Technical Datasheet

CarTech® 2205 Stainless

Identification

UNS Number

• S32205/S31803

DIN Number

• 1.4462

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.03 %	**Manganese (Maximum)**	2.00 %
Phosphorus (Maximum)	0.030 %	**Sulfur (Maximum)**	0.020 %
Silicon (Maximum)	1.00 %	**Chromium**	22.50 %
Nickel	5.50 %	**Molybdenum**	3.25 %
Nitrogen (Maximum)	0.20 %	**Iron**	Balance

General Information

Description

CarTech 2205 stainless is a duplex stainless steel that has a microstructure consisting of austenite and ferrite phases. This duplex microstructure and the chemical composition of CarTech 2205 stainless results in an excellent combination of strength and corrosion resistance.

The higher alloyed UNS S32205 provides improved corrosion resistance and meets the requirements of both the S31803 and DIN 1.4462 specifications.

CarTech 2205 stainless possesses good resistance to general corrosion in many acid environments and, has excellent resistance to chloride stress corrosion cracking, pitting and crevice corrosion.

Applications

CarTech 2205 stainless has been used in high pressure fuel injector systems; oil and gas production equipment such as valves, fittings, shafts, and pump parts; heat exchangers in chemical and pulp and paper plants; and brewery tanks. It can be considered in situations where the strength and or corrosion resistance of Type 316 is inadequate.

Elevated Temperature Use

Carpenter 2205 stainless is subject to 885 embrittlement when exposed for extended times between about 575 and 1000°F (300 and 538°C).

The alloy is also subject to precipitation of sigma phase when exposed between about 1250 and 1550°F (677 and 843°C) for an extended time. Sigma phase increases strength and hardness but decreases ductility and corrosion resistance.

Corrosion Resistance

Compared to conventional austenitic stainless steels such as Type 304 and 316, Carpenter 2205 possesses superior resistance in most oxidizing and reducing acids; superior chloride pitting and crevice corrosion resistance due to higher chromium, molybdenum and nitrogen content; and superior resistance to chloride stress corrosion cracking.

Carpenter 2205 has good intergranular corrosion in the as-annealed and as-weld conditions. Some intergranular attack may occur in the hot rolled unannealed condition.

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)	Excellent
Sea Water	Moderate	Sour Oil/Gas	Moderate
Humidity	Excellent		

Properties

Physical Properties

Specific Gravity		
Annealed	7.80	
As Rolled	7.82	
Density		
Annealed	0.2820	lb/in³
As Rolled	0.2830	lb/in³
Mean CTE		
77 to 122°F, Annealed	6.22	x 10 -6 in/in/°F
77 to 212°F, Annealed	7.11	x 10 -6 in/in/°F
77 to 302°F, Annealed	7.29	x 10 -6 in/in/°F
77 to 392°F, Annealed	7.53	x 10 -6 in/in/°F
77 to 482°F, Annealed	7.72	x 10 -6 in/in/°F
77 to 572°F, Annealed	7.86	x 10 -6 in/in/°F
77 to 662°F, Annealed	7.97	x 10 -6 in/in/°F
77 to 752°F, Annealed	7.99	x 10 -6 in/in/°F
77 to 842°F, Annealed	8.12	x 10 -6 in/in/°F
77 to 932°F, Annealed	8.23	x 10 -6 in/in/°F
77 to 1012°F, Annealed	8.30	x 10 -6 in/in/°F
77 to 1112°F, Annealed	8.44	x 10 -6 in/in/°F
77 to 1202°F, Annealed	8.57	x 10 -6 in/in/°F
77 to 1292°F, Annealed	8.77	x 10 -6 in/in/°F
77 to 122°F, Hot Rolled	7.02	x 10 -6 in/in/°F
77 to 212°F, Hot Rolled	7.48	x 10 -6 in/in/°F
77 to 302°F, Hot Rolled	7.70	x 10 -6 in/in/°F
77 to 392°F, Hot Rolled	7.82	x 10 -6 in/in/°F
77 to 482°F, Hot Rolled	8.04	x 10 -6 in/in/°F
77 to 572°F, Hot Rolled	8.17	x 10 -6 in/in/°F
77 to 662°F, Hot Rolled	8.26	x 10 -6 in/in/°F
77 to 752°F, Hot Rolled	8.34	x 10 -6 in/in/°F
77 to 842°F, Hot Rolled	8.44	x 10 -6 in/in/°F
77 to 932°F, Hot Rolled	8.53	x 10 -6 in/in/°F
77 to 1012°F, Hot Rolled	8.57	x 10 -6 in/in/°F
77 to 1112°F, Hot Rolled	8.68	x 10 -6 in/in/°F
77 to 1202°F, Hot Rolled	8.78	x 10 -6 in/in/°F
77 to 1292°F, Hot Rolled	8.92	x 10 -6 in/in/°F

Mean Coefficient of Thermal Expansion – Carpenter 2205 Stainless

0.5" (12.5 mm) diameter rebar

Test Temperature		Hot Rolled Condition		Annealed Condition	
77°F to	25°C to	10^{-6}/°F	10^{-6}/°C	10^{-6}/°F	10^{-6}/°C
122	50	7.02	12.64	6.22	11.20
212	100	7.48	13.47	7.11	12.48
302	150	7.70	13.86	7.29	13.12
392	200	7.82	14.07	7.53	13.56
482	250	8.04	14.47	7.72	13.89
572	300	8.17	14.71	7.86	14.14
662	350	8.26	14.87	7.97	14.34
752	400	8.34	15.01	7.99	14.39
842	450	8.44	15.20	8.12	14.62
932	500	8.53	15.36	8.23	14.82
1012	550	8.57	15.42	8.30	14.94
1112	600	8.68	15.63	8.44	15.19
1202	650	8.78	15.81	8.57	15.42
1292	700	8.92	16.11	8.77	15.79

Annealed 1950°F (1066°C) for 1 hour and water quenched. Dilatometer specimens were .250" (6.4 mm) sq. x 2" (50.8 mm) long.

Magnetic Properties

In the annealed and hot rolled conditions, Carpenter 2205 stainless is ferromagnetic.

Typical Mechanical Properties

Typical Room Temperature Mechanical Properties - Carpenter 2205 Stainless

Condition	0.2% Yield Strength		Ultimate tensile Strength		% Elongation in 4D	% Reduction in Area	Hardness
	ksi	MPa	ksi	MPa			Midradius
Direct Water Quenched	94	648	117	806	38	39	26
Mill Annealed	81	558	110	758	45	46	23

Data consists of a compilation of tests of round bars .625" to 1.000" dia. Surface hardness can depend upon the processing. Mill annealed bars are not available in all sizes.

Heat Treatment

Annealing

Heat to 1850/2050°F (1010/1121°C) and rapidly quench in water or air. Typical hardness as-annealed is HRC 23.

Hardening

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

Workability

Hot Working

Heat uniformly to 2000/2100°F (1093/1149°C).Reheat as often as necessary. Cool forgings in air.

Cold Working

Cold working increases strength and hardness. Work hardening rate is lower than Type 304, but the annealed strength of 2205 is significantly higher.

Machinability

Carpenter 2205 stainless has a machinability between conventional Type 316 and Carpenter 22Cr-13Ni-5Mn stainless. The alloy machines with chip characteristics that are tough and stringy. Use of chip curlers and breakers is advised.

The following are typical machining parameters. The data should be used as a guide for initial machine setup only.

Typical Machining Speeds and Feeds – Carpenter 2205 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)	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	1½	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	1½	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.

Weldability

Carpenter 2205 stainless has been welded using many of the standard electric arc welding processes. Autogeneous welding will increase the amount of ferrite present in the weldement and heat affected zone. When a filler metal is required, consider AWS E/ER 2209.

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

Postweld annealing is not required for most applications but is recommended for severe service.

Other Information

Applicable Specifications

- ASME SA479
- ASTM A240
- ASTM A276
- ASTM A479
- BS 6744

Forms Manufactured

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

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