Technical Datasheet

CarTech® No. 481

Identification

UNS Number

• T41905

AISI Number

• Type S5

Type Analysis

Single figures are nominal except where noted.

Carbon	0.55 %	**Manganese**	0.80 %
Silicon	1.90 %	**Chromium**	0.25 %
Molybdenum	0.40 %	**Iron**	Balance

General Information

Description

CarTech No. 481 is a fine-grained, oil hardening, electric furnace shock steel. It combines exceptional toughness to withstand stresses in service with good hardness to resist wear and abrasion. CarTech No. 481 is carefully processed to impart uniform response to heat treatment in both large and small sections.

Applications

CarTech No. 481 was originally designed as a collet steel. The alloy's exceptional toughness and ability to resist wear and abrasion has produced exceptionally long-lasting collets.

In addition, CarTech No. 481 has found applications in a variety of other tooling applications such as:

Pneumatic tools
Chipping chisels
Beating tools
Caulking tools
Flaring tools
Scarfing tools
Button sets
Rivet sets
Shear blades
Clutch dogs
Vise jaws

CarTech No. 481 could be considered for use wherever extreme toughness is a requirement.

Properties

Physical Properties

Specific Gravity	7.75	
Density	0.2800	lb/in³
Mean CTE		
100 to 800°F	7.00	x 10 $^{-6}$ in/in/°F
100 to 1000°F	7.30	x 10 $^{-6}$ in/in/°F
100 to 1200°F	7.60	x 10 $^{-6}$ in/in/°F

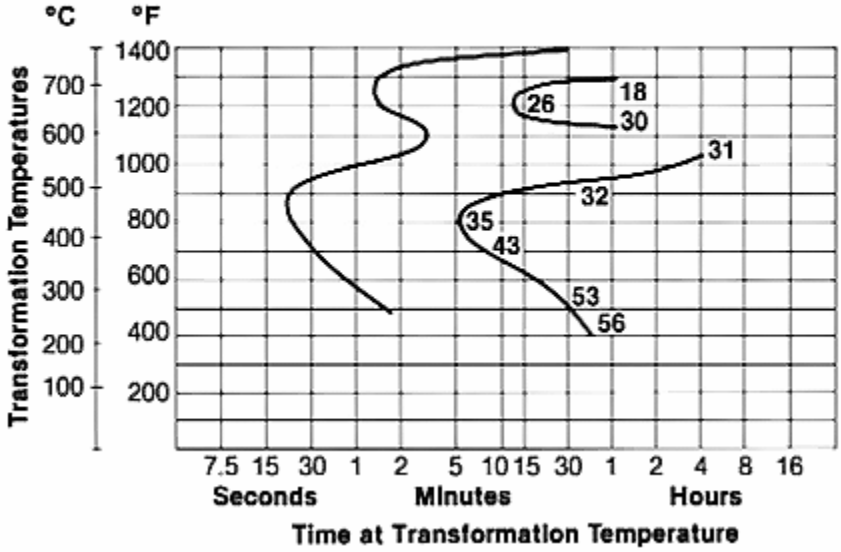
Coefficient of thermal expansion

From 100°F to	38°C to	10^{-6}/°F	10^{-6}/°C
800°F	427°C	7.0	12.6
1000°F	538°C	7.3	13.1
1200°F	649°C	7.6	13.7

Modulus of Elasticity (E) 30.0 x 10^3 ksi

Isothermal transformation diagram

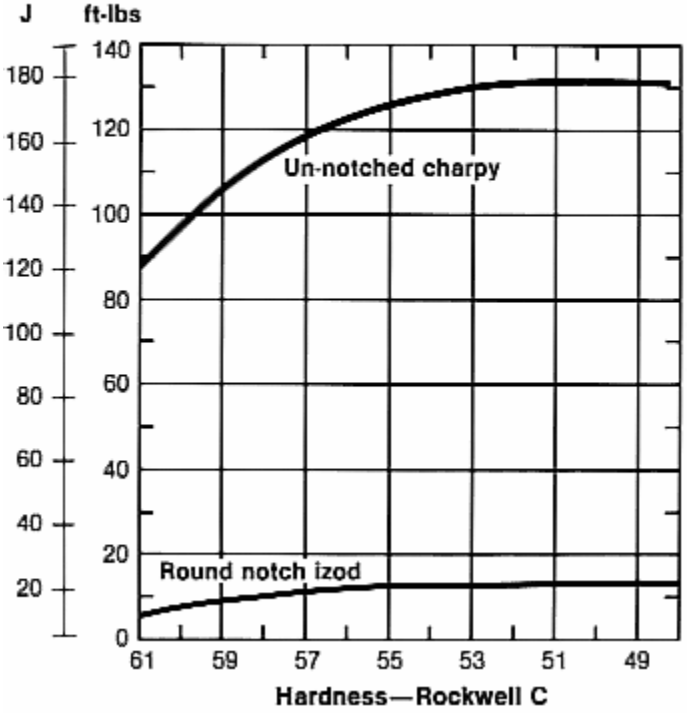
Heated 10 minutes at 1625°F (885°C), then quenched into salt at indicated temperatures and held for various times before water quenching. Results are reported in Rockwell C hardness.



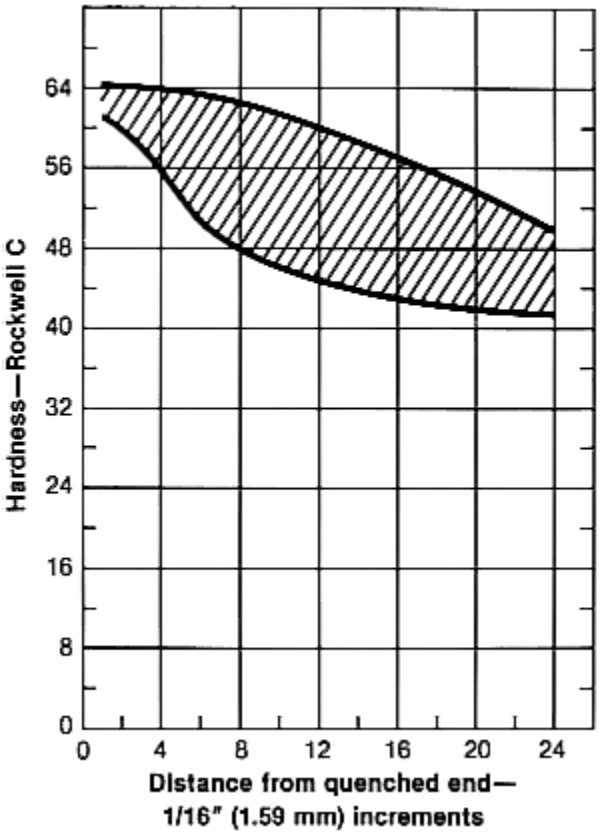
Typical Mechanical Properties

Impact Strength

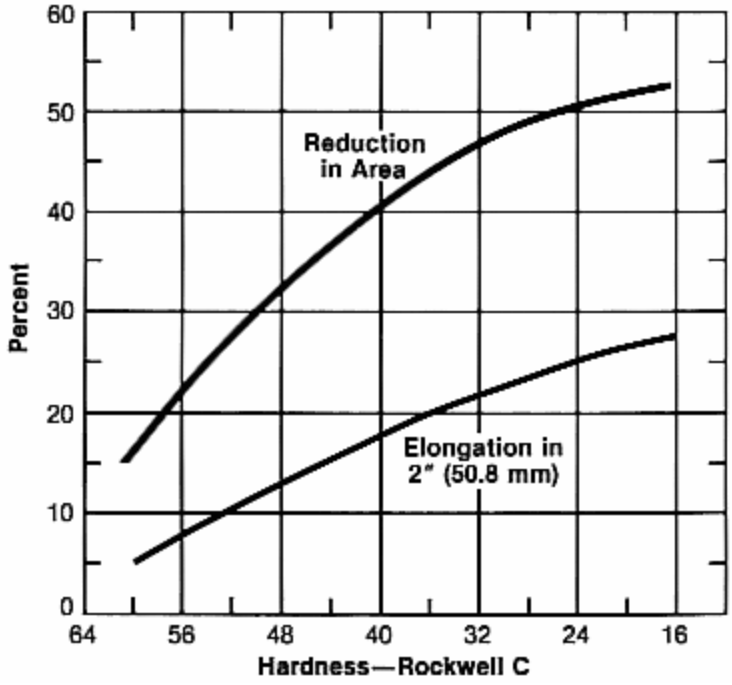
Un-notched charpy and round notch izod

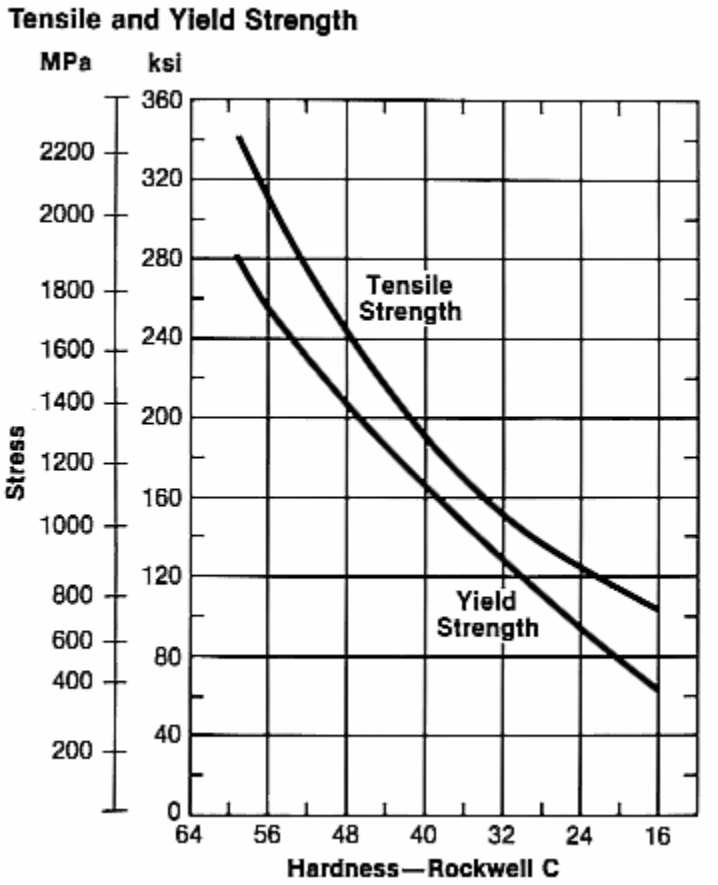


Jominy Hardenability



Percent Elongation in 2″ (50.8 mm) and Percent Reduction in Area





Heat Treatment

Decarburization

Like other silicon tool steels, No. 481 is susceptible to decarburization during heat treating. Precautions must be taken to control this condition.

Neutral salt baths or controlled atmosphere furnaces will minimize decarburization problems. If a controlled endothermic atmosphere is used, a dew point of 50°F (10°C) is suggested. If an exothermic atmosphere is employed, 4% excess oxygen is recommended. A minimum required time at temperature of 5 minutes per inch of thickness is suggested to insure proper hardening.

Normalizing

If proper precautions are taken in controlling the amount of working, and the forging and finishing temperature, it will generally not be necessary to normalize No. 481. Should normalizing be required for the purpose of grain refinement, heat uniformly to 1600/1650°F (871/899°C), then cool in still air.

Annealing

No. 481 should either be packed in a suitable container using a neutral packing compound or placed in a controlled atmosphere furnace.

Heat uniformly to 1350/1400°F (732/760°C), then cool very slowly in the furnace at a rate of not more than 20°F (11.1°C) per hour until the furnace is black. The furnace may then be turned off and allowed to cool naturally. This will produce a maximum hardness of Brinell 229.

Hardening

No. 481 may be hardened from temperatures between 1575/1600°F (857/871°C). Endothermic atmospheres should be held to dew point limits of between 50/60°F (10/15.6°C).

Without preheating, place the tool right in the hot furnace and let it heat naturally until its color uniformly matches the color of the thermocouple in the furnace. Soak an additional 5 minutes per inch of thickness, then quench in oil. The temperature of the tool should be brought right down to the temperature of the oil in the quench.

The basket in the quenching tank serves as a good place to store hardened tools while waiting to be tempered.

No. 481 is an easy tool steel to harden. Simply heat it, soak it, then quench it. This procedure saves time and trouble, is the safest procedure and yields better tools.

No. 481 may also be water quenched using a hardening range of 1525/1550°F (830/843°C). This will yield an extra point or two of Rockwell C hardness and will increase wear resistance to some degree, however, this introduces a danger of cracking in complicated sections. In addition, increased size change and distortion may occur due to the more drastic water quench.

Deformation (Size Change) in Hardening

No. 481 will exhibit some growth during the hardening and tempering operation. While this tool steel can be both water and oil quenched, its size change characteristics are minimized when using oil.

Stress Relieving

To relieve machining stresses for greater accuracy in hardening, first rough machine, then heat to a temperature of 1200/1250°F (649/677°C), hold at heat for a minimum of 1 hour, then cool slowly. After cooling the part or parts may be finish machined.

Tempering

Effect of Tempering Temperature on No. 481
Austenitize 1600°F (871°C)—tempered at indicated temperature

Tempering Temperature		Oil Quench Rockwell Hardness
°F	°C	
As quenched		C 61-62
300	149	60
400	204	59
500	260	59
600	316	58
700	371	57
800	427	54
900	482	51
1000	538	49
1100	593	44
1200	649	37
1300	704	31

Workability

Forging

Heat slowly and uniformly to 1900/2100°F (1038/1149°C), then proceed to work. Do not forge below 1550°F (843°C). After forging, cool slowly in lime, ashes or in the furnace.

As silicon shock steels are subject to decarburization during the forging operation, allow enough forging stock for cleanup of finished parts. Also, avoid unduly long exposure to forging heat as this may contribute to excessive decarburization.

Machinability

The machinability of No. 481 may be rated between 65 and 75% of a 1% carbon water hardening tool steel, or about 45% to 55% of B1112.

Approximate turning speeds of 85/110 surface feet per minute (SFPM) (0.43/0.56 m/s) are suggested when using high-speed cutting tools.

Following are typical feeds and speeds for No. 481.

The machinability of No. 481 may be rated between 65 and 75% of a 1% carbon water hardening tool steel, or about 45% to 55% of B1112.

Approximate turning speeds of 85/110 surface feet per minute (sfpm) (0.43/0.56 m/s) are suggested when using high-speed cutting tools.

The following charts contain information on typical speeds and feeds used in machining No. 481. All results are for operations performed on material in the annealed condition.

Turning—Single Point and Box Tools

Depth of Cut In.	High-Speed Tools			Carbide			
				Speed, fpm			
	Speed, fpm	Feed, ipr	Tool Material	Brazed	Throw Away	Feed, ipr	Tool Material
.150	90	.015	M-2	310	410	.020	C-6
.025	100	.007	M-3	410	500	.007	C-7

Turning—Cut-Off and Form Tools

Speed, fpm	Feed, ipr							Tool Material
	Cut-Off Tool Width, Inches			Form Tool Width, Inches				
	1/16	1/8	1/4	1/2	1	1-1/2	2	
75	.0015	.002	.0025	.0025	.0015	.0015	.001	M-2
250	.004	.005	.006	.005	.0035	.0035	.0025	C-6

Drilling

Speed, fpm	Feed, ipr								Tool Material
	Nominal Hole Diameter, Inches								
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
55	.001	.002	.003	.007	.009	.011	.014	.016	M-1;M-10

Reaming

High-Speed Tool							Carbide Tool		
Speed, fpm	Feed, Inches per Rev						Tool Material	Speed, fpm	Tool Material
	Reamer Diameter, Inches								
	1/8	1/4	1/2	1	1-1/2	2			
85	.003	.005	.008	.011	.015	.018	M-7	250	C-2

Milling—End Peripheral

Depth of Cut In.	High-Speed Tools						Carbide Tools					
	Speed, fpm	Feed—Inches per tooth				Tool Material	Speed, fpm	Feed—Inches per tooth				Tool Material
		Cutter Diameter, Inches						Cutter Diameter, Inches				
		1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
.150	85	.002	.003	.004	.005	M-2;M-7	365	.002	.003	.005	.007	C-6

Additional Machinability Notes

Figures used for all metal removal operations covered are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds and feeds should be increased and decreased in small steps.

Other Information

Applicable Specifications

- ASTM A681

Speed, fpm	Chip Load, Inches per tooth	Tool Material
15	.003	M-42

Sawing—Power Hack Saw

Pitch—Teeth per Inch				Speed	Feed
Material Thickness, Inches					
Under 1/4	1/4-3/4	3/4-2	Over 2	Strokes/Minute	Inches/Stroke
10	6	6	4	140	006

Forms Manufactured

• Bar-Rounds

Edition Date: 07/01/1986

Visit us on the web at www.cartech.com