Carburising Case Depth vs Time and Temperature (Harris)

Total case depth of gas or pack carburised steel after a time at temperature, and the time for a wanted depth, by the Harris diffusion equation.

Method: F.E. Harris (1943); Metal Progress 44; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Carburising temperature	925.00	°C
Time at temperature	4.0000	h
Case depth wanted	1.0000	mm

Calculated results

Parameter	Value	Unit
Total case depth after the time	1.2558	mm
Carburising factor (depth after 1 h)	0.62788	mm
Time for the wanted depth	2.5365	h

Notes for this case

- Total case depth for a saturated carbon potential at the surface; effective case depth (to a hardness such as 50 HRC) is smaller. Boost–diffuse cycles need their own calculation.

Formula and method

$$d = \frac{31.6\sqrt{t}}{10^{6700/T}} \quad (\text{in},\ \text{h},\ ^\circ\text{R}) = \frac{803\sqrt{t}}{10^{3722/T}} \quad (\text{mm},\ \text{h},\ \text{K})$$

$$t_t = \left(\frac{d_t}{k}\right)^2$$

Variables

T	Carburising temperature	K
t	Time at temperature	s
d_t	Case depth wanted	m
d	Total case depth after the time	m
k	Carburising factor (depth after 1 h)	m
t_t	Time for the wanted depth	s

Method and standards

Harris's diffusion relation: case depth grows with the square root of time, with a temperature factor of Arrhenius form.

Assumptions and limits

- Saturated carbon potential at the surface; plain carbon and low-alloy steels.

References

- F.E. Harris (1943)
- Metal Progress 44
- total case depth

Report details

Report reference	FCC-ZWQ9-AXGJ (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/carburising-case-depth

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.