RA DATA SHEET

20Cb-3®* STAINLESS

Features

- Excellent resistance to hot sulfuric acid
- Resists intergranular corrosion in the as-welded condition
- Practical immunity to chloride stress corrosion cracking

Applications

- Acid cleaning and pickling equipment
- Heat exchangers
- Chemical process piping, reactor vessels
- Bubble caps
- Petrochemical process equipment
- Pumps, valves

Composition, %

Chromium	19.00 - 21.00
Nickel	32.50 - 35.00
Molybdenum	2.00 - 3.00
Copper	3.00 - 4.00
Carbon	0.06 max
Manganese	2.00 max
Phosphorus	0.035 max
Sulphur	0.035 max
Silicon	1.00 max
Columbium + Tantalum	8 x C min 1.00 max
Iron	Remainder

Specifications

UNS N08020

ASME SB-463, SB-474, SB-468, SB-473
20Cb-3 stainless for use in welded unfired pressure vessels is included in the main body of the ASME Boiler and Pressure Vessel Code, Section VIII Division 1 and Section III Class 2 and 3. Under Section IX, 20Cb-3 (N08020) has been assigned P No. 45.

ASTM A 265, B 366, B 462, B 463, B 464 B 468, B 471, B 472, B 473, B 474, B 475

NACE MR0175

	Minimum	Typical
Ultimate Tensile Strength, psi (MPa)	80,000 (551)	91,000 (627)
0.2% Yield Strength, psi (MPa)	35,000 (241)	48,000 (331)
Elongation in 2" (50mm) or 4D, %	30	45
Reduction of Area %	50*	67
Hardness, Brinell	217 max	174
Charpy V-notch impact strength ft-lb (J)	--	200 (271)

*Bar and forgings only.

Physical Properties

Density	0.292 lb/in^3 (8080 kg/m^3)
Melting Point	2515°F (1379°C)
Modulus of elasticity (E)	28 x 10^6 psi (193 x 10^3 MPa)
Modulus of rigidity (G)	11 x 10^6 psi (75.8 x 10^3 MPa)
Poisson's Ratio	0.31
Electrical resistivity	651 ohm - cir mil/ft (1.08 microhm•m)
Specific Heat	0.12 Btu/lb°F (500 J/kg • K)

Mean Coefficient of Thermal Expansion

Temperature		Coefficient	
77°F	(20°C) to	10^{-6}/°F	(10^{-6}/°C)
212°F	(100°C)	8.16	(14.7)
392°F	(200°C)	8.37	(15.1)
662°F	(350°C)	8.71	(15.7)
842°F	(450°C)	8.84	(15.9)
1652°F	(900°C)	9.53	(17.15)

* Registered Trademark of Carpenter Technology
The mechanical and corrosion data in this brochure were developed by Carpenter Technology

Physical Properties, continued

Thermal Conductivity

Temperature °F	(°C)	Btu•ft/ft²•hr°F	W/mK
122	(50)	7.05	12.2
212	(100)	7.57	13.1
392	(200)	8.56	14.8
572	(300)	9.53	16.5
752	(400)	10.5	18.1

Corrosion Resistance

20Cb-3 stainless was originally developed to withstand sulphuric acid. The corrosion resistance in reagent grade acid, with no intentional aeration or deaeration, is shown in Figures 1-3. Corrosion rates in reagent grade acid should be used only as a guide. Many contaminants in commercial sulphuric acid can affect the degree of corrosive attack. The iron, copper and chromium ions, usually present in pickling and plating solutions, tend to reduce corrosion rates. Conversely, the presence of chloride ions increases corrosion attack.

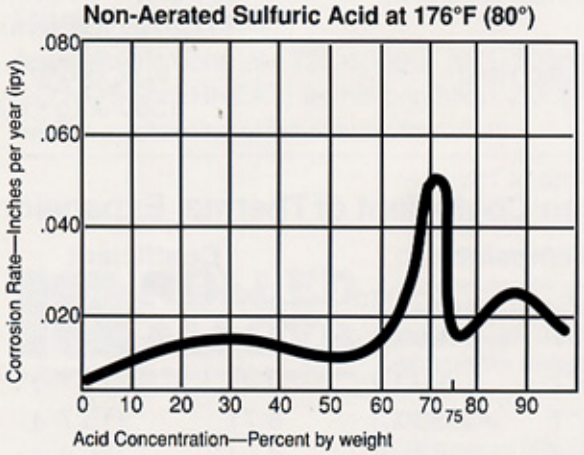

Figure 1

Typical Corrosion Resistance of 20Cb-3 Stainless in nonaerated Sulphuric Acid at 176°F (80°C)

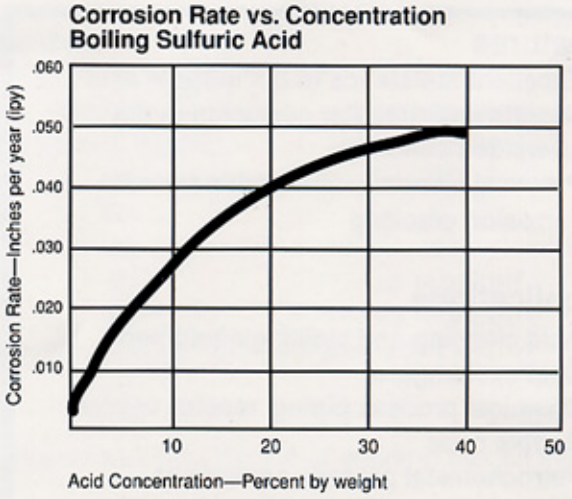

Figure 2

Typical Corrosion Resistance of 20Cb-3 Stainless in Boiling Sulphuric Acid

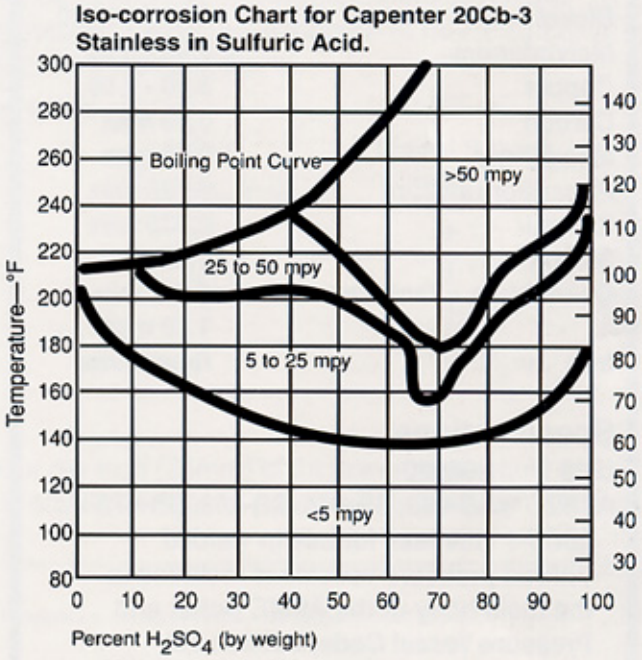

Figure 3

Typical Iso-Corrosion Chart for 20Cb-3 Stainless in Sulphuric Acid

Corrosion rates shown in Figure 4 were obtained under heat transfer conditions. That is, with the metal temperature maintained hotter than the surrounding acid solution. This is typical of heat exchanger conditions. These corrosion rates are higher than if the metal and the acid were at the same temperature.

The Corrosion of Annealed Carpenter 20Cb-3 Stainless to Boiling Sulfuric Acid at Various Concentrations as a Function of Metal Temperature

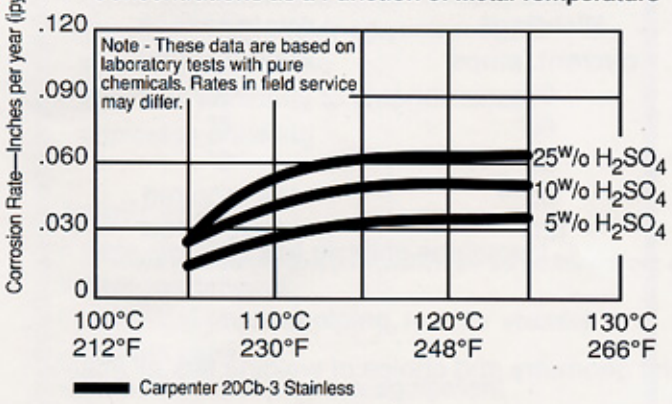

Figure 4

Typical Corrosion Resistance of Annealed 20Cb-3 Stainless in Boiling Sulphuric Acid as a function of Metal Temperature

20Cb-3 stainless is a good engineering choice to resist chloride stress corrosion cracking under conditions that crack the lower nickel stainless steels. U-bend samples of 20Cb-3 stainless have not cracked in 1000 hour exposure to boiling 25 weight percent sodium chloride to pH 1.5, per ASTM G 123.

Welding

Welding is the preferred method of joining 20Cb-3 stainless for severe corrosive service. Brazing and soldering can reduce the corrosion resistance of the assembly because of galvanic interaction with the filler metal. All joints should be designed to eliminate undesireable crevice conditions. Oxy-fuel welding should not be used with 20Cb-3 stainless as the resultant carbon pick-up will damage corrosion resistance.

Gas Metal Arc Welding

The use of high purity AWS ER320LR wire permits the use of the spray transfer mode to achieve sound welds without microfissuring.

Typical weld parameters, spray-arc transfer, 0.45" dia 320LR wire:

Shielding Gas	99.95% Argon, 40 SCFH
Gas Nozzle Diameter	3/4"
Wire Feed	250 ipm
Contact tip to work distance	3/4"
Torch Travel Speed	18 ipm
Voltage	28 volts
Current, DCRP	335 amps

Short circuiting arc pulsed arc GMAW is particularly suited to single pass welds in thin sheet metal.

Gas Tungsten Arc Welding

Suggestions:

1. Thoriated tungsten electrodes should be ground to a sharp point (20° taper) on a fine grinding wheel. Use direct current, straight polarity (DCSP), electrode negative.
2. ER320LR is the preferred weld filler.
3. Never use the core wire from a covered electrode as filler metal for GTA welding. This core wire often will not match the composition of 20Cb-3 weld fillers.
4. Strike the arc in the weld groove itself, and not on the base metal outside the weld zone.
5. Adjust welding current to get acceptable penetration at a travel speed of about 6 to 12 inches per minute.

Typical Welding Parameters for Manual Gas-Tungsten Arc Welding

Base metal thickness	Approximate welding current (DCSP), amps
20 ga (.035")	40
18 ga (.048")	50
16 ga (.0625")	60
14 ga (.075")	75
11 ga (.120")	120

Shielded Metal Arc Welding

Low residual E320LR-15 lime coated, DC reverse polarity electrodes are preferred. These electrodes produce the convex weld bead most resistant to hot cracking in restrained welds. Titania coated AC-DC electrodes produce a flatter, better looking weld bead but are less suitable for restrained welds or welds in heavy plate.

Welding, continued

Typical Welding Parameters for Shielded Metal-Arc Welding

Base Metal thickness	Electrode diameter	Welding* current, amps	Average tack weld interval
14 ga (.075")	3/32"	60	3"
11 ga (.120")	3/32"	60	6"
11 ga (.120")	1/8"	85	6"
1/4"	1/8"	85	as required
1/4"	5/32"	120	as required

*Use as a low current as will maintain a stable arc. Weld with as short an arc as possible without the electrode coating touching the weld pool.

Submerged Arc Welding (SAW)

Low interpass temperature, relatively low heat input, joint geometry and choice of welding flux all influence the soundness of SAW welds in 20Cb-3 stainless.

Interpass temperature should be 212°F (100°C) maximum. Keep heat input preferably below 42.5 kJ/inch (1.67kJ/mm). Geometry—the width of the weld should be 2 to 3 times greater than the depth. Flux—should be highly basic, and neutral with respect to chromium. Absolutely do not use acid or chromium compensating fluxes meant for common 18-8 stainless steel. A suggested flux is Avesta® Flux 805. Flux must be dry. Flux 805 may be redried by heating two hours minimum at 660°F (350°C). Flux should be mixed once during the heating period to ensure uniform drying.

Suggested Starting Parameters, AWS ER320LR Filler Wire

Wire Size inch	DCRP Current amperes	Voltage	Wire Stickout, inch	Travel Speed inch/minute
.045	150-225	25-28	1/2	8-12
.062	225-300	25-28	3/4	8-12
.094	275-350	25-28	1	8-12
.125	325-400	25-28	1	12-16

Heat Treatment

Annealing is done at 1725-1850°F (941-1010°C) for 1/2 hour per inch (25mm) of thickness, water quench. DO NOT OVERHEAT. In this condition, 20Cb-3 stainless is stabilized against possible intergranular corrosion.

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