Technical Datasheet

CarTech® 316/316L Project 70®+ Stainless

Identification

U.S. Patent Number

- 5,512,238

UNS Number

- S31600/S31603

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.03 %	**Manganese (Maximum)**	2.00 %
Phosphorus (Maximum)	0.045 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	16.00 to 18.00 %
Nickel	10.00 to 14.00 %	**Molybdenum**	2.00 to 3.00 %
Iron	Balance		

General Information

Description

CarTech 316/316L Project 70+ Stainless is an improved-machining version of conventional Type 316/316L.

Customers may be able to attain machining speed improvements averaging up to 50% and higher over AISI Type 316/316L stainless. CarTech 316/316L Project 70+ Stainless has reduced tool wear and increased machine speeds and feeds to help improve productivity and reduce part costs. It is a good general purpose product for simple as well as complex parts at a wide range of machining speeds.

CarTech 316/316L Project 70+ Stainless meets most industry specifications for CarTech 316/316L. It has been shown to minimize carbide precipitation during welding. Customers reported that they have used this steel in the as-welded condition in a variety of corrosive applications.

CarTech 316/316L 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.

A special premium-melted version of CarTech 316L stainless, called carTech 316L-SCQ® stainless, is available which offers improved internal cleanness (lower inclusion content) over conventional air melted product. This enhancement is advantageous for thin sections under high pressure or vacuum, and to achieve optimum surface quality after electropolishing. Contact Carpenter for details.

Applications

CarTech 316/316L Project 70+ Stainless may be considered for use in paper pulp handling equipment, process equipment for producing photographic chemicals, ink, rayon, rubber, textile bleaches and dyestuffs, as well as various high temperature equipment applications.

Scaling

The safe scaling temperature for continuous service is 1600°F (871°C).

Corrosion Resistance

Project 70+ Type 316/316L stainless has been used in sulfite pulp mills to resist corrosion by sulfurous acid compounds. Due to its superior corrosion resistance, its use has been extended to handling many of the chemicals used by chemical process industries.

The alloy is more resistant to pitting than conventional 18-8 alloys.

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	Good	Sulfuric Acid	Moderate
Phosphoric Acid	Moderate	Acetic Acid	Good
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Good
Sea Water	Moderate	Sour Oil/Gas	Moderate
Humidity	Excellent		

Properties

Physical Properties

Specific Gravity	7.95	
Density	0.2870	lb/in³
Mean Specific Heat (32 to 212°F)	0.1200	Btu/lb/°F
Mean CTE (32 to 1200°F)	10.3	x 10^{-6} in/in/°F
Thermal Conductivity (212°F)	113.0	BTU-in/hr/ft²/°F
Modulus of Elasticity (E)	28.0	x 10^{3} ksi
Electrical Resistivity (73°F)	445.0	ohm-cir-mil/ft

Typical Mechanical Properties

Typical Elevated Temperature Mechanical Properties– Project 70+ Type 316/316L Stainless

1" (25.4 mm) round bar, annealed 2050°F (1121°C), water quenched

Test Temperature		Short-Time Tensile Tests		Creep Tests	
		Ultimate Tensile Strength		Stress for 1% Elongation in 10,000 hours	
°F	°C	ksi	MPa	ksi	MPa
70	21	85	586	--	--
1000	538	73	503	25	172
1100	593	70	483	18	124
1200	649	67	462	13	90
1300	704	65	448	8	55
1400	760	51	352	5	34
1500	816	40	276	3	21

Typical Room Temperature Mechanical Properties–Project 70+ Type 316/316L
1" (25.4 mm) round bar, annealed 1950°F (1066°C), water quenched

Condition	0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Rockwell B Hardness at Midradius	Charpy V-Notch Impact Strength	
	ksi	MPa	ksi	MPa				ft-lb	J
Annealed	36	248	82	565	69	76	80	240*	325*
Annealed + Cold Drawn	75	517	96	662	42	75	96	140	190

*Specimen did not fracture completely. Tensile specimens from center of bar; impact specimens from mid-radius location.

Heat Treatment

Annealing

Heat to 1850/2050°F (1010/1121°C) and water quench. Brinell hardness approximately 150.

Hardening

Cannot be hardened by heat treatment. Hardens only by cold working.

Workability

Hot Working

Project 70+ Type 316/316L stainless can be readily forged, upset and hot headed.

To forge, heat uniformly to 2100/2300°F (1149/1260°C). Do not forge below 1700°F (927°C). Forgings can be air cooled.

Best corrosion resistance is obtained if the forgings are given a final anneal. For optimum forgeability, Type 316 or 316L Forging Quality may be considered.

Cold Working

Project 70+ Type 316/316L stainless can be deep drawn, stamped, headed and upset without difficulty. Since this alloy work hardens, severe cold forming operations should be followed by an anneal.

Machinability

Project 70+ Type 316/316L stainless is chemically balanced and processed for optimum machinability in a Type 316/316L analysis without using full resulfurization as is done for the Type 316F analyses.

The alloy machines with chip characteristics between those of conventional Type 316/316L and Type 316F. Although chips may not be as stringy as those of conventional Type 316/316L, the use of chip curlers and breakers is still advised. Since the austenitic stainless steels work harden rapidly heavy positive feeds should be considered.

Following are starting point feeds and speeds for Project 70+ Type 316/316L stainless.

Typical Machining Speeds and Feeds—Project 70+ Type 316/316L stainless

The speeds and feeds in the following charts are conservative recommendations for initial setup. 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	140	.0180	C2	470	600	.0180
.025	M48,T15	171	.0084	C3	530	660	.0084

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		124	.0018	.0024	.0024	.0024	.0018	.0012	.0012
	C2	468	.0048	.0066	.0084	.0060	.0048	.0042	.0042

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	124	C2	130	.0036	.0060	.0096	.0144	.0180	.0216

Drilling

Tool Material	Speed (ipm)	Tools: Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1½	2
M42	78-98	.0012	.0024	.0048	.0084	.0120	.0204	.0252	.0300
C2-Uncoated	110	--	.002	.004	.006	.0085	.0096	.0113	.0113
C2-Coated	180	.0005	.002	.004	.006	.0085	.0096	.0113	.0113

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
T15, M42	11-13	16-29	26-39	39-46

Milling, End—Peripheral

Depth of Cut (inches)	Micro-Melt® Powder HS Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (inches) 1/4	1/2	3/4	1-2	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (inches) 1/4	1/2	3/4	1-2
.050	M48, T15	140	.0012	.0024	.0036	.0048	C2	358	.0012	.0024	.0036	.0060

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
T15, M42	19-50

Broaching

High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
T15, M42	20	.0036

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 316/316L stainless can be satisfactorily welded by the shielded fusion and resistance welding processes. Since austenitic welds do not harden on air cooling, the welds should have good toughness.

Oxyacetylene welding is not recommended since carbon pickup in the weld may occur.

The alloy can be welded without loss of corrosion resistance due to intergranular carbide precipitation. Usually the alloy can be used in the as-welded condition; however, for service in the most severe environments, the welded structure should be reannealed after welding.

Where a filler metal is required, AWS E/ER 316L welding consumables should be considered.

Other Information

Applicable Specifications

Project 70+ Type 316/316L, Type 316L-SCQ and Project 70+ PDB Type 316/316L stainless meet most standard industry and government specifications for Type 316/316L.

- AMS 5648
- AMS 5653
- AMS-QQ-S-763
- ASME SA479
- ASTM A193
- ASTM A276
- ASTM A479
- ASTM F899
- QQ-S-763

Forms Manufactured

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

Technical Articles

- How to Passivate Stainless Steel Parts
- Improved Stainless Steels for Medical Instrument Tubing
- Invar Alloy-There's Profit to be Made in Machining This Popular, High Tech Material
- Passivating and Electropolishing Stainless Steel Parts
- Selecting Alloys for Severely Corrosive Environments
- Selecting New Stainless Steels for Unique Applications
- Selecting Optimal Stainless Steels for Bio-Pharmaceutical Service
- Selecting Stainless Steels for Valves
- Two Galling Resistant Stainless Steels Used for Bridge Hinge Pins

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