

Pre-heat and Cooling Temperatures for Tool and Die Repair Welding

Pre-heat and cooling temperatures for tool steel repair welding, with the standard pre-heat and the lower no-discoloration pre-heat for ten tool steels, the pre-heat by carbon content and the discoloration colours. The values are printed as they appear in the source.

Reference only. This card is a reference summary of published practice. It is not an Aobo Steel standard and not a welding procedure specification. Confirm the pre-heat, the cooling method and any post weld treatment against the applicable standard, the material test certificate and your own procedure.

Standard pre-heats by tool steel grade

Material	Standard	No discoloration	Cooling
A2	250–350	100–140* max	Slow
D2	250–350	140–180* max	Slow
D3	350–450	Not recommended*	Slow
H13	150–250	110–150 max	Air
L6	200–250	110–150 max	Air
O1	250–350	100–140* max	Slow
P20	150–200	100–140 max	Air
S1	200–250	110–150 max	Air
2767	150–250	110–150 max	Air
Modified 420 stainless steel (Stavax type)	200–250	140–180 max	Air

Source, Handbook of Mold, Tool and Die Repair Welding (Steve Thompson), table 5.1, printed page 50. Standard pre-heats and the lower no-discoloration pre-heats in degrees Celsius.

Pre-heat by carbon content

Group	Carbon content (%)	Pre-heat (°C)	Cooling
Low	0.2–0.3	100–150	Air
	0.3–0.4	150–200	Air
Medium	0.4–0.5	150–250	Air
	0.5–0.6	200–300	Slow
High	0.6–0.7	250–350	Slow
	0.7–2.5	250–450	Slow

Source, same book, table 5.2, printed page 51. Pre-heats by carbon content for small tools.

Discoloration colours on low alloy tool steel

Colour	Temperature
Very pale yellow to light yellow	225 °C
Straw to deep straw yellow	235 °C
Dark yellow to brown yellow	245 °C
Brown to reddish brown	258 °C
Purple brown to light purple	270 °C
Full purple to dark purple	280 °C
Blue	295 °C
Dark blue	315 °C

Source, same book, table 5.3, printed page 51. Discoloration of low alloy tool steel.

Notes

- *A2, D2 and O1 are very crack sensitive and must be welded with extreme caution at lower than standard pre-heat temperatures. D3 is extremely crack sensitive even at its standard pre-heat temperature.
- The carbon figure is enough for a small tool. For a large tool, a tool that needs a large amount of weld, or a tool welded in a crack sensitive area, add up to 50 percent more pre-heat, but do not go above 450 °C.
- Tools of 60 HRC and above should have a minimum pre-heat of 350 °C. Hardened and tempered high speed tool steels should have a minimum pre-heat of 400 °C and tempering after welding for one to two hours at 540 to 550 °C, then slow cool.
- Once the pre-heat temperature is decided, it has to be reached gradually and evenly and then held, with the tool not allowed to drop below it or rise more than a hundred degrees above it during welding. Avoid keeping the tool above 475 °C.
- Air cooling lets the tool cool naturally, away from drafts where possible. Slow cooling means burying the tool in sand or vermiculite, both of which are available from a builders merchant.

Aobo Steel, tool steel supplier

Aobo Steel supplies forged tool steel and engineering steel from Huangshi, Hubei, China, where the local supply chain covers ESR melting, vacuum degassing and LF refining, forging, hot rolling, turned and peeled bar, heat treatment and third party inspection. We have worked in steel since 2003 and supply to order in cold work grades such as D2, D3 and O1, hot work grades such as H10 and H13, stainless grades 420, 440C and 4Cr13, and carbon and alloy bar, with EN 10204 3.1 certification.

Reference data compiled from Handbook of Mold, Tool and Die Repair Welding (Steve Thompson), chapter 5 Heat control, tables 5.1, 5.2 and 5.3.

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