Weld Cooling Time t8/5 (Rosenthal Thick and Thin Plate)

Weld cooling time from 800 to 500 °C by Rosenthal's thick-plate (3-D) and thin-plate (2-D) solutions, the transition thickness and which one governs.

Method: Rosenthal (1946) moving point and line heat source solutions (Kou, Welding Metallurgy, 2nd ed., ch. 2)

Input parameters

Unit system: SI

Parameter	Value	Unit
Net heat input	1.5000	kJ/mm
Preheat or plate temperature	20.000	°C
Plate thickness	15.000	mm
Thermal conductivity of steel (500–800 °C)	30.000	W/(m·K)
Volumetric heat capacity (MJ/(m³·K)) A plain number in MJ/(m³·K); about 5 for steel.	5.0000	

Calculated results

Parameter	Value	Unit
Thick-plate t8/5	6.3764	s
Thin-plate t8/5	14.306	s
Transition thickness	22.468	mm
Governing t8/5	14.306	s

Notes for this case

• Rosenthal's point and line sources with constant properties. Real joints cool somewhat differently; empirical shape factors (fillet, T-joint) correct for joint geometry. Longer t8/5 gives softer, tougher HAZ; very short t8/5 gives hard martensite.

Formula and method

$$t_{8/5,3D} = \frac{Q}{2\pi k}\left(\frac{1}{500 - T_0} - \frac{1}{800 - T_0}\right), \quad t_{8/5,2D} = \frac{(Q/d)^2}{4\pi k \rho c}\left[\frac{1}{(500 - T_0)^2} - \frac{1}{(800 - T_0)^2}\right]$$

Variables

Q	Net heat input (kJ/mm)	-
T_0	Preheat or plate temperature	K
d	Plate thickness	m
k	Thermal conductivity of steel (500–800 °C)	W/(m·K)
ρc	Volumetric heat capacity (MJ/(m³·K))	-
$t_{8/5,3D}$	Thick-plate t8/5	s
$t_{8/5,2D}$	Thin-plate t8/5	s
d_t	Transition thickness	m
$t_{8/5}$	Governing t8/5	s

Method and standards

Rosenthal solutions.

Assumptions and limits

- Constant properties; bead-on-plate. Pure Rosenthal solutions without the empirical joint factors of codes such as EN 1011-2, whose $t_{8/5}$ values differ.
- Q (kJ/mm) and ρc (MJ/(m³·K)) are plain numbers in every unit system; divide kJ/in by 25.4.

References

- Rosenthal (1946) moving point and line heat source solutions (Kou, Welding Metallurgy, 2nd ed., ch. 2)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/welding/weld-cooling-time-t85

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Reopens the calculator with the inputs of this report.