Technical Datasheet CARPENTER TECHNOLOGY

CarTech® 309 Stainless

Identification

UNS Number

• S30900

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.20 %	**Manganese (Maximum)**	2.00 %
Phosphorus (Maximum)	0.045 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	22.00 to 24.00 %
Nickel	12.00 to 15.00 %	**Iron**	Balance

General Information

Description

CarTech 309 stainless in an austenitic chromium-nickel modification of CarTech 304 stainless with superior heat-resisting characteristics. It offers slightly better corrosion resistance than Type 304 because of the higher percentages of both chromium and nickel. In addition, this alloy possesses better creep strength than the straight chrome grades. CarTech 309 stainless possesses resistance to oxidation up to 2000ºF (1093ºC) in continuous services. This alloy has been used for furnace parts, fire box sheets, high temperature containers, and weld wire.

Scaling

Carpenter Stainless Type 309 possesses excellent scaling resistance up to 2000ºF (1093ºC) if used in continuous service and up to about 1850ºF (1010ºC) where intermittent heating and cooling are encountered.

In gas carburizing and bright hardening or annealing atmospheres, the alloy has excellent resistance to corrosion or scaling. Its resistance to the corrosive action of high-sulfur flue gases is outstanding if the sulfur compounds are oxidizing, such as SO2, but poor if the sulfur compounds are reducing, such as H2S.

Corrosion Resistance

Because of the higher chromium and nickel contents, the corrosion resistance of these grades is slightly better than that of Stainless Type 304.

This alloy has better corrosion resistance than Type 304 in hot petroleum products. Type 309 also has higher resistance to sulphite liquors in paper and paper pulp mills and are useful for handling nitric acid, nitric-sulfuric acid mixtures, acetic, citric and lactic acids. For use in the temperature range of 800/1500ºF (427/816ºC), Type 309S should be considered for better 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	7.95	
Density	0.2870	lb/in³
Mean Specific Heat (32 to 212°F)	0.1200	Btu/lb/°F
Mean CTE (32 to 1200°F)	10.0	x 10^{-6} in/in/°F
Modulus of Elasticity (E)	29.0	x 10^{3} ksi
Electrical Resistivity (70°F)	469.0	ohm-cir-mil/ft

Typical Mechanical Properties

Typical Creep Strength
Annealed condition

Test Temperature		Stress for 1% elongation in			
		10,000 hrs.		100,000 hrs.	
°F	°C	ksi	MPa	ksi	MPa
1000	538	16	110	—	—
1100	593	12	83	7	48
1200	649	7	48	5	34
1300	704	5	34	3	21
1400	760	2	14	2	14
1500	816	1	7	—	—

Typical Elevated Temperature Tensile Properties
Annealed condition

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area
°F	°C	ksi	MPa	ksi	MPa		
70	21	42	290	90	621	50	77
300	149	37	255	81	558	47	77
400	204	35	241	80	552	46	75
500	260	32	221	77	531	45	75
600	316	30	207	75	517	44	73
700	371	28	193	74	510	43	72
800	427	27	186	72	496	40	67
900	482	25	172	69	476	39	66
1000	538	24	166	66	455	36	58
1100	593	23	159	59	407	35	54
1200	649	22	152	55	379	35	50
1300	704	21	145	44	303	37	41
1400	760	20	138	36	248	40	40
1500	816	19	131	27	186	46	37
1600	871	18	124	21	145	50	48
1700	927	—	—	15	103	59	47
1800	982	—	—	11	76	65	66

Typical Room Temperature Mechanical Properties
1" (25.4 mm) round bar annealed 1950°F (1066°C), water quench

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Hardness		Izod Impact Strength	
ksi	MPa	ksi	MPa			Brinell	Rockwell B	ft/lb	J
40	276	90	620	50	77	160	83	110	149

Typical Stress-Rupture Strength
Annealed condition

Test Temperature		Stress for Rupture in					
°F	°C	1,000 hrs.		10,000 hrs.		100,000 hrs.	
		ksi	MPa	ksi	MPa	ksi	MPa
1200	649	21	145	15	103	11	76
1300	704	12	83	7	48	4	28
1400	760	8	55	5	34	3	21
1500	816	5	34	4	28	2	14
1600	871	3	21	2	14	1	7
1800	982	1	7	1	7	—	—

Heat Treatment

Annealing

Heat to 1900/2050ºF (1038/1121ºC) and water quench. Brinell hardness approximately 160.

Hardening

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

Workability

Hot Working

Carpenter Stainless Type 309 can be forged, hot headed, and upset satisfactorily. Initial forging temperature should be about 2150ºF (1177ºC) and forging should not be done much below about 1800ºF (982ºC). Small forgings should be cooled rapidly in air, or water quenched from the hammer. Optimum corrosion resistance is obtained by annealing.

Cold Working

Carpenter Stainless Type 309 can be deep drawn, stamped, headed, and upset without difficulty. Since this steel work hardens, severe forming operations should be followed by an anneal.

Machinability

Carpenter Stainless Type 309 machines similarly to Stainless Type 304 with a tough, stringy chip. Increased feeds and lower speeds will usually be helpful. Carpenter Stainless Type 309 machines similarly to copper-nickel alloys, except that it work hardens. Machined surface finish can be somewhat improved by using moderately cold-drawn bars.

Following are typical feeds and speeds for Carpenter Stainless Types 309.

Typical Machining Speeds and Feeds – Carpenter Stainless Type 309

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) Uncoated	Speed (fpm) Coated	Feed (ipr)
.150	T15	85	.015	C2	350	450	.015
.025	M42	100	.007	C3	400	525	.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	Carbide Tools		1/16	1/8	1/4	1/2	1	1 ½	2
M2		75	.001	.0015	.002	.0015	.001	.001	.001
	C2	275	.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

Tool Material	Speed (fpm)	High Speed Tools: Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1 ½	2
M7, M10	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) 1/4	1/2	3/4	1-2	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (in) 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 309 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/ER309 or E/ER309L welding consumables should be considered. Resistance to intergranular corrosion can be restored by a postweld annealing treatment.

Other Information

Applicable Specifications

- ASME SA479
- ASTM A276
- ASTM A314
- ASTM A479
- ASTM A580
- QQ-S-763

Forms Manufactured

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

Technical Articles

- A Guide to Etching Specialty Alloys for Microstructural Evaluation

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