

Quench to Temper Delay for Shock-Resisting Tool Steels

A tool that has just been quenched is hard and brittle, and the temper that follows is what makes it usable. The table below is the published allowable time between quenching and tempering for the five shock-resisting grades, at two austenitizing temperatures each, for the prevention of cracking.

Reference only. This is a reference summary of published practice and it is not a specification of ours. The figures were determined by a study conducted in one plant, and the source notes that the allowable time may vary significantly with the size and shape of the part. Final cycle parameters are set by the heat treater.

Allowable time between quenching and tempering

The published rule for shock-resisting tool steel is to temper immediately after quenching, or cracking is likely to result. The warning is strongest for tools quenched in water or in brine.

Grade	Austenitizing temperature, °C (°F)	Quenching medium	Allowable time before tempering, min
S1	900 (1650)	Oil	30
S1	980 (1800)	Oil	15
S2	845 (1550)	Brine	10
S2	900 (1650)	Brine	5
S3	815 (1500)	Brine	10
S3	870 (1600)	Brine	5
S4	870 (1600)	Brine	10
S4	925 (1700)	Brine	5
S4	900 (1650)	Oil	30
S4	955 (1750)	Oil	15
S5	870 (1600)	Oil	30
S5	925 (1700)	Oil	15

Allowable time between quenching and tempering, for the prevention of cracking. The values were determined by an extensive study conducted in one plant, and the allowable time may vary significantly with the size and shape of the part. Source, Table 3 of Heat Treating of Shock-Resisting Tool Steels, in ASM Handbook, Volume 4, Heat Treating.

What the numbers show

Two things move the allowance, and the quenching medium moves it more. Where the quench is in brine, the allowable time is 5 to 10 minutes. Where the quench is in oil, the allowable time is 15 to 30 minutes, three times as long at the same grade and the same section. The severity of the quench sets the amount of residual stress in the part, and that stress is what the temper has to relieve before cracking becomes likely.

Double tempering for the S grades

Tool records from the same plant indicate that double tempering is beneficial for tools made from the S steels. The first tempering operation is done at a temperature 30 to 55 °C (50 to 100 °F) lower than the second and the final tempering operation. The lower first temper starts the stress relief gently while the structure is still at its most brittle, and the higher second temper sets the working hardness.

Surface treatment notes for the S grades

Surface treatments such as carburizing and carbonitriding are often applied to S1 steel, which is the silicon bearing grade used for chisels and punches. Types S4 and S5 do not take an effective carburized case, so a case hardening treatment on those two grades does not produce the surface hardness the specification is asking for.

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. Source, Table 3 of Heat Treating of Shock-Resisting Tool Steels, in ASM Handbook, Volume 4, Heat Treating.

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