Grain Growth during Annealing or Austenitising

Grain size after holding at temperature by the grain growth law $d^n - d_0^n = Kt$ with an Arrhenius rate constant, and the time to reach a grain size.

Method: Grain growth law with Arrhenius rate

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial grain size	20.000	µm
Rate constant pre-factor (m^n/s)	7.0000e-04	
Activation energy	200.00	kJ/mol
Temperature	900.00	°C
Growth exponent	2.0000	
Holding time	1.0000	h
Target grain size	50.000	µm

Calculated results

Parameter	Value	Unit
Rate constant at temperature (m^n/s)	8.7146e-13	
Grain size after the time	59.475	µm
Time to reach the target size	0.66937	h

Notes for this case

- $d^n - d_0^n = K_0 e^{(-Q/RT)} \cdot t$: n = 2 for ideal curvature-driven growth, larger (3–4) where particles or solutes drag boundaries. K_0, Q and n come from tests on the alloy; the defaults are illustrative.

Formula and method

$$d^n - d_0^n = K_0 e^{-Q/RT} t$$

Variables

d_0	Initial grain size	m
K_0	Rate constant pre-factor (m^n/s)	-
Q	Activation energy	J/mol
T	Temperature	K
n	Growth exponent	-
t	Holding time	s
d_t	Target grain size	m
K	Rate constant at temperature (m^n/s)	-
d	Grain size after the time	m
t_d	Time to reach the target size	s

Method and standards

Grain growth law.

Assumptions and limits

- Isothermal hold; normal grain growth.

References

Grain growth law with Arrhenius rate

Report details

Report reference	FCC-30X6-6DF6 (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/grain-growth-kinetics

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.