Technical Datasheet

CARPENTER

CarTech® S7

Identification

AISI Number

• S7

Type Analysis

Single figures are nominal except where noted.

Carbon	0.50 %	**Manganese**	0.70 %
Silicon	0.30 %	**Chromium**	3.25 %
Molybdenum	1.40 %	**Iron**	Balance

General Information

Description

CarTech S7 is a general purpose air hardening tool steel having high impact and shock resistance. It has good resistance to softening at moderately high temperatures. This combination of properties makes it suitable for many hot-work and cold-work applications.

It is available as a DeCarb-Free product. DCF bars have been cold finished in the mill eliminating the need for bar bark removal.

Both CarTech S7 and Bearcat, a trademark of Bethlehem Steel, Corp., have the same AISI tool steel designation...S7.

Properties

Physical Properties

Specific Gravity	7.83	
Density	0.2830	lb/in³

Mean CTE

77 to 392°F	6.99	x 10 $^{-6}$ in/in/°F
77 to 572°F	7.22	x 10 $^{-6}$ in/in/°F
77 to 752°F	7.41	x 10 $^{-6}$ in/in/°F
77 to 932°F	7.60	x 10 $^{-6}$ in/in/°F
77 to 1112°F	7.78	x 10 $^{-6}$ in/in/°F
77 to 1292°F	7.93	x 10 $^{-6}$ in/in/°F

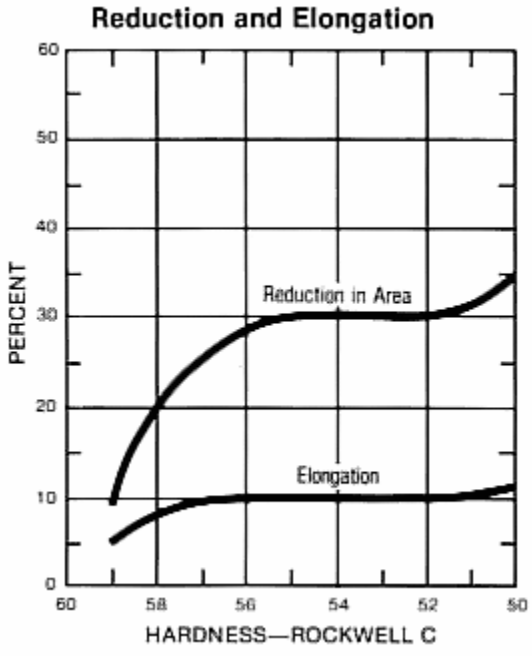
Mean Coefficient of Thermal Expansion

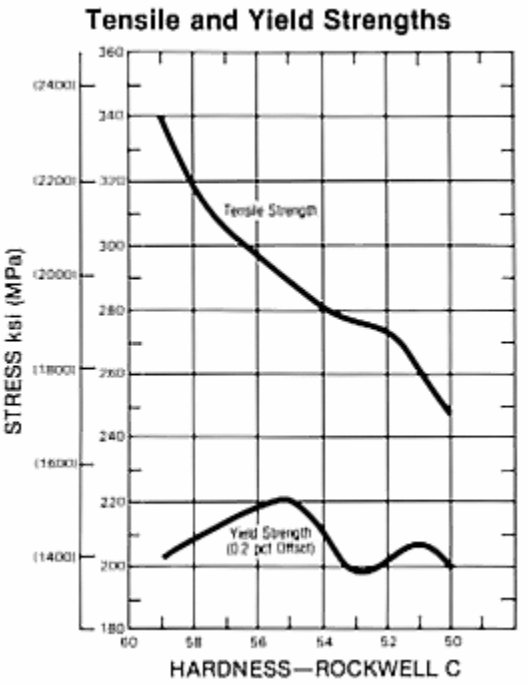
The following figures are the average coefficients between room temperature and the specified elevated temperature. They represent material in the annealed condition and the dimensions are in in/in/° temperature.

Temperature Range		Average Coefficient	
°F	°C	10^{-6}/°F	10^{-6}/°C
77/392	25/200	6.99	12.59
77/572	25/300	7.22	12.99
77/752	25/400	7.41	13.33
77/932	25/500	7.60	13.68
77/1112	25/600	7.78	14.01
77/1292	25/700	7.93	14.27

Critical Temperature (AC1) 1445 °F

Typical Mechanical Properties





Heat Treatment

Decarburization

S7 alloy, like all high carbon tool steels is subject to decarburization during thermal processing and precautions must be taken to control this condition.

Modern furnaces are available which provide environments designed to minimize decarburization.

Annealing

For annealing, the steel should either be placed in a controlled-atmosphere furnace or packed in a suitable container, using a neutral packing compound. Heat uniformly to 1500/1550°F (816/843°C) and cool very slowly in the furnace at a rate of not more than 20°F per hour to a temperature below 1000°F (538°C), then allow to cool naturally. This will produce a maximum hardness of Brinell 223.

Hardening

Tools made of Carpenter S7 tool steel may be hardened by placing them in the furnace maintained at a temperature of 1700/1750°F (927/954°C). Let the tools heat naturally to the furnace temperature, soak for 20 minutes plus 5 minutes per inch (25.4 mm) of maximum thickness and quench.

Sections up to 2 ½" (64.5 mm) thick may be cooled in air. Heavier sections, i.e., with section thickness larger than 2 ½", should be oil quenched to 150°F (66°C). Temper as quickly as possible after the hardening operation.

Control of decarburization can be accomplished by using any one of the several modern heat-treating furnaces designed for this purpose. If endothermic atmospheres are used, a dew point between 40/50°F (+4/10°C) is suggested.

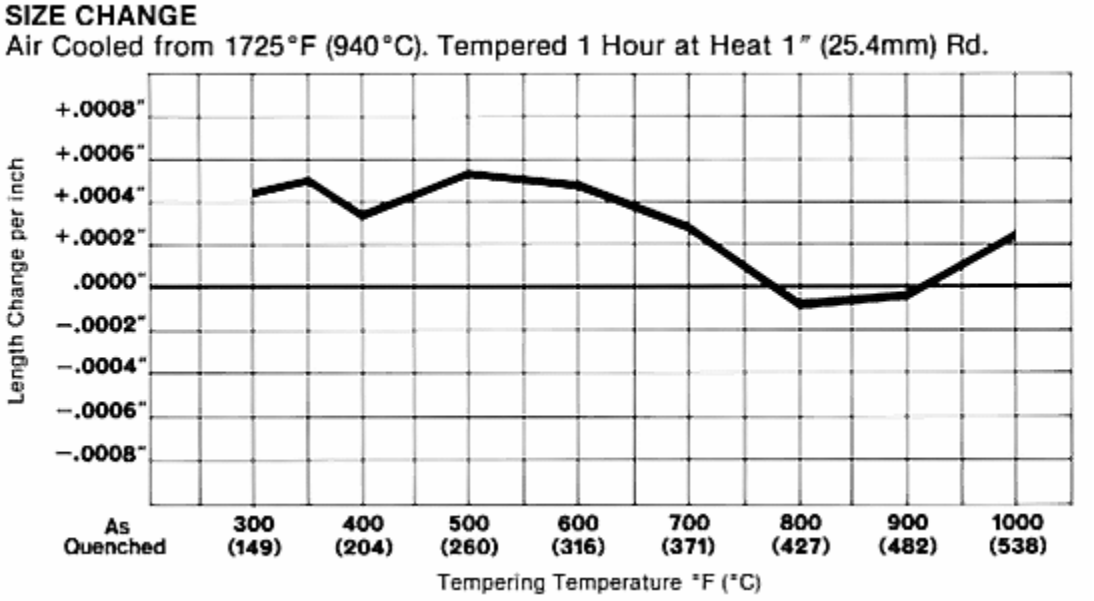
In older type manually operated exothermic atmosphere furnaces, an oxidizing atmosphere is required. Excess oxygen of about 4 to 6% is preferred.

If pack hardening allow 30 minutes per inch (25.4 mm) of packed thickness to ensure that the entire pack is uniformly at the hardening temperature.

Deformation (Size Change) in Hardening

The hyperlink entitled "Size Change in Hardening" shows typical length changes of this steel when it has been properly hardened and tempered. Please note that the length change information is presented in inches per inch of original length. The chart shows that this alloy can be expected to expand slightly over most of it tempering range.

It should be remembered that tool steels hold size best when quenched from the proper hardening temperature. If overheated, they tend to show shrinkage after tempering. The temperatures used to develop this data are shown on the accompanying chart.



Stress Relieving

To relieve machining stresses for greater accuracy in hardening - first rough machine, then anneal below the critical at 1200/1250°F (649/677°C) a minimum of one hour at temperature and cool slowly, then finish machine.

Tempering

The best combination of hardness and toughness is obtained by tempering at about 400°F (204°C). This tempering temperature is therefore suggested for cold-work applications. Tempering at 900/1000°F (482/538°C) is usually desirable for hot-work applications.

Effect of Tempering Temperature on Hardness
Air Cooled from 1725°F (940°C), (Temper 1 Hour at Temperature)

Tempering Temperature		Rockwell C Hardness
°F	°C	
As hardened		59/61
300	149	57/59
400	204	55/57
500	260	53/55
600	316	52/54
700	371	51/53
800	427	51/53
900	482	51/53
1000	538	50/52
1100	593	43/48
1200	649	37/40

Workability

Forging

Heat uniformly and forge from a temperature in the range of 1950/2050°F (1066/1121°C). Do not continue forging below 1700°F (927°C) but reheat as often as necessary. Small, simple forgings can be cooled slowly in dry lime, ashes or other insulating material. The best practice for large forgings is to place them in a furnace heated to about 1400°F (760°C), soak uniformly at this heat, then shut off the heat and let the forgings cool in the furnace. This is not an anneal, and after the forging is cold, it must be properly annealed.

Machinability

The machinability of Carpenter S7 alloy may be rated at about 75/80% of a 1% carbon tool steel, or about 50/55% of B1112. Approximate turning speeds 85/90 surface feet per minute (0.48/0.56 m/s) are suggested when using high-speed cutting tools.

Other Information

Applicable Specifications

- ASTM A681
- QQ-T-570

Forms Manufactured

- Bar-Rounds

Technical Articles

- A Three-Point Program for Improving the Performance of Cold Work Tooling
- Coated Tools of High Strength, High Tough Steel Produce up to 100 Times More Powder Metal Parts
- The ABC's of Alloy Selection, Heat Treating and Maintaining Cold Work Tooling

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