Technical Datasheet

CarTech® Duplex 2507 Stainless

Identification

UNS Number

• S32750

DIN Number

• 1.4410

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.03 %	**Manganese (Maximum)**	1.20 %
Phosphorus (Maximum)	0.035 %	**Sulfur (Maximum)**	0.020 %
Silicon (Maximum)	0.80 %	**Chromium**	25.00 %
Nickel	7.00 %	**Molybdenum**	4.00 %
Nitrogen	0.28 %	**Iron**	Balance

General Information

Description

CarTech Duplex 2507 stainless is a duplex stainless steel with a microstructure consisting of austenite and ferrite phases in approximately equal amounts. The chemical composition and microstructure of CarTech Duplex 2507 stainless impart a good combination of strength, corrosion resistance and toughness.

The yield strength of annealed CarTech Duplex 2507 stainless is twice that of typical austenitic stainless steels possessing comparable impact strength. CarTech Duplex 2507 stainless exhibits good resistance to general corrosion in many acid environments with exceptional resistance to chloride stress corrosion cracking, pitting and crevice corrosion.

Applications

CarTech Duplex 2507 stainless may be considered for use in oil and gas production equipment, such as valves, fittings, shafts and pump parts as well as equipment with exposure to a seawater environment.

Elevated Temperature Use

Duplex 2507 stainless is subject to 885 embrittlement when exposed for extended periods of time at temperatures of approximately 600 to 1000°F (315 to 538°C).

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

Corrosion Resistance

Duplex 2507 stainless provides excellent resistance to chloride-induced localized corrosion. An indicator of excellent chloride pitting and crevice corrosion is its high Pitting Resistance Equivalent Number (PREN) determined by the following chemical equation: (Cr%) + 3.3(Mo%) + 16(N%). Duplex 2507 stainless has a PREN greater than 40 compared to a PREN of 25 for Type 316.

Duplex 2507 stainless offers excellent resistance to uniform corrosion in various organic acids such as formic and acetic acids and inorganic acids containing chlorides. This alloy provides resistance in strong oxidizing media such as nitric acid and can be considered for use in dilute hydrochloric acid.

Austenitic stainless steels such as Type 304 and 316 can suffer stress corrosion in high-chloride, high-temperature conditions. Duplex 2507 stainless provides improved resistance under these conditions.

Duplex 2507 stainless provides good intergranular 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	Excellent	Sour Oil/Gas	Good
Humidity	Excellent		

Typical Corrosion Properties – Duplex 2507 Stainless

1.375" (34.9 mm) Round Bar, annealed condition

Environment	Duration of Test	Duplex 2507	Type 316	22Cr-13Ni-5Mn
10% Formic - boiling	3-48 hr periods	0.07 mpy	19.3 mpy	2.3 mpy
50% Acetic - boiling	3-48 hr periods	0.0 mpy	0.1 mpy	0.1 mpy
10% H_2SO_4 - 80°C	3-48 hr periods	0.15 mpy	112 mpy	15 mpy

Typical Intergranular Corrosion Properties – Duplex 2507 Stainless

1.375" (34.9 mm) Round Bar, annealed condition

Environment	Duration of Test	Duplex 2507
65% HNO_3 - boiling	5-48 hr periods	7.4 mpy
Ferric Sulfate/Sulfuric Acid - boiling	1-120 hr period	8.5 mpy

*Intergranular tests

Typical Pitting and Critical Crevice Temperature – Duplex 2507 Stainless

1.375" (34.9 mm) Round Bar, annealed condition

Environment	Duration of Test	Critical Crevice Temperature °F (°C)	Critical Pitting Temperature ° F (°C)
6% Ferric Chloride +1%HCL	24 hr period	113 (45)	176 (80)

Properties

Physical Properties

Specific Gravity	7.82	
Density	0.2817	lb/in³
Mean Specific Heat	0.1200	Btu/lb/°F
Mean CTE		
77 to 212°F	7.20	x 10^{-6} in/in/°F
77 to 302°F	7.50	x 10^{-6} in/in/°F
77 to 392°F	7.80	x 10^{-6} in/in/°F
Thermal Conductivity		
77°F	104.0	BTU-in/hr/ft²/°F
212°F	110.9	BTU-in/hr/ft²/°F
392°F	117.9	BTU-in/hr/ft²/°F
572°F	128.8	BTU-in/hr/ft²/°F
Poisson's Ratio	0.300	
Modulus of Elasticity (E)	29.0	x 10^{3} ksi
Electrical Resistivity	481.0	ohm-cir-mil/ft

Typical Mechanical Properties

RR Moore Rotating Beam Fatigue Tests – Duplex 2507 Stainless

1.375" (34.9 mm) Round Bar

Annealed Condition		
Test Stress		Cycles to Fracture
ksi	MPa	
60	414	1.4×10^7 (NF)
65	449	1.3×10^7 (NF)
70	483	9.9×10^4
75	517	7×10^4
80	552	0.8×10^4

Annealed condition (2050F-1h-WQ)
NF indicates test was terminated without specimen fracturing.
Standard 0.250" (6.4 mm) gage diameter fatigue specimens.

Typical Cryogenic Charpy V-Notch Impact Strength – Duplex 2507 Stainless

1.375" (34.9 mm) Round Bar

Test Temperature		Longitudinal Specimen	
°F	°C	ft-lb	J
73	23	266	361
32	0	254	344
0	-18	268	363
-50	-46	208	282

Longitudinal Specimens, Transverse Crack Propagation
Annealed condition (2050F-1h-WQ)

Typical Room and Elevated Temperature Tensile Properties – Duplex 2507 Stainless

1.375" (34.9 mm) Round Bar

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 1" (25.4 mm) or 4D	% Reduction of Area
°F	°C	ksi	MPa	ksi	MPa		
73	23	86	594	126	869	47	81
350	177	65	449	107	737	43	79
500	260	62	430	109	754	44	76
700	371	59	405	108	745	41	73

Longitudinal specimens, annealed condition (2050F-1h-WQ)

Typical Room Temperature Tensile Properties – Duplex 2507 Stainless

0.6875" (17.5 mm) Cold Drawn Hexagonal Bar

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 1" (25.4 mm) or 4D	% Reduction of Area
°F	°C	ksi	MPa	ksi	MPa		
73	23	147	1013	163	1124	20	76

Longitudinal specimens, annealed condition (2050F-1h-WQ), 15% cold drawn

Heat Treatment

Annealing

Heat to 1850/2050°F (1010/1121°C) and rapidly quench in water or air.

Hardening

Cannot be hardened by heat treatment. Can be hardened only by cold working. Typical hardness as-annealed is HRC 25.

Workability

Hot Working

Heat uniformly to 2200/2300°F (1204/1260°C). Reheat as often as necessary, keeping the temperature above 1850°F (1010°C). Cool forgings in air.

Cold Working

Cold working increases strength and hardness. The work hardening rate of Duplex 2507 stainless is lower than Type 304, an austenitic stainless steel; however, the annealed strength of Duplex 2507 is significantly higher.

Machinability

The machinability of Duplex 2507 generally has been between that of conventional Type 316 stainless and Carpenter 22Cr-13Ni-5Mn stainless.

The following chart includes typical machining parameters to machine Duplex 2507 stainless. The data listed should be used as a guide for initial machine setup only.

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 .025	T15 M42	85 100	.015 .007	C2 C3	350 400	450 525	.015 .007

Turning – Cut Off and Form Tools

Tool Material		Speed, fpm	Feed, (ipr)						
High Speed Tools	Carbide Tools		Cut-Off Tool Width, Inches			Form Tool Width, Inches			
			1/16	1/8	1/4	1/2	1	1-1/2	2
M2	C2	75 275	.001 .004	.0015 .0055	.002 .007	.0015 .005	.001 .004	.001 .0035	.0001 .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	1-1/2	2
M7	70	C2	90	.003	.006	.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	1-1/2	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, In	High Speed Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed – Inches Per Tooth Cutter Diameter, Inches				Tool Material	Speed (fpm)	Feed – Inches Per Tooth Cutter Diameter, Inches			
			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

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

Duplex 2507 stainless has been welded using many of the standard electric arc welding processes. Autogeneous welding will increase the amount of ferrite present in the weldment and heat affected zone. When a filler metal is required, consider AWS E/ER 2509.

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

Duplex 2507 stainless can be supplied according to the following ASTM specifications (and their corresponding ASME specifications, as available).

- ASTM A182
- ASTM A479

Forms Manufactured

- Bar-Hexagons
- Bar-Rounds

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