Constant-Rate Drying Time

Drying time in the constant-rate period from dry solids, drying area, initial and critical moisture and the rate h(T − T_w)/λ_w (Perry's sec. 12).

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Dry solids	500.00	kg
Drying surface	25.000	m²
Initial moisture (dry basis)	0.80000	kg/kg
Critical moisture (dry basis)	0.30000	kg/kg
Gas-to-surface heat transfer coefficient	30.000	W/(m²·K)
Gas temperature	80.000	°C
Wet-bulb (surface) temperature	40.000	°C
Latent heat at the wet-bulb temperature	2,420.0	kJ/kg

Calculated results

Parameter	Value	Unit
Constant drying rate	1.7851	kg/(m²·h)
Constant-rate drying time	5.6019	h
Water removed	250.00	kg

Formula and method

$$N_c = \frac{h(T_g - T_w)}{\lambda_w}, \quad t_c = \frac{m_s(X_1 - X_c)}{AN_c}$$

Variables

m_s	Dry solids	kg
A	Drying surface	m²
X_1	Initial moisture (dry basis)	kg/kg
X_c	Critical moisture (dry basis)	kg/kg
h	Gas-to-surface heat transfer coefficient	W/(m²·K)
T_g	Gas temperature	K
T_w	Wet-bulb (surface) temperature	K
λ_w	Latent heat at the wet-bulb temperature	J/kg
N_c	Constant drying rate	kg/(m²·s)
t_c	Constant-rate drying time	s
W	Water removed	kg

Method and standards

Heat-transfer-limited constant drying rate.

Assumptions and limits

- Radiation and conduction to the surface neglected.
- The latent heat is an input so other liquids can be used; for water a note appears when it differs by more than 2 % from the IAPWS-IF97 value at the wet-bulb temperature.

References

• Perry's Chemical Engineers' Handbook
• 9th ed. (McGraw-Hill, 2019)
• sec. 12 (drying): constant-rate period controlled by heat transfer to the surface at the wet-bulb temperature

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/chemical/unit-operations/constant-rate-drying-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.