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AISI S7

AISI S7 - Chrome-Moly-Shock Resistant Steel

AISI S7 is a shock steel with exceptional impact properties - unnotched Charpy over 200 ft-lb at 400F temper. Since it hardens in air, it is safe and stable in heat treatment. But perhaps the most remarkable characteristic of S7 is its versatility. It is used widely for medium-run cold-work tools and dies, for plastic-molding dies, for shear blades, for medium hot-work dies, for master hobs, and for component parts of many products.

S7 has an unusual combination of properties, making it suitable for an extremely wide range of tool and die work - where shock-resistance, medium hot-work properties, or ease of machining and heat-treatment are most important.

It is recommended for both hot and cold shock applications such as rivet sets, chisels, punches, moil points, hot headers and gripper dies. S7 is also suited for short-run dies used in cold-forming, blanking, and bending. Other uses include: engraving dies, machined cavities for plastic-molding dies, die-casting dies, shear blades, and master hobs.

S7 is often chosen for hot-work jobs which involve shock. When tempered in the higher range, it is an excellent performer as a hot-work tool where the operating conditions do not cause the temperature of the tool to exceed 1000F.

Machinability - When annealed to Brinell 197 max, S7 is rated at 95, as compared to a rating of 100 for a 1.00 pct carbon tool steel.

Dimensional Stability - When quenched in air from the proper hardening temperature, S7 can be expected to expand no more than 0.001 in./in. of cross-section.

Typical Analysis

Carbon 0.500	Manganese 0.700
Silicon 0.250	Molybdenum 1.400
Vanadium 3.250	

Annealing

Anneal in a protective atmosphere. Heat rapidly to 1500 to 1550°F and hold at that temperature for one and one-half hours for each inch of greatest thickness. To obtain best machining properties, cool slowly to 1000°F, and then air-cool. This annealing procedure should produce a hardness of Brinell 197 max.

Hardening

In order to maintain the surface chemistry, S7 should be hardened in a controlled neutral environment. It should be recognized that packing in cast-iron chips could result in imparting a light, carburized case. Unless such a case is considered desirable for the end use, provision must be made for grinding it off after treatment.

S7 should be preheated at 1200 to 1300°F and raised to the hardening temperature of 1725°F, holding at temperature for one hour for each inch of greatest cross-section. Sections 2-1/2-in. or less should be quenched in still air. Upon reaching 150°F, the piece should be tempered without delay.

Sections over 2-1/2-in. and up to 6 in. should be oil-quenched until black (1000°F), then cooled in air. For massive sections larger than 6 in., it is advisable to oil-quench until the piece reaches 150°F; then temper immediately. (After oil-quenched sections have cooled to room temperature, temper again to insure complete transformation).

To determine the refinement produced by hardening, the fracture grain size and Rockwell C hardness of S7 specimens 1 in. round by 3 in. long were established. Still-air quench, air-blast quench, and oil-quench followed a preheat at 1300°F, and a quench from various temperatures. See accompanying tables.

Still-Air Quench

Quenching	Fracture	
Temperature - °F	rating	Rockwell C
1550	6-1/2	43.5
1600	7	48
1650	8	57
1700	9	60
1725	8-1/2	60
1750	8	60
1800	7	60

Air-Blast Quench

Quenching	Fracture	
Temperature - °F	rating	Rockwell C
1550	6-1/2	52.5
1600	7	57
1650	8-1/2	57.5
1700	9	58
1725	8-1/2	60
1750	8	60
1800	7-1/2	60
1850	7	61

Oil Quench

Quenching	Fracture	
Temperature - °F	rating	Rockwell C
1550	8	52
1600	8	54
1650	9	57.5
1700	9	61
1725	8-1/2	61
1750	8	61.5
1800	8	62
1950	7	62

Tempering

S7 is normally tempered one and one-half hours to two hours for each inch of greatest cross-section. The tempering temperature varies according to the intended use. For cold-working and similar applications, a tempering temperature of 400°F is recommended. For hot-work applications, a tempering temperature of 900 to 1000°F is suggested. Never temper at less than 400°F.

When interrupted oil-quench (to 1000°F) or full oil-quench (to 150°F) has been utilized in hardening, always temper immediately. Then, after cooling all the way down to room temperature, temper again to insure complete transformation.

Specimens 1 in. round by 3 in. long were air-hardened from 1725°F and tempered at various temperatures for 2 hours. Results are shown in the above table.
