EnduraMet™ 32 Stainless

Identification

UNS Number

- S24100

Type Analysis

Carbon (Maximum)	0.15 %	**Manganese**	11.00 to 14.00 %
Phosphorus (Maximum)	0.060 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	16.50 to 19.00 %
Nickel	0.50 to 2.50 %	**Nitrogen**	0.20 to 0.45 %
Iron	Balance		

General Information

Description

EnduraMet™ 32 stainless is a high-manganese, low-nickel, nitrogen-strengthened austenitic stainless steel. By means of solid solution strengthening, the nitrogen provides significantly higher yield and tensile strength as annealed than conventional austenitic stainless steels such as Type 304 and Type 316, without adversely affecting ductility, corrosion resistance or non-magnetic properties. In the hot rolled unannealed condition, yield strengths of 75 ksi (518 MPa) or higher can be achieved for bar diameters up to 2 in. (50.8 mm).

Applications

EnduraMet 32 stainless may be considered for rebar in bridge decks, barrier and retaining walls, anchoring systems, chemical plant infrastructure, coastal piers and wharves, bridge parapets, sidewalks and bridge pilings. Because of its low magnetic permeability, EnduraMet 32 may also be considered for concrete rebar applications in close proximity to sensitive electronic devices and magnetic resonance medical equipment. The higher strength capability, 75 ksi (518 MPa) minimum yield strength, of EnduraMet 32 is an added economical advantage.

EnduraMet 32 may also be considered for dowel bars, welded-wire mesh and tie wire.

Scaling

The safe scaling temperature for continuous service is 1600ºF (871ºC).

Corrosion Resistance

EnduraMet 32 stainless has good resistance to atmospheric corrosion and long-term resistance to general corrosion when embedded in concrete. In the 15 week corrosion macrocell test in simulated concrete pore solution, EnduraMet 32 stainless had an average corrosion rate less than 0.25 micro-meter/yr.

Intergranular corrosion may be a problem if the material is heated between 800ºF (427ºC) and 1650ºF (899ºC) or cooled slowly through that range.

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 5-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	Restricted
Phosphoric Acid	Restricted	Acetic Acid	Moderate
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Good
Sea Water	Restricted	Humidity	Excellent

Properties

Physical Properties		
Specific Gravity		
--	7.75	
Density		
--	0.2800	lb/in^3
Mean Coefficient of Thermal Expansion		
70.00 °F, 1000.0 °F	10.3	x 10^{-6} in/in/°F
Modulus of Elasticity (E)		
--	29.0	x 10^3 ksi
Electrical Resistivity		
70.0 °F	421.0	ohm-cir-mil/ft
Magnetic Properties		
Magnetic Permeability		
Annealed, 200 Oe	1.0100	Mu
Cold Drawn 70%, 200 Oe	1.0200	Mu

Typical Mechanical Properties

Typical Room Temperature Hot Rolled Mechanical Properties – EnduraMet 32 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	
0.625	15.9	5	81	559	118	814	40.0
1.000	25.4	8	84	580	121	835	42.0

Heat Treatment

Annealing

Heat to 1900/1950ºF (1038/1066ºC) and water quench, or rapidly cool as with other austenitic stainless steels. Typical hardness as annealed is approximately Rockwell B 95.

Hardening

Cannot be hardened by heat treatment; however, high strength can be achieved by thermal mechanical processing Can be hardened by cold work as well.

Workability

Hot Working

EnduraMet 32 stainless can be forged, hot-rolled, hot-headed and upset. Because of its higher strength, greater force than for Type 304 is required. For hot working, heat uniformly to 2100/2200ºF (1149/1204ºC). Preheating to an intermediate temperature is not required. For rebar, a controlled hot rolling practice is used.

Cold Working

EnduraMet 32 stainless can be cold formed by drawing, bending, upsetting and stamping. Because of its higher strength and work-hardening rate, the force required is greater than for Types 302, 304 or 316. The high work-hardening rate can be used to advantage when cold working to increase strength; i.e., less reduction is required to achieve high levels of strength.

Machinability

EnduraMet 32 stainless has a machinability rating about 41% of AISI 1212. Slow to moderate speeds, moderate feeds and rigid tools should be considered. Chips tend to be tough and stringy. Chip curlers or breakers are helpful. Use a sulfurized cutting fluid, preferable of the chlorinated type.

Following are typical feeds and speeds for EnduraMet 32.

Typical Machining Speeds and Feeds – EnduraMet 32 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) Uncoated	Speed (fpm) Coated	Feed (ipr)
.150	M48, T15	72	.015	C6	250	300	.015
.025	M48, T15	84	.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)			
Micro-Melt® Powder HS Tools	Carbide Tools		1/16	1/8	1/4	1/2	1	1 ½	2
M48, T15		54	.001	.001	.0015	0015	.001	.0007	.0007
	C6	192	.004	.0055	.004	.004	.003	.002	.002

Rough Reaming

Micro-Melt® Powder High Speed Tools		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
M48, T15	72	C2	80	.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
M42	45-55	.001	.002	.004	.007	.010	.012	.015	.018
C2 Coated	140	.0005	.002	.004	.006	.0077	.0088	.0098	.0098

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)	Micro-Melt® Powder 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	M48, T15	78	.001	.002	.003	.004	C2	245	.001	.002	.003	.005

Tapping

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

Broaching

Micro-Melt® Powder High Speed Tools		
Tool Material	Speed (fpm)	Chip Load (ipt)
M48, T15	12	.0030

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 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

EnduraMet 32 stainless can be satisfactorily welded by the shielded fusion and resistance welding processes. Oxyacetylene welding is not recommended, since carbon pickup in the weld may occur. When a filler metal is required, consider AWS E/ER240 welding consumables which should provide welds with strength approaching that of the base metal.

If high weld strength is not necessary, then consider E/ER308. Resistance to intergranular corrosion can be restored by a postweld annealing treatment.

Other Information

Applicable Specifications

Note: While this material meets the following specifications, it may be capable of meeting or being manufactured to meet other general and customer-specific specifications.

- ASTM A276 (Grade XM-28)
- ASTM A313 (Grade XM-28)
- ASTM A580 (Grade XM-28)
- ASTM A955 (Grade XM-28)

Forms Manufactured

- Bar-Rounds
- Rebar or (Bar-Reinforcing)
- Wire

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