging ≈ 1)	90.000	%
Compressor air flow (dry air)	540,000	kg/h
Gas turbine output at ambient	40.000	MW
Output gain per K of inlet cooling (%/K)	0.60000	

Calculated results

Parameter	Value	Unit
Wet bulb temperature	25.093	°C
Compressor inlet temperature	26.583	°C
Inlet cooling	13.417	K
Output gain	3.2200	MW
Water evaporated	3.0571	t/h

Notes for this case

- Wet bulb from the psychrometric relation (ASHRAE Fundamentals) with saturation from IAPWS-IF97; the cooling follows the wet-bulb line. Take the output sensitivity from the gas turbine maker's ambient correction curve (typically 0.5–0.8 %/K).

Formula and method

$$T_2 = T_{db} - \varepsilon(T_{db} - T_{wb}), \quad \Delta P = \frac{s}{100} P_0 (T_{db} - T_2), \quad \dot{m}_w = \dot{m}_a (W_2 - W_1)$$

Variables

T_{db}	Ambient dry bulb	K
ϕ	Relative humidity	-
p	Ambient pressure	Pa
ε	Cooler effectiveness (fogging ≈ 1)	-
$\dot{m}_a$	Compressor air flow	kg/s
P_0	Gas turbine output at ambient	W
s	Output gain per K of inlet cooling (%/K)	-
T_{wb}	Wet bulb temperature	K
T_2	Compressor inlet temperature	K
ΔT	Inlet cooling	K
ΔP	Output gain	W
$\dot{m}_w$	Water evaporated	kg/s

Method and standards

Psychrometrics with the maker's sensitivity.

Assumptions and limits

- Adiabatic cooling along the wet-bulb line; s is entered in %/K, hence the division by 100.
- The air flow is taken as dry air in the water balance; using the moist-air flow instead changes the water by 1–3 % in hot humid weather.
- Air whose wet bulb is below 0 °C is rejected: the method assumes liquid water.

Report details

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Release checks	2 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/boilers-power-plant/gas-turbines-combined-cycle/gas-turbine-inlet-cooling-gain

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.