

5CrMnMo Tool Steel Heat Treatment and Properties

Composition, critical points, forging range, annealing, hardening, isothermal hardening, tempering and mechanical property data for 5CrMnMo, a low alloy hot work die steel for hammer and press forging dies, as printed in a Chinese die material reference. Read from the searchable text layer and checked table by table. Reference data only, not an Aobo Steel specification.

Reference only. This sheet is a reference summary of published practice, not an Aobo Steel specification or a release condition. Confirm the grade and the heat treatment cycle against the applicable standard and the mill certificate before the data is written into a process sheet.

Composition

5CrMnMo, GB/T 1299-2000, mass fraction in percent

Grade	C	Si	Mn	Cr	Mo	P	S
5CrMnMo	0.50-0.60	0.25-0.60	1.20-1.60	0.60-0.90	0.15-0.30	0.030 max	0.030 max

Table 5-24, printed page 225. Phosphorus and sulfur are printed as a maximum.

Critical points

Approximate values, in degrees Celsius

Ac1	Ac3	Ar1	Ms
710	760	650	220

Table 5-25, printed page 225.

Forging practice

Item	Heating, °C	Initial forging, °C	Final forging, °C	Cooling
Steel ingot	1140-1180	1100-1150	800-880	Slow cooling, pit or sand
Steel billet	1100-1150	1050-1100	800-850	Slow cooling, pit or sand

Table 5-26, printed page 225. The source note requires slow cooling after forging, and a hold at about 600 °C for a large die.

Annealing, preliminary heat treatment

Plan	Process parameters
General annealing	Heat to 760-780 °C, hold 2-4 h, furnace cool below 500 °C, air cool. Hardness 197-241 HBW.
Isothermal annealing after forging	Heat to 850-870 °C, hold 2-4 h, furnace cool to 680 °C, hold 4-6 h, furnace cool below 500 °C, air cool. Hardness 197-241 HBW.

Table 5-27, printed page 226.

Hardening

Quenching, °C	Medium	Medium temp, °C	Operation	Hardness HRC
820-850	Oil	150-180	Cool to 150-180 °C; small dies air cool, medium and large dies temper at once	52-58

Table 5-28, printed page 226. The source note takes the upper heating range for medium and large dies and pre-cools in air to 740-760 °C.

5CrMnMo heat treatment, continuation

Isothermal hardening

Plan	Process parameters
I	Heat to 840-860 °C, stepped stop in 160-180 °C nitrate salt so part of the austenite transforms, then 280-300 °C salt for 2-3 h.
II	Heat to 840-860 °C, oil quench, transfer warm at 150-200 °C to the isothermal bath at 280-300 °C for 2-3 h.

Table 5-29, printed page 226. Resulting structure is martensite plus lower bainite plus retained austenite, tempered to lower bainite.

Tempering, by part of the die

Part of the die	Die size	Tempering, °C	Heating medium	Hardness HRC
Working part	Small forging die	490-510	Gas or electric furnace	41-47
Working part	Medium forging die	520-540	Gas or electric furnace	38-41
Shank, dovetail	Small forging die	600-620	Gas or electric furnace	35-39
Shank, dovetail	Medium forging die	620-640	Gas or electric furnace	34-37

Table 5-30, printed page 226. The die is tempered twice, each temper followed by an oil cool.

Tempering temperature against room temperature mechanical properties

Tempering, °C	200	300	400	450	500	550	600	650
Hardness HRC	57	52	47	44	41	37	34	30
Tensile strength Rm, MPa	-	-	-	1630	1600	1430	1260	1120
Impact energy aK, J/cm ²	-	-	-	19	20	27	42	30
Elongation A, %	-	-	-	5.5	7.5	9.5	10	11.5

Table 5-31, printed page 227. Specimens oil quenched from 840 °C. A dash means the source gives no value.

High temperature hardening and tempering

Process	Process parameters
High temperature route	Harden at 890-900 °C, oil quench, hardness 61.5 HRC. Temper at 420-550 °C, twice.

Table 5-32, printed page 227. Above 900 °C the source notes that impact toughness begins to fall.

Aobo Steel, tool steel supplier

We supply forged and rolled tool steel from Huangshi, China, in D2, D3, O1, A2, H10, H11, H13, 5CrNiMo, 5CrMnMo, 420, 440C and related grades, in round bar and plate, annealed and ready to machine. Reference data for the grades and the heat treatment cycles of tool and die steels is collected for the buyers and process engineers who work with us.

Source, 实用模具材料与热处理速查手册, Tables 5-24 to 5-32, printed pages 225 to 227. Page, aobosteel.com/5crmnmo-tool-steel-heat-treatment/

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