Technical Datasheet

CarTech® 416 Project 70®+ Stainless

Identification

U.S. Patent Number

- 6,146,475

UNS Number

- S41600

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.15 %	**Manganese (Maximum)**	1.20 %
Phosphorus (Maximum)	0.060 %	**Sulfur (Minimum)**	0.150 %
Silicon (Maximum)	1.00 %	**Chromium**	12.00 to 14.00 %
Iron	Balance		

General Information

Description

CarTech 416 Project 70+ Stainless is an improved modification of CarTech No. 5 stainless, the first free-machining stainless steel. Customers reported that this grade has significantly better machinability than the conventional Type 416, including the following characteristics:

1. 100 to 200% longer tool life.
2. 15% faster machining speeds.
3. Improved finishes.

The low frictional properties of CarTech 416 Project 70+ stainless have minimized scratching and galling in service. Threaded sections have worked freely without seizing and disassembly was particularly easy because of the absence of corrosion in the threads. Pump shafts and valve stems worked more smoothly in packing, and many metal-to-metal contacts withstood more pressure without seizing. This product meets most industry specifications for type 416.

This grade is available in machining bar stock in the Annealed Condition (A), and also Mill Treated in the Intermediate Temper Condition (T), and Hard Temper Condition (H). The Mill Treated Conditions may be utilized to eliminate piece part heat treatment if piece part hardness requirements are compatible with treated barstock hardness ranges. Where corrosion resistance is required, treated CarTech Project 70+ Type 416 stainless may be considered as a replacement for Mill Treated carbon steel grade 1144.

CarTech 416 Project 70+ PDB® stainless combines the superior machinability of CarTech Project 70+ stainless with improved straightness and half-standard dimensional tolerances. This precision drawn bar has been used successfully in a variety of machining operations including CNC Swiss-type screw machines.

Applications

The uses of CarTech 416 Project 70+ Stainless have included fittings, gears, housings, lead screws, shafts, valve bodies, valve stems, and valve trim. It may be considered for parts requiring considerable machining.

This alloy possesses better nongalling properties than Type 410, making disassembly of parts easy and helping to avoid scratching or galling in moving parts.

It is not recommended for vessels containing gases or liquids under high pressures.

Scaling

The safe scaling temperature for continuous service is 1200ºF (649ºC).

Corrosion Resistance

Project 70+ Type 416 stainless has been used for corrosion resistance to mild atmospheres, fresh water, steam, ammonia, many petroleum products and organic materials and several mild acid environments. A polished finish is not necessary, but a smoother surface is helpful in providing added corrosion resistance.

For optimum corrosion resistance, surfaces must be free of scale, lubricants, foreign particles, and coatings applied for drawing and heading. After fabrication of parts, cleaning and/or passivation should be considered.

Important Note: *The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Nitric Acid	Restricted	Sulfuric Acid	Restricted
Phosphoric Acid	Restricted	Acetic Acid	Restricted
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Restricted
Humidity	Moderate		

Properties

Physical Properties

Specific Gravity	7.64	
Density	0.2760	lb/in³
Mean Specific Heat (32 to 212°F)	0.1100	Btu/lb/°F
Mean CTE (32 to 1200°F)	6.50	x 10 $^{-6}$ in/in/°F
Electrical Resistivity (73°F)	343.0	ohm-cir-mil/ft

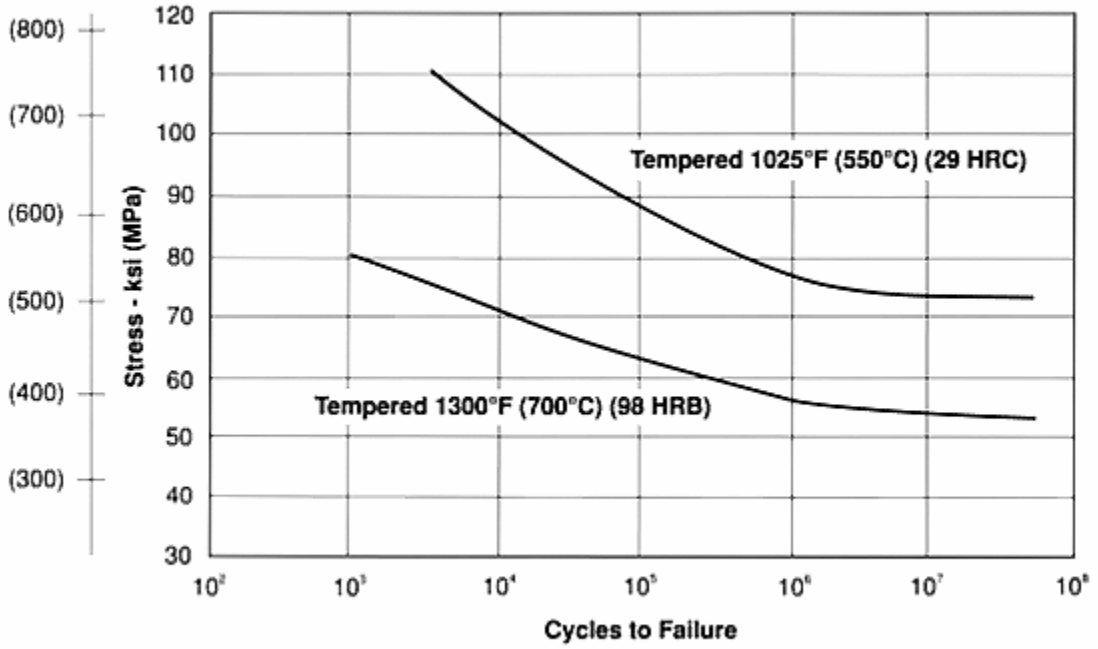
Typical Mechanical Properties

Typical Room Temperature Mechanical Properties

1" (25.4 mm) round bar, hardened 1800°F (982°C) 1/2 hour, oil quench, tempered two hours

Tempering Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Hardness		Impact Strength			
										Izod		Charpy V-Notch	
°F	°C	ksi	MPa	ksi	MPa			Brinell	Rockwell	ft-lb	J	ft-lb	J
300	149	138	951	176	1213	10	20	363	C 38	20	27	20	27
500	260	136	938	171	1179	11	32	352	C 37	25	34	22	30
700	371	136	938	171	1179	14	45	352	C 37	20	27	22	30
900	482	125	862	160	1103	15	45	331	C 35	16	22	15	20
1000	538	110	758	137	945	16	50	285	C 30	25	34	23	31
1100	593	95	655	114	786	17	54	235	C 22	40	54	40	54
1200	649	83	572	103	710	21	57	207	B 95	55	75	50	68
1300	704	75	517	95	655	21	60	187	B 92	80	108	75	102

Typical Rotating Beam Fatigue Data
R.R.Moore specimens from 1" (25.4mm) rd. bar



Tempered 1025°F (550°C) = 130 ksi (896 MPa) UTS
Tempered 1300°F (700°C) = 103 ksi (710 MPa) UTS

Heat Treatment

Annealing

Heat uniformly to 1200/1400ºF (649/760ºC); soak, then remove from the furnace and cool in air. Brinell hardness approximately 187. For maximum softness anneal from a temperature of 1500/1650ºF (816/899ºC) and cool in furnace. Brinell hardness 155.

Hardening

Heat to 1800/1900ºF (982/1038ºC), soak at heat about 1/2 hour, quench in oil-hardness as-quenched will be Rockwell C 36 to 41. Air cooling will yield about Rockwell C 35 to 39. Bright hardening will usually yield lower hardness since the cooling rate is frequently less than air cooling. Carpenter No. 5 BQ may be considered when bright hardening is necessary.

Tempering

Temper to secure the hardness and mechanical properties desired.

Tempering this alloy in the range of 750/1050ºF (399/566ºC) results in decreased impact strength and also reduced corrosion resistance (the nature and extent of which vary with the media involved). However, tempering in this range is sometimes necessary to obtain the strength and ductility properties required. In many applications and environments, the reduced impact strength is not necessarily detrimental, and the corrosion resistance is only mildly reduced or even unaffected.

Workability

Hot Working

Although this grade can be forged, it is not recommended for upsetting operations. (A special modification of Type 416 is available for forging operations.) To forge, heat uniformly to 2100/2250ºF (1149/1232ºC), then forge and cool in air. Cool large forgings slowly in dry lime or ashes. Trim hot if possible; otherwise, anneal and trim cold. Do not forge below 1700ºF (927ºC).

Cold Working

Carpenter Project 70+ Type 416 stainless will withstand some cold work, but it is not recommended for cold upsetting. The primary application to be considered for this steel is in parts that are machined to shape.

Machinability

Project 70+ Type 416 stainless cuts very freely primarily because of the addition of sulfur. When it has been used in automatic screw machines, this grade machines like AISI C1117.

Following are typical suggested starting feeds and speeds for Project 70+ Type 416 stainless.

Typical Machining Speeds and Feeds—Project 70+ Type 416 stainless

The speeds and feeds in the following charts are conservative recommendations for initial setu
Higher speeds and feeds may be attainable depending on machining environment.

Turning—Single-Point and Box Tools

Depth of Cut (Inches)	Micro-Melt® Powder HS Tools			Carbide Tools (Inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed (fpm) Uncoated	Speed (fpm) Coated	Feed (ipr)
.150	M48,T15	210	.015	C6	600	775	.015
.025	M48,T15	240	.007	C7	675	875	.007

Turning—Cut-Off and Form Tools

Tool Material		Speed (fpm)	Feed (ipr)						
Micro-Melt® Powder HS	Carbide Tools		Cut-Off Tool Width (inches)				Form Tool Width (inches)		
			1/16	1/8	1/4	1/2	1	1½	2
M48, T15		150	.0015	.002	.0025	.002	.002	.0015	.001
	C6	360	.004	.005	.007	.005	.004	.0035	.0035

Rough Reaming

Micro-Melt® Powder HS		Carbide Tools		Feed (ipr) Reamer Diameter (inches)					
Tool Material	Speed (fpm)	Tool Material	Speed (fpm)	1/8	1/4	1/2	1	1½	2
M48, T15	130	C2	150	.005	.008	.013	.018	.022	.025

Drilling

Tools									
Tool Material	Speed (fpm)	Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1½	2
C2-Uncoated	225	.001	.003	.006	.0085	.0119	.0136	.0158	.016
C2-Coated	280	.001	.003	.006	.0085	.0119	.0136	.0158	.016
M42	100-120	.001	.003	.006	.010	.014	.017	.021	.025

Die Threading

FPM for High Speed Tools				
Tool Material	7 or less, tpi	8 to 15, tpi	16 to 24, tpi	25 and up, tpi
M7, M10	15-25	25-35	35-45	40-50

Milling, End-Peripheral

Depth of Cut (inches)	Micro-Melt® Powder HS Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (in)				Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (in)			
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2
.050	M48, T15	140	.001	.002	.004	.005	C6	375	.001	.002	.005	.007

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
M7, M10	25-50

Broaching

High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M7	25	.004

Additional Machinability Notes

Figures used for all metal removal operations covered are starting points. 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 or feeds should be increased or decreased in small steps.

This alloy is available in an enhanced precision drawn bar product. Learn more about the Project 70+ PDB stainless family at Carpenter's MachiningZone.com.

Weldability

Project 70+ Type 416 stainless is not recommended for welding.

Other Information

Applicable Specifications

Project 70+ Type 416 and Project 70+ PDB Type 416 stainless meet most standard industry and government specifications for Type 416.

- AMS 5610
- ASTM A314
- ASTM A581
- ASTM A582
- MIL-S-52263
- MIL-S-862
- QQ-S-764

Forms Manufactured

Annealed Condition A: Brinell Hardness 241 Maximum, Bar Sizes
Annealed Condition A: Tensile Strength 85-115 ksi, Wire Sizes
Heat Treated Condition T: Brinell Hardness 255-302, Bar Sizes
Heat Treated Condition T: Tensile Strength 125-145 ksi, Wire Sizes
Heat Treated Condition H: Brinell Hardness 302-352, Bar Sizes
Heat Treated Condition H: Tensile Strength 145-175 ksi, Wire Sizes

- Bar-Flats
- Bar-Hexagons
- Bar-Rounds
- Bar-Squares
- Wire
- Wire-Rod

Technical Articles

- A Designer's Manual On Specialty Alloys For Critical Automotive Components
- Alloy Variation Solves Metal Flow Problem in Staking components for Emission Controls
- How to Passivate Stainless Steel Parts
- New Ideas for Machining Austenitic Stainless Steels
- Passivating and Electropolishing Stainless Steel Parts

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