Nitriding Case Depth and Time at Temperature

Nitrided case depth after a time from a parabolic growth constant, corrected for temperature by an activation energy, and the time for a target depth.

Method: Parabolic case growth with Arrhenius temperature dependence

Input parameters

Unit system: SI

Parameter	Value	Unit
Case growth constant at the reference temperature (mm/√h)	0.070000	
Reference temperature	510.00	°C
Activation energy	140.00	kJ/mol
Process temperature	530.00	°C
Nitriding time	40.000	h
Target case depth	0.50000	mm

Calculated results

Parameter	Value	Unit
Growth constant at process temperature (mm/√h)	0.091487	
Case depth after the time	0.57862	mm
Time for the target depth	29.869	h

Notes for this case

- Diffusion-controlled growth d = k√t; k² follows Arrhenius, so k scales with exp(−Q/2R·(1/T − 1/T_ref)). Fit k_ref from your own process (gas, salt bath or plasma) and steel; the default is illustrative only.

Formula and method

$$d = k\sqrt{t}, \quad k = k_{ref} \exp\left[-\frac{Q}{2R}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]$$

Variables

k_{ref}	Case growth constant at the reference temperature (mm/√h)	-
T_{ref}	Reference temperature	K
Q	Activation energy	J/mol
T	Process temperature	K
t	Nitriding time	s
d_t	Target case depth	m
k	Growth constant at process temperature (mm/√h)	-
d	Case depth after the time	m
t_t	Time for the target depth	s

Method and standards

Parabolic growth.

Assumptions and limits

- Diffusion-controlled growth.

References

Parabolic case growth with Arrhenius temperature dependence

Report details

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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/nitriding-case-depth

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.