Hydrogen Bake-Out Time for Steel Plate

Time to remove a fraction of dissolved hydrogen from a steel plate baked at temperature, from the slab desorption series with an Arrhenius effective diffusivity.

Method: Desorption from a plane sheet

Input parameters

Unit system: SI

Parameter	Value	Unit
Plate thickness (outgassing from both faces)	25.000	mm
Diffusivity pre-exponential (effective)	0.10000	mm²/s
Activation energy (effective)	18.000	kJ/mol
Bake-out temperature	200.00	°C
Fraction of hydrogen to leave in	10.000	%

Calculated results

Parameter	Value	Unit
Effective diffusivity	0.001030	mm²/s
Bake-out time	35.734	h
Characteristic time	168.54	h

Notes for this case

• Mean concentration in a slab of thickness L degassing from both faces: $\bar{C}/C_0 = \Sigma\ 8/((2m+1)^2\pi^2)\cdot\exp(-(2m+1)^2\pi^2 Dt/L^2)$. Trapping makes the effective diffusivity in steels far lower than lattice values; take D_0 and Q for the steel and microstructure (the defaults are illustrative).

Formula and method

$$\frac{\bar{C}}{C_0} = \sum_{m=0}^{\infty} \frac{8}{(2m+1)^2\pi^2} \exp\left[-\frac{(2m+1)^2\pi^2 Dt}{L^2}\right]$$

Variables

L	Plate thickness (outgassing from both faces)	m
D_0	Diffusivity pre-exponential (effective)	m²/s
Q	Activation energy (effective)	J/mol
T	Bake-out temperature	K
f	Fraction of hydrogen to leave in	-
D	Effective diffusivity	m²/s
t	Bake-out time	s
L^2/D	Characteristic time	s

Method and standards

Slab desorption.

Assumptions and limits

- Plane sheet; zero surface concentration; constant D.

References

Desorption from a plane sheet

Report details

Report reference	FCC-M3YP-AS9A (the same inputs always give the same reference)
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Release checks	3 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/materials/heat-treatment/hydrogen-bakeout-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.