Technical Datasheet

CarTech® 316/316L Stainless

Identification

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 stainless is a low carbon version of conventional CarTech 316 stainless.

In this low-carbon austenitic alloy, control of carbon to a maximum of 0.03% has been shown to minimize carbide precipitation during welding. Customers have reported the use of this steel in the as-welded condition in a variety of corrosive applications.

CarTech 316/316L stainless is suggested for applications requiring a moderate level of improvement in machinability for shorter runs of less complex parts, particularly at larger bar diameters.

Manufacturers interested in realizing the potential economic benefits and lower costs associated with higher machining speeds and lower cycle times should consider CarTech 316/316L Project 70+® stainless.

Customers have reported that CarTech 316/316L Project 70+ stainless offers significantly improved machinability characteristics over generic CarTech 316/316L stainless. This includes up to 50% and higher machining speeds, with improved finishes and longer tool life.

Applications

CarTech 316/316L stainless should be considered for use in paper pulp handling equipment, process equipment for producing photographic chemicals, inks, 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

Carpenter Stainless Type 316/316L 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
Electrical Resistivity (73°F)	445.0	ohm-cir-mil/ft

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

Forging

Carpenter Stainless Type 316/316L 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.

Cold Working

Carpenter Stainless Type 316/316L 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

Carpenter Stainless Type 316/316L machines with chip characteristics that are tough and stringy. The use of chip curlers and breakers is advised. Since the austenitic stainless steels work harden rapidly, heavy positive feeds should be considered.

Following are typical feeds and speeds for Carpenter Stainless Type 316/316L.

Typical Machining Speeds and Feeds—Carpenter Stainless Type 316/316L

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	102	.015	C2	350	450	.015
.025	M48,T15	120	.007	C3	400	525	.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		90	.001	.0015	.002	.0015	.001	.001	.001
	C2	330	.004	.0055	.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	84	C2	90	.003	.005	.008	.012	.015	.018

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	1 ½	2
M42	50-60	.001	.002	.004	.007	.010	.012	.015	.018
C2-Uncoated	110	--	.002	.004	.006	.0085	.0096	.0113	.0113
C2-Coated	140	.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
M7, M10	8-15	10-20	15-25	25-30

Milling, End—Peripheral

Depth of Cut (inches)	Micro-Melt® Powder HS Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (inches)				Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (inches)			
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2
.050	M48, T15	90	.001	.002	.003	.004	C2	270	.001	.002	.003	.005

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
M7, M10	12-25

Broaching

High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M48, T15	18	.0040

Additional Machinability Notes

When using carbide tools, surface speed feet/minute (SFPM) can be increased between 2 and 3 times over the high-speed suggestions. Feeds can be increased between 50 and 100%.

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 or feeds should be increased or decreased in small steps.

Weldability

Carpenter Stainless Type 316/316L 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/ER316L welding consumables should be considered.

Other Information

Applicable Specifications

- AMS 5648
- AMS 5653
- ASME SA479
- ASTM A182
- ASTM A276
- ASTM A314
- ASTM A479
- MIL-S-862
- QQ-S-763

Forms Manufactured

- Bar-Hexagons
- Bar-Rounds

Technical Articles

- A Designer's Manual On Specialty Alloys For Critical Automotive Components
- Alloy Selection for Cold Forming (Part I)
- Alloy Selection for Cold Forming (Part II)
- How to Select the Right Stainless Steel or High Temperature Alloy for Heading
- New Ideas for Machining Austenitic Stainless Steels
- Selecting Optimal Stainless Steels for Bio-Pharmaceutical Service
- Selecting Stainless Steels for Valves
- Selection of High Strength Stainless Steels for Aerospace, Military and Other Critical Applications
- Stainless Steel Rebar For Concrete Reinforcement: An Update And Selection Guide

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