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AISI W2

Water Hardening Carbon Tool Steel

W2 tool steel depends primarily upon a comparatively high carbon content for its useful properties. For proper application, the correct carbon content must be selected. Standard carbon contents range from .070 to 1.30 per cent, generally in 0.10 per cent increments. Microscopic, macroscopic, and hardenability requirements are not specified for standard quality carbon tool steels but do apply for cold-heading die or special quality material.

This carbon range produces a tool steel having both maximum toughness and adequate wear-resistance for general-purpose blacksmithing tools such as chisels, moil points, etc.

In heat-treatment carbon tool steels develop high surface hardness with a relatively tough core. This characteristic makes them an excellent choice for a wide variety of uses. Carbon tool steeels are low in cost, easy to machine and simple to heat-treat.

For greater wear-resistance or safety in hardening, use an oil- or air-hardening grade.

Annealing

For best results, annealing should be carried out in controlled-atmospheric furnaces. Otherwise, use sealed pipes or containers with the parts protected by cast-iron chips, mica, charcoal, or a mixture of sand and a carbonaceous material, to prevent decarburizing the surface. Three types of annealing procedures based on the carbon content and size of the piece to be annealed are outlined below.

Normalize and Anneal - If carbon content is 1.10 or under and size is over 2 in., or if carbon content is over 1. and size is 2 in. or under.

Oil-Quench and Anneal - If carbon content is over 1.10 and size is over 2 in.

Anneal Only - If carbon content is 1.10 or under and size is 2 in. or under.

For normalizing and annealing or oil-quenching and annealing, the piece should be heated slowly and held at the proper temperature for at least one hour per inch of greatest thickness during both treatment operations. Where annealing is the only treatment, the part should be held at the proper temperature for at least one hour per inch of greatest thickness. After holding, the part should be cooled slowly. Temperatures for these operations are as follows:

	Normalizing	
	or Oil-Quenching	**Annealing**
Carbon Range	**Temperature - °F**	**Temperature - °F**
.70 to .090	1450-1525	1400-1450
.90 to 1.00	1475-1550	1375-1425
1.00 to 1.10	1500-1575	1375-1425
1.10 to 1.30	1500-1650	1375-1425

Hardening

Heat slowly and uniformly and hold at the quenching temperature at least one-half hour per inch of greatest thickness. Carbon grades can be quenched in water but brine-quenching is preferred because it results in more positive response to treatment and insures uniform surface hardness. When the section is light and maximum hardness is not desired, oil may be used as a quenching medium. For best results, the temperature of the quenching medium should be about 70°F. Quenching temperatures, depending upon the carbon content, are as follows:

	Quenching
Carbon Range	**Temperature-°F**
.70 to .90	1425-1475
.90 to 1.00	1425-1475
1.00 to 1.10	1400-1450
1.10 to 1.30	1390-1425

Parts should be cooled in the quenching medium until they have reached about 150 to 200°F. They should then be charged into the tempering furnace at once and not permitted to reach room temperature until the tempering operation is complete.

The depth of chill of carbon tool steel can be regulated to some extent by vary ing the quenching temperature. The higher the quenching temperature, the deeper will be the chill. A series of specimens, 3/4 in. round x 3 in. long, were rough-turned from 1 in. round stock of 0.80 and 1.05 shallow-hardening carbon tool steel and hardened by quenching in water at the temperatures given in
the accompanying tables. The resulting Rockwell C hardness, depth of penetration, and fracture rating of
the hardened chill are as shown.

HARDENING SERIES .080 CARBON

Water Quenching Temperature - °F	Depth of Chill in 64ths	Fracture Rating of Chill	Hardness of Chill Rockwell C
1375	6	8-1/2	61
1400	6-1/2	9-1/4	65
1425	7	9-1/4	67
1450	7-1/2	9-1/4	67
1475	8-1/2	9-1/4	67
1500	9-1/2	9	67
1550	10	8-1/2	67
1600	10-1/2	8	66
1650	11-1/2	7-1/2	66

HARDENING SERIES 1.050 CARBON

Water Quenching Temperature - °F	Depth of Chill in 64ths	Fracture Rating of Chill	Hardness of Chill Rockwell C
1375	6	7-1/2	61
1400	7	8-1/4	65
1425	8	9-1/4	67
1450	8-1/2	9-1/4	67
1475	9-1/4	9-1/4	66
1500	10	9-1/4	66
1550	12-1/2	8-3/4	66
1600	Through	5-3/4	65
1650	Through	5-1/4	65

Tempering

Carbon tool steels are usually temperated at temperatures between 300 and 600°F. The warm steel, as quenched, should be brought slowly to the desired tempering temperature and held at this temperature for at least two hours per inch of greatest cross section.

Specimens of 1.00 carbon tool steel, 3/4 in. round by 3 in. long were hardened by quenching in water from 1450°F. They were then tempered at various temperatures with the following results:

Temperature - °F	Rockwell C
As Quenched	67
300	64
400	61
500	59
600	55