Technical Datasheet

CarTech® 321 Stainless

Identification

UNS Number

- S32100

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.08 %	**Manganese (Maximum)**	2.00 %
Phosphorus (Maximum)	0.045 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	17.00 to 19.00 %
Nickel	9.00 to 12.00 %	**Titanium**	5 X C Minimum
Iron	Balance		

General Information

Description

CarTech 321 stainless is a titanium stabilized austenitic chromium-nickel stainless steel which was developed to provide an 18-8 type alloy with improved intergranular-corrosion resistance. Since titanium has a stronger affinity for carbon than chromium, titanium carbide tends to precipitate randomly within the grains instead of forming continuous patterns at the grain boundaries. Type 321 should be considered for applications requiring intermittent heating between 800ºF (427ºC) and 1650ºF (899ºC) such as aircraft collector rings and exhaust manifolds, expansion joints, and high temperature chemical process equipment.

Scaling

The safe scaling temperature for continuous service is 1600ºF (871ºC).

Corrosion Resistance

Annealed Carpenter Stainless Type 321 is resistant to atmospheric corrosion, foodstuffs, sterilizing solutions, many organic chemicals and dyestuffs, and a wide variety of inorganic chemicals. It has excellent intergranular-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	Good	Sulfuric Acid	Moderate
Phosphoric Acid	Moderate	Acetic Acid	Moderate
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Good
Sea Water	Restricted	Sour Oil/Gas	Moderate
Humidity	Excellent		

Properties

Physical Properties

Specific Gravity	7.86	
Density	0.2844	lb/in³
Mean Specific Heat (32 to 212°F)	0.1200	Btu/lb/°F
Mean CTE (32 to 1200°F)	10.4	x 10^{-6} in/in/°F
Electrical Resistivity (70°F)	433.0	ohm-cir-mil/ft

Typical Mechanical Properties

Typical Elevated Temperature Mechanical Properties
Annealed condition

Test Temperature		0.2% Yield Strength		Short-Time Tensile Tests				Creep Tests	
				Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Stress for 1% Creep in 10,000 Hours	
°F	°C	ksi	MPa	ksi	MPa			ksi	MPa
70	21	35	241	85	586	60	70	—	—
800	427	25	172	61	421	37	66	—	—
1000	538	23	159	55	379	36	69	17	117
1200	649	20	138	45	310	32	66	7	48
1400	760	15	103	30	207	33	55	2	14
1600	871	10	69	20	138	40	60	—	—

Typical Room Temperature Mechanical Properties
1" (25.4 mm) round bar, annealed 1900°F (1038°C)

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Brinell Hardness	Izod Impact Strength	
ksi	MPa	ksi	MPa				ft-lb	J
35	241	85	586	60	70	150	110	149

Heat Treatment

Annealing

Heat to 1750/1950ºF (954/1066ºC) and quench in water. Brinell hardness approximately 150.

Hardening

Can only be hardened by cold working.

Stabilizing

When temperatures up to about 1600ºF (871ºC) are expected in service, a stabilizing treatment at 1550/1650ºF (843/899ºC) may be used to provide optimum intergranular corrosion resistance.

Workability

Hot Working

Carpenter Stainless Type 321 can be readily forged, hot headed, riveted and upset. Because of its high red-hardness, more power for a given reduction is required than with mild steel.

Forging

Heat uniformly to 2100/2300ºF (1149/1260ºC). Do not forge below 1700ºF (927ºC). Forgings can be air-cooled. For full corrosion resistance, forgings must be water quenched or annealed.

Cold Working

Carpenter Stainless Type 321 is readily fabricated by cold working. Being extremely tough and ductile, it responds to deep drawing, bending, forming and upsetting. After cold working, it is slightly magnetic. The tensile strength and hardness of Carpenter Stainless Type 321 can be significantly increased by cold working.

Machinability

Like all the austenitic steels, this alloy machines with a tough and stringy chip. Rigidly supported tools, with as heavy a cut as possible, should be used to prevent glazing. Moderate cold working can improve machined surface finish.

Following are typical feeds and speeds for Carpenter Stainless Type 321.

Typical Machining Speeds and Feeds – Carpenter Stainless Type 321

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)	High Speed Tools			Carbide Tools (Inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed (fpm)		Feed (ipr)
					Uncoated	Coated	
.150	T15	85	.015	C2	350	450	.015
.025	M42	100	.007	C3	400	520	.007

Turning—Cut-Off and Form Tools

Tool Material		Speed (fpm)	Feed (ipr)						
			Cut-Off Tool Width (inches)				Form Tool Width (inches)		
High Speed Tools	Car-bide Tools		1/16	1/8	1/4	1/2	1	1 ½	2
M2		80	.001	.0015	.002	.0015	.001	.001	.001
	C2	300	.004	.0055	.007	.005	.004	.0035	.0035

Rough Reaming

High Speed		Carbide Tools		Feed (ipr) Reamer Diameter (inches)					
Tool Material	Speed (fpm)	Tool Material	Speed (fpm)	1/8	1/4	1/2	1	1 ½	2
M7	70	C2	90	.003	.005	.008	.012	.015	.018

Drilling

High Speed Tools									
Tool Material	Speed (fpm)	Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1 ½	2
T15, M42	50-60	.001	.002	.004	.007	.010	.012	.015	.018

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
M1, M2, M7, M10	8-15	10-20	15-25	25-30

Milling, End-Peripheral

Depth of Cut (inches)	High Speed 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	M2, M7	75	.001	.002	.003	.004	C2	270	.001	.002	.003	.005

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
M1, M7, M10	12-25

Broaching

High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M2, M7	15	.003

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.

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 321 can be satisfactorily welded by the shielded fusion and resistance welding processes. Oxyacetylene welding is not recommended, since carbon pickup in the weld may occur. Since austenitic welds do not harden on air cooling, the welds should have good toughness. When a filler metal is required, AWS E/ER347 welding consumables should be considered. To decrease the susceptibility to hot cracking, keep heat inputs, base metal dilution, and joint restraint to a minimum. The alloy can be used in the as-welded condition; however, for elevated temperature service, a postweld stabilizing heat treatment should be considered.

Other Information

Applicable Specifications

- AMS 5557
- AMS 5570

Forms Manufactured

- Bar-Rounds
- Billet
- Strip
- Wire
- Wire-Rod

Technical Articles

- A Guide to Etching Specialty Alloys for Microstructural Evaluation
- 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

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