Drying Time of a Slab by Moisture Diffusion

Falling-rate drying time of a slab drying from both faces under internal diffusion control, from thickness, diffusivity and the moisture contents.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Slab thickness (drying from both faces)	10.000	mm
Effective moisture diffusivity	1.0000e-09	m²/s
Initial moisture, dry basis	1.0000	kg/kg
Final moisture, dry basis	0.15000	kg/kg
Equilibrium moisture, dry basis	0.050000	kg/kg

Calculated results

Parameter	Value	Unit
Moisture ratio (X − X_e)/(X₀ − X_e)	10.526	%
Drying time	5.7451	h

Formula and method

$$t = \frac{4L^2}{\pi^2 D_{eff}} \ln\left(\frac{8}{\pi^2}\frac{X_0 - X_e}{X - X_e}\right)$$

Variables

$2L$	Slab thickness (drying from both faces)	m
D_{eff}	Effective moisture diffusivity	m²/s
X_0	Initial moisture, dry basis	kg/kg
X	Final moisture, dry basis	kg/kg
X_e	Equilibrium moisture, dry basis	kg/kg
MR	Moisture ratio (X − X_e)/(X₀ − X_e)	-
t	Drying time	s

Method and standards

First-term series solution.

Assumptions and limits

- Constant D_eff; no shrinkage.
- One term of the series: above a moisture ratio of $8/\pi^2 \approx 0.81$ it gives no time, and none is shown.

References

• Perry's Chemical Engineers' Handbook
• 9th ed. (McGraw-Hill, 2019)
• sec. 12 (diffusion-controlled falling rate: first term of the series solution of Fick's law)

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/slab-drying-diffusion

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.