

Quenching Media for Tool Steel, Cooling Rates and Quenching Behaviour

Cooling rates of the common quenching media in the two temperature windows that decide hardness and cracking, with the cracking sensitivity, section hardness and distortion measured for a polymer quenchant at three concentrations. Read from a Chinese mould and tool steel heat treatment handbook. Reference data only, not an Aobo Steel specification.

Reference only. This sheet is a reference summary of published Chinese handbook practice, not an Aobo Steel specification. Confirm the medium and the cycle against the mill certificate and the governing drawing before an order or a production run is set against them.

Cooling rate of the common quenching media

Quenching medium	Peak rate at, °C	Peak rate, °C/s	Average 650–500 °C, °C/s	Average 300–200 °C, °C/s
Still tap water, 20 °C	340	775	135	450
Still tap water, 40 °C	285	545	110	410
Still tap water, 60 °C	220	275	80	185
10% NaCl solution, 20 °C	580	2000	1900	1000
15% NaOH solution, 20 °C	560	2830	2750	775
5% Na ₂ CO ₃ solution, 20 °C	430	1640	1140	820
L-AN15 neat oil, 20 °C	430	230	60	65
L-AN15 neat oil, 80 °C	430	230	70	55
L-AN32 neat oil, 20 °C	500	120	100	50

Table 8-9, printed page 464. Cooling rate measured on a 20 mm steel ball and estimated from the cooling curve of each medium. Percentages are mass fractions.

Salt and caustic solutions against water and oil

Quenching medium	Average 650–550 °C, °C/s	Average 300–200 °C, °C/s
Saturated CaCl ₂ solution	1000	150
Water, 18 °C	600	270
10% NaCl solution, 20 °C	1100	300
15% NaOH solution, 20 °C	1200	300
Rapeseed oil, 50 °C	200	35
L-AN15 neat oil, 50 °C	150	30
Transformer oil, 50 °C	120	25

Table 8-10, printed page 465. Average cooling rate across each range.

Polymer quenchants, cracking sensitivity

Quenching medium	Specimens	Cracked
Water	3	3
5% NQ-1 polymer	3	1
15% NQ-1 polymer	3	0
25% NQ-1 polymer	3	0
L-AN15 neat oil	3	0

Table 8-11, printed page 466. T8 carbon tool steel, 30 mm by 30 mm, austenitized at 840 °C and held 30 minutes, checked by magnetic particle inspection.

Tool steel quenching media, continuation

Hardness through the section

Specimen	Quenching medium	Surface, HRC	Half radius, HRC	Centre, HRC
45 steel, 20 mm × 60 mm	Water	60	54	52
45 steel, 20 mm × 60 mm	5% NQ-1 polymer	61	57	53
45 steel, 20 mm × 60 mm	15% NQ-1 polymer	61	57	54
45 steel, 20 mm × 60 mm	25% NQ-1 polymer	58	52	50
45 steel, 20 mm × 60 mm	L-AN15 neat oil	54	48	45
45 steel, 30 mm × 90 mm	Water	56	33	31
45 steel, 30 mm × 90 mm	5% NQ-1 polymer	59	40	34
45 steel, 30 mm × 90 mm	15% NQ-1 polymer	58	38	33
45 steel, 30 mm × 90 mm	25% NQ-1 polymer	54	33	30
45 steel, 30 mm × 90 mm	L-AN15 neat oil	50	25	23

Table 8-12, printed page 466. 45 steel, austenitized at 840 °C and held 30 minutes, hardness in HRC across the section. The 30 mm bar is short of full hardness at the half radius and at the centre in every medium.

Distortion and surface hardness

Quenching medium	Average distortion, mm	Surface hardness, HRC
Water	+0.80	60
5% NQ-1 polymer	+0.61	61
15% NQ-1 polymer	+0.12	60
25% NQ-1 polymer	+0.26	58
L-AN15 neat oil	+0.09	54

Table 8-13, printed page 466. 45 steel disc, 50 mm by 10 mm, austenitized at 840 °C and held 15 minutes. Distortion is the average measured change in size, positive meaning growth.

Notes on the data

The medium names follow the source. L-AN grades are Chinese full loss system oils, L-AN15 near an ISO VG15 viscosity grade and L-AN32 near an ISO VG32, so the number is a viscosity class rather than a brand. The polymer figures are for the NQ-1 polymer used in the source test programme and the concentrations are mass fractions, so a bath mixed to the same percentage from a different polymer will not necessarily behave identically. The cracking, hardenability and distortion tests were run on T8 and 45 steel, which are plain carbon grades rather than die steels, so those readings measure the medium and are not a prediction for a particular tool steel section. The rates in the first two tables were measured on a 20 mm steel ball and estimated from published cooling curves, so they are comparative rather than absolute.

Aobo Steel, tool steel supplier

We supply forged and rolled tool steel from Huangshi, China, in D2, D3, O1, A2, H10, H11, H13, 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, Chinese mould and tool steel heat treatment handbook, Tables 8-9 to 8-13, printed pages 464 to 466. Page, aobosteel.com/tool-steel-quenching-media-cooling-rates/

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