Technical Datasheet

CarTech® EnduraMet®® 2304 Stainless

Identification

UNS Number

• S32304

DIN Number

• 1.4362

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.03 %	**Manganese (Maximum)**	2.50 %
Phosphorus (Maximum)	0.040 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	21.50 to 24.50 %
Nickel	3.00 to 5.50 %	**Molybdenum**	0.05 to 0.60 %
Nitrogen	0.05 to 0.20 %	**Iron**	Balance

General Information

Description

CarTech EnduraMet 2304 stainless is a lean duplex stainless steel that has a microstructure consisting of austenite and ferrite phases. This duplex microstructure and the chemical composition of CarTech EnduraMet 2304 stainless results in an excellent combination of strength and corrosion resistance.

CarTech EnduraMet 2304 stainless has twice the annealed yield strength of typical austenitic stainless steels, like Type 304. In the hot rolled unannealed condition, yield strength of 75 ksi (518 MPa) or higher can be achieved for bar diameters up to 1.375 in. (34.925 mm).

CarTech EnduraMet 2304 stainless possesses good resistance to general corrosion in many acid environments, chloride stress corrosion cracking, pitting and crevice corrosion.

Applications

Rebar has been a primary application for CarTech EnduraMet 2304 stainless. Specific rebar applications have included bridge decks, barrier and retaining walls, anchoring systems, chemical plant infrastructure, coastal piers and wharves, bridge parapets, sidewalks and bridge pilings. The higher strength capability, 75 ksi (518 MPa) minimum yield strength of CarTech EnduraMet 2304 stainless rebar is an added economical advantage. Other applications for CarTech EnduraMet 2304 stainless have included bridge tie wire and dowels.

Corrosion Resistance

Compared to conventional austenitic stainless steels, like Type 304, EnduraMet 2304 stainless has good resistance in most oxidizing and reducing acids; chloride pitting and crevice corrosion resistance due to higher chromium, molybdenum and nitrogen content; and resistance to chloride stress corrosion cracking due to its duplex microstructure.

EnduraMet 2304 stainless has good intergranular corrosion resistance in the as-annealed and as-welded conditions due to its low carbon content. 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	Good	Sour Oil/Gas	Moderate
Humidity	Excellent		

Properties

Physical Properties

Specific Gravity	7.77	
Density	0.2810	lb/in³

Magnetic Properties

In the annealed and hot rolled conditions, EnduraMet 2304 stainless is ferromagnetic.

Typical Mechanical Properties

Typical Room Temperature Hot Rolled Mechanical Properties – EnduraMet® 2304 Stainless

Samples were full-section rebar

Bar Size		Rebar #	0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 8" (203 mm)
in	mm		ksi	MPa	ksi	MPa	
0.5	12.7	4	86.5	597	121.0	835	25.0
0.625	15.9	5	92.0	635	117.0	807	27.0
0.750	19.1	6	88.0	607	115.0	794	30.0
1.00	25.4	8	96.5	666	120.0	828	29.0

Heat Treatment

Annealing

Heat to 1900/2000°F (1038/1093°C) and rapidly quench in water or air. Typical hardness as-annealed is HRC 20.

Hardening

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

Hot rolling and controlling the finishing temperature can strengthen EnduraMet 2304 stainless bar. After hot rolling, bars are not annealed.

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; however, the annealed strength is significantly higher.

Machinability

The machinability of EnduraMet 2304 stainless generally has been between that of conventional Type 316 stainless and Carpenter 22Cr-13Ni-5Mn stainless.

The following chart includes typical machining parameters used to machine EnduraMet 2304 stainless. The data listed should be used as a guide for initial machine setup only.

Typical Machining Speeds and Feeds – EnduraMet® 2304 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)						
High Speed Tools	Carbide Tools		Cut-Off Tool Width (Inches)			Form Tool Width (Inches)			
			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

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

EnduraMet 2304 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 2209.

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

Postweld annealing is not required for most applications, but will provide optimum properties for severe service.

Other Information

Applicable Specifications

- ASME SA479
- ASTM A240
- ASTM A276
- ASTM A479
- ASTM A955M
- BS 6744

Forms Manufactured

- Billet
- Rebar or (Bar-Reinforcing)
- Wire
- Wire-Rod

Disclaimer:
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