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.

Method: Psychrometric wet-bulb relation (ASHRAE Handbook — Fundamentals, ch. 1) with IAPWS-IF97 saturation; output from the maker's correction factor

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.

References

• Psychrometric wet-bulb relation (ASHRAE Handbook — Fundamentals, ch. 1) with IAPWS-IF97 saturation; output from the maker's correction factor

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/boilers-power-plant/turbines-cycles/gas-turbine-inlet-cooling-gain

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.