

CarTech® 15-15HS® Max Stainless

Type Analysis

Single figures are nominal except where noted.

Carbon (Up to)	0.04 %	Manganese	18.00 %
Phosphorus (Up to)	0.050 %	Sulfur (Up to)	0.050 %
Silicon	0.50 %	Chromium	19.00 %
Nickel (Up to)	3.50 %	Molybdenum (Up to)	3.00 %
Nitrogen (Up to)	0.70 %	Iron	Balance

General Information

Description

CarTech 15-15HS Max stainless is an austenitic, nitrogen-strengthened stainless steel. It can be considered for oil and gas industry applications such as nonmagnetic drill collars, stabilizers, and MWD housings, especially when high strength 140 ksi (966 MPa) minimum yield strength is desired.

The lower carbon content of CarTech 15-15HS Max stainless results in less tendency for carbides to precipitate in grain boundaries compared with normal chrome-manganese stainless grades. This provides CarTech 15-15HS Max stainless with improved resistance to intergranular stress-corrosion cracking. In addition, nickel, chromium, nitrogen, manganese and molybdenum are controlled to enhance the resistance to transgranular attack stress-corrosion cracking and pitting. Typical PRE equivalent is greater than 30.

A post-machining ID compressive stress treatment for drill collars has been developed to further improve the resistance to stress-corrosion cracking.

CarTech 15-15HS Max stainless is capable of high strength with improved pitting corrosion resistance when compared with competitive Cr-Mn-N stainless alloys.

Corrosion Resistance

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		

Typical Pitting Corrosion Resistance — 15-15HS® Max Stainless

Alloy	Pitting Potential (m Volts recorded at current shown)		
	50µ A/cm ²	100µ A/cm ²	200µ A/cm ²
15-15HS® Max	282	294	303
Competitive Cr-Mn-N Stainless	- 23	- 2	23

Test Solution: Nitrogen purged 8% Cl (as NaCl) at room temperature.
Stirred solution at 20-23°C (68-73°F), initial pH of 6.8-7.0, scan rate at 0.1 m volts/sec.
Higher potential is indicative of higher pitting resistance.

Properties

Physical Properties

Specific Gravity	7.76
Density	0.2800 lb/in ³
Mean Specific Heat (79 to 240°F)	0.1180 Btu/lb/°F
Mean CTE	
77 to 212°F	8.85 x 10 ⁻⁶ in/in/°F
77 to 350°F	9.11 x 10 ⁻⁶ in/in/°F
77 to 392°F	9.34 x 10 ⁻⁶ in/in/°F
77 to 482°F	9.57 x 10 ⁻⁶ in/in/°F
77 to 572°F	9.75 x 10 ⁻⁶ in/in/°F
77 to 662°F	9.96 x 10 ⁻⁶ in/in/°F
77 to 752°F	10.2 x 10 ⁻⁶ in/in/°F
77 to 842°F	10.4 x 10 ⁻⁶ in/in/°F
77 to 932°F	10.5 x 10 ⁻⁶ in/in/°F
77 to 1022°F	10.7 x 10 ⁻⁶ in/in/°F

Mean Coefficient of Thermal Expansion

Temperature Range		10 ⁻⁶ /°F	10 ⁻⁶ /K
77°F to	25°C to		
212	100	8.85	15.95
350	150	9.11	16.41
392	200	9.34	16.84
482	250	9.57	17.26
572	300	9.75	17.59
662	350	9.96	17.98
752	400	10.16	18.33
842	450	10.35	18.68
932	500	10.52	18.98
1022	550	10.67	19.25

Thermal Conductivity	
73°F	95.57 BTU-in/hr/ft ² /°F
122°F	98.84 BTU-in/hr/ft ² /°F
212°F	104.6 BTU-in/hr/ft ² /°F
392°F	114.9 BTU-in/hr/ft ² /°F
572°F	124.5 BTU-in/hr/ft ² /°F
752°F	133.0 BTU-in/hr/ft ² /°F

Thermal Conductivity

Test Temperature		Btu-in/ ft ² •h•°F	W/m•K
°F	°C		
73	23	95.57	13.8
122	50	98.84	14.3
212	100	104.62	15.1
392	200	114.90	16.6
572	300	124.51	18.0
752	400	133.01	19.2

Modulus of Elasticity (E)	27.7 x 10 ³ ksi
Electrical Resistivity (70°F)	441.0 ohm-cir-mil/ft

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Magnetic Properties

15-15HS Max stainless is essentially nonmagnetic in both the annealed and warm-worked conditions.

Magnetic permeability of warm-worked material is less than 1.01 based on Severn gauge.

ASTM A342 (field strength-200 oersteds): 1.002

Typical Mechanical Properties

Typical Room Temperature Mechanical Properties — CarTech 15-15HS Max Stainless

Bar Size		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation In 4D	% Reduction of Area	Charpy V-Notch Impact Strength		Rockwell Hardness
Inches	mm	ksi	MPa	ksi	MPa			Ft-lb	J	
3.5	88.9	166	1145	187	1289	21	66	147	199	C37
5.0	127.0	157	1082	176	1213	22	66	143	194	C38
7.0	177.8	154	1062	173	1193	23	66	131	178	C38
Condition Annealed (1950°F, WQ)		71	490	120	828	56	79	--	--	B95

Heat Treatment

Annealing

15-15HS Max stainless is generally used in the as-forged, warm-worked condition. However, if annealing is desired, heat to 1900/2100°F (1040/1150°C), hold for one hour per inch of thickness, and water quench. The strength will be lower in the annealed condition.

Workability

Machinability

Following are starting point feeds and speeds for 15-15HS Max stainless.

CarTech® 15-15HS® Max Stainless

Typical Machining Speeds and Feeds – 15-15HS® Max 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 High Speed Tools			Carbide Tools (inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed (fpm)		Feed (ipr)
					Uncoated	Coated	
.150	M2	55	.015	C6	250	300	.015
.025	T15	70	.007	C7	300	350	.007

Turning—Cut-Off and Form Tools

Tool Material		Speed (fpm)	Feed (ipr)						
Micro-Melt® Powder HS Tools	Carbide Tools		Cut-Off Tool Width (Inches)			Form Tool Width (Inches)			
			1/16	1/8	1/4	1/2	1	1 ½	2
T15	C6	40	.001	.001	.0015	.0015	.001	.0007	.0007
		140	.004	.0055	.0045	.004	.003	.002	.002

Rough Reaming

Micro-Melt® Powder HS Tools		Carbide Tools (inserts)		Feed (ipr)					
Tool Material	Speed (fpm)	Tool Material	Speed (fpm)	Reamer Diameter (inches)					
				1/8	1/4	1/2	1	1 ½	2
M7	60	C2	80	.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	45-50	.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
M42	4 - 8	6-10	8-12	10-15

Milling, End-Peripheral

Depth of Cut (Inches)	Micro-Melt® Powder High Speed Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed (ipt)				Tool Material	Speed (fpm)	Feed (ipt)			
			Cutter Diameter (in)						Cutter Diameter (in)			
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2
.050	M2, M7	65	.001	.002	.003	.004	C2	245	.001	.002	.003	.005

Tapping

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

Broaching

Micro-Melt® Powder High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M2, M7	10	.003

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.

Weldability

15-15HS Max stainless can be readily joined by the standard electric-arc welding methods. Welding consumables of matching composition are not currently available; however, other stainless steel consumables can be considered depending on the application. Contact Carpenter for specific details on filler metal selection.

Other Information

Forms Manufactured

- Bar-Rounds
- Multi-Dimensional Bar
- Hollow Bar

Disclaimer:

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