Technical Datasheet

CarTech® SCF 19® Max Alloy

Identification

UNS Number

• S21000

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.04 %	**Manganese**	4.00 to 7.00 %
Phosphorus (Maximum)	0.030 %	**Sulfur (Maximum)**	0.003 %
Silicon (Maximum)	0.60 %	**Chromium**	18.00 to 23.00 %
Nickel	16.00 to 20.00 %	**Molybdenum**	4.00 to 6.00 %
Nitrogen	0.35 %	**Iron**	Balance

General Information

Description

CarTech SCF 19 Max alloy is an austenitic, nitrogen-strengthened stainless steel containing 5% Mo for improved stress-corrosion-cracking resistance. The alloy can be warm worked to achieve a minimum yield strength of 140 ksi. Because of its combination of stress-corrosion-cracking resistance, chloride pitting resistance, high strength, and low magnetic permeability it has been used as a nonmagnetic drill collar and MWD/LWD housing alloy in some of the harshest drilling environments. Laboratory and field evaluations have shown its superiority over the conventional chromium-manganese stainlesses commonly used for such applications.

CarTech SCF 19 Max has been used for the following oil and gas well drilling components:

– Drill collars
– MWD/LWD housings

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

Typical Pitting Corrosion Resistance — SCF-19® Max Alloy

Alloy	Pitting Potential (m Volts recorded at current shown)		
	50μ A/cm^2	100μ A/cm^2	200μ A/cm^2
SCF-19 Max Alloy	1055	1105	1115
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.

Typical Stress Corrosion Cracking Resistance — SCF 19® Max Alloy

Alloy	Tensile Stress		Tensile Fracture
	Ksi	MPa	Time
SCF-19 Max Alloy	120	828	1000 hrs. – No Failure
Competitive Cr-Mn-N Stainless	80	552	215 Hours

Test Solution: Boiling saturated sodium chloride with 2.5 wt % ammonium bisulfate (simulated drilling fluid). Note, higher stress used for more resistance SCF19 Max.

Properties

Physical Properties

Specific Gravity	7.96	
Density	0.2880	lb/in³
Mean Specific Heat (79 to 240°F)	0.1220	Btu/lb/°F
Mean CTE		
77 to 212°F	8.93	x 10^{-6} in/in/°F
77 to 350°F	9.06	x 10^{-6} in/in/°F
77 to 392°F	9.11	x 10^{-6} in/in/°F
77 to 482°F	9.23	x 10^{-6} in/in/°F
77 to 572°F	9.32	x 10^{-6} in/in/°F
77 to 662°F	9.42	x 10^{-6} in/in/°F
77 to 752°F	9.51	x 10^{-6} in/in/°F
77 to 842°F	9.61	x 10^{-6} in/in/°F
77 to 932°F	9.64	x 10^{-6} in/in/°F
77 to 1022°F	9.72	x 10^{-6} in/in/°F

Mean Coefficient of Thermal Expansion

Temperature		10^{-6}/°F	10^{-6}/K
77°F to	25°C to		
212	100	8.93	16.08
350	150	9.06	16.30
392	200	9.11	16.40
482	250	9.23	16.61
572	300	9.32	16.77
662	350	9.42	16.95
752	400	9.51	17.11
842	450	9.61	17.29
932	500	9.64	17.35
1022	550	9.72	17.50

Thermal Conductivity

122°F	81.10	BTU-in/hr/ft^2/°F
212°F	85.30	BTU-in/hr/ft^2/°F
392°F	98.40	BTU-in/hr/ft^2/°F
572°F	117.9	BTU-in/hr/ft^2/°F
752°F	141.4	BTU-in/hr/ft^2/°F

Thermal Conductivity

Test Temperature		Btu-in/ft^2•h•°F	W/m•K
°F	°C		
122	50	81.1	11.7
212	100	85.3	12.3
392	200	98.4	14.2
572	300	117.9	17.0
752	400	141.4	20.4

Modulus of Elasticity (E)	27.7	x 10^3 ksi
Electrical Resistivity	549.0	ohm-cir-mil/ft

Typical Mechanical Properties

Typical Room Temperature Mechanical Properties — SCF 19® Max Alloy

Condition	0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 4D	% Reduction of Area	Charpy V-Notch Impact Strength	
	ksi	MPa	ksi	MPa			Ft-lbs.	J
Bar – 7.50" Warm-Worked (191 mm) Round	144	994	159	1097	25	74	187	253
Bar – 5.50" Warm-Worked (140 mm) Round	145	1000	163	1124	25	69	220	298

Heat Treatment

Annealing

SCF 19 Max alloy is generally used in the as-forged, warm-worked condition. However, if annealing is desired, heat to 2150°F (1177°C), hold for one hour per inch of thickness, and water quench. The strength of annealed SCF 19 Max will be greatly reduced since high strength is imparted through warm working.

Workability

Machinability

SCF 19 Max alloy machines similarly to chromium-manganese nitrogen-strengthened stainless steels. Following are typical feeds and speeds.

Typical Machining Speeds and Feeds – SCF 19® 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)	High Speed Tools			Carbide Tools (Inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed (fpm) Uncoated	Speed (fpm) Coated	Feed (ipr)
.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)						
			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
T15		40	.001	.001	.0015	.0015	.001	.0007	.0007
	C6	140	.004	.0055	.0045	.004	.003	.002	.002

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	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

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
T15, M42	4-8	6-10	8-12	10-15

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	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

High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M2, M7	10	.003

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

SCF 19 Max alloy can be readily joined by standard electric-arc welding methods. Welding consumables of matching composition are not currently available; however, other stainless steel consumables may be used depending on the application. Because the alloy achieves high strength primarily through warm working, the weld and areas adjacent to the weld will have significantly reduced strength compared to base metal.

Other Information

Forms Manufactured

- Bar-Rounds
- Hollow Bar

Edition Date: 1/21/10