

Mold Steel Processing Data for P2 to P21 and Stainless Grades

A mold steel is bought against the cavity it has to fill, so the numbers that decide the purchase are the working hardness, the temperature the block is hardened from, the annealed hardness it arrives in and the size change it makes in the quench. The three tables below collect those figures for the P group of mold steels and for three carburized martensitic stainless grades.

Reference only. This is a reference summary of published practice and not a specification of ours. Ratings run from 1 to 9, where 9 is the highest value, and (a) marks the carburized condition. The P21 tempering range is printed in the source as 580-540 C (900-1000 F), which cannot be read in both scales at once, so it is given here as 480-540 C and the source printing is recorded below. Confirm the cycle for the grade and the section before it is written into a process sheet.

Performance ratings

Wear resistance, toughness and hot hardness

Factor	P2	P3	P4	P5	P6	P20	P21	13Cr-0.12C	13Cr-0.35C	17Cr-0.65C
Wear resistance	1(a)	1(a)	1(a)	1(a)	1(a)	1(a)	1	2	3	5
Toughness	9	9	9	9	9	8	8	8	6	5
Hot hardness	2(a)	2(a)	4(a)	2(a)	3(a)	2(a)	4	5	6	6

Source, Tool Steels (G. A. Roberts and G. Krauss), Table 15-2, printed page 293.

Hardness and hardening response

Working hardness, depth of hardening and hardness after the quench

Factor	P2	P3	P4	P5	P6	P20	P21	13Cr-0.12C	13Cr-0.35C	17Cr-0.65C
Usual working hardness, HRC	58-64(a)	58-64(a)	58-64(a)	50-64(a)	58-61(a)	30-50	36-39	40-42	50-53	51-57
Depth of hardening	S	S	M	S	M	M	D	M	M	M
Finest grain size at full hardness, Shepherd standard	...	...	...	...	...	7½	...	...	7	7½
Surface hardness as-quenched, HRC	62-65(a)	62-64(a)	62-65(a)	62-65(a)	60-62(a)	52-54	22-26	40-43	50-53	55-58
Core hardness (25 mm, or 1 in., diam round), HRC	15-21	15-21	33-35	20-25	35-37	45-50	22-26	40-43	50-53	55-58

Source, Tool Steels (G. A. Roberts and G. Krauss), Table 15-2, printed page 293.

Manufacturing and heat treatment data

Availability, machinability, quench medium and temperatures

Factor	P2	P3	P4	P5	P6	P20	P21	13Cr-0.12C	13Cr-0.35C	17Cr-0.65C
Availability	2	1	2	2	2	3	2	1	1	1
Cost	1	1	2	1	1	1	2	2	2	2
Machinability	7	7	5	7	6	8	5	2	4	4
Quenching medium	O	O	A, O	O, W	O	O	O	O, A	O	O, A
Hardening temperature, °C (°F)	830-845(a) (1525-1550)	800-830(a) (1475-1525)	885-925(a) (1625-1700)	845-870(a) (1550-1600)	790-815(a) (1450-1500)	815-870 (1500-1600)	870-900 (1600-1650)	955-1010 (1750-1850)	980-1040 (1800-1900)	1010-1065 (1850-1950)
Dimensional change on hardening	M	M	M	M	M	M	M	M	M	M
Safety on hardening	M	M	M	M	M	M	H	H	M	M

Factor	P2	P3	P4	P5	P6	P20	P21	13Cr-0.12C	13Cr-0.35C	17Cr-0.65C
Susceptibility to decarburization	M	M	M	M	M	M	L	M	M	M
Approximately hardness as-rolled or forged, HB	200	200	350	230	280	310	...	400	500	550
Annealed hardness, HB	103-123	109-137	116-135	103-123	180-207	150-180	248-269	150-180	160-202	187-228
Annealing temperature, °C (°F)	730-815 (1350-1500)	730-815 (1350-1500)	870-900 (1600-1650)	845-870 (1550-1600)	675-695 (1250-1280)	760-790 (1400-1450)	870-900 (1600-1650)	790-845 (1450-1550)	845-900 (1550-1650)	845-900 (1550-1650)
Tempering range, °C (°F)	150-260 (300-500)	150-260 (300-500)	150-260 (300-500)	150-260 (300-500)	150-230 (300-450)	150-260 (300-500)	480-540 (900-1000)	260-425 (500-800)	150-425 (300-800)	150-425 (300-800)
Forging temperature, °C (°F)	1010-1120 (1850-2050)	1010-1120 (1850-2050)	1010-1120 (1850-2050)	1010-1120 (1850-2050)	1065-1175 (1950-2150)	1010-1120 (1850-2050)	...	1120-1175 (2050-2150)	1095-1205 (2000-2200)	1095-1150 (2000-2100)

Source, Tool Steels (G. A. Roberts and G. Krauss), Table 15-2, printed page 293.

Read the three tables together. The low carbon grades are soft as supplied and take their wear resistance from a carburized case, which is why their working hardness carries the note (a). P20 and P21 arrive prehardened and are machined straight into the cavity. The stainless grades harden through to the core, so their surface and core hardness are the same figure, and they are the only grades in the table that resist a corrosive plastic.

Aobo Steel, tool steel supplier

Aobo Steel supplies tool steel to distributors and mold, tool and die shops, including D2, D3, O1, O2, A2, S7, H13, H11, H10, H21, M2, M42, L6, P20, P20+Ni and 420 and 440C stainless. Forged or hot rolled, annealed or pre-hardened, cut to your sizes, with test certificates. Compiled from Tool Steels (G. A. Roberts and G. Krauss), Table 15-2, Performance factors and processing information for mold steels, on printed page 293, in the mold steels chapter. Every figure was read from the 500 dpi page image and cross-checked against the word coordinates of the searchable text of the file, column by column. The table is reproduced as published except for the P21 tempering range, which the source prints as 580-540 C (900-1000 F). It is a reference summary rather than an Aobo Steel specification.

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