Dryer Thermal Efficiency and Specific Heat Use

Thermal efficiency of a convective dryer from water evaporated, latent heat and heat supplied, with the ideal adiabatic efficiency (T_in − T_out)/(T_in − T_ambient).

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Water evaporated	2,000.0	kg/h
Latent heat of evaporation	2,330.0	kJ/kg
Heat supplied to the dryer	2,200.0	kW
Inlet air temperature	180.00	°C
Exhaust air temperature	80.000	°C
Ambient temperature	25.000	°C

Calculated results

Parameter	Value	Unit
Thermal efficiency	58.838	%
Heat per kg of water evaporated	3.9600	MJ/kg
Adiabatic (ideal) efficiency	64.516	%

Notes for this case

- Raising the inlet temperature or lowering the exhaust temperature (within dew-point and product limits) improves efficiency most.

Formula and method

$$\eta = \frac{E\lambda}{Q}, \quad \eta_{ad} = \frac{T_1 - T_2}{T_1 - T_0}$$

Variables

E	Water evaporated	kg/s
λ	Latent heat of evaporation	J/kg
Q	Heat supplied to the dryer	W
T_1	Inlet air temperature	K
T_2	Exhaust air temperature	K
T_0	Ambient temperature	K
η	Thermal efficiency	-
Q/E	Heat per kg of water evaporated	J/kg
η_{ad}	Adiabatic (ideal) efficiency	-

Method and standards

Energy balance definitions.

Assumptions and limits

- Steady operation.
- Notes flag the impossible cases: latent heat above the heat supplied, or exhaust colder than ambient.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)

- sec. 12 (drying): thermal efficiency of convective dryers

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/chemical/unit-operations/dryer-thermal-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.