G. O. Carlson Plate Products

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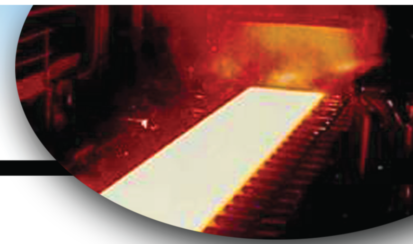

CARLSON ALLOY NITRONIC® 33 (ASTM XM-29, UNS S24000) PRODUCT DATA BULLETIN

Twice the yield strength of 304 stainless with comparable corrosion resistance. Low magnetic permeability retained after severe cold working. Resistance to chloride stress corrosion cracking superior to 304. Excellent strength and ductility at cryogenic temperatures. Wear and galling resistance superior to the standard austenitic grades.

GENERAL PROPERTIES AND TYPICAL APPLICATIONS

Nitronic® 33 is a nitrogen-strengthened austenitic stainless steel that combines high yield strength with excellent toughness and ductility. Its magnetic permeability remains very low after severe cold working and at cryogenic temperatures.

The alloy is superior to 304 stainless in a least five specific areas: (1) Yield strength in the annealed condition is approximately twice that of 304, (2) it has excellent strength and ductility at cryogenic temperatures, (3) has better stress corrosion cracking resistance than 304, (4) low magnetic permeability is retained at cryogenic temperatures and after severe cold working and, (5) resistance to wear and galling is superior to the standard austenitic stainless steels.

The corrosion resistance of Nitronic® 33 is superior to 409 and, in general, is nearly equal to 304. In weak acid solutions, the corrosion resistance of Nitronic® 33 approaches that of 304. In more aggressive media Nitronic® 33 is somewhat less resistant than 304.

Nitronic® 33 is markedly more resistant than 304 and 304L to stress corrosion cracking in hot chloride solutions at lower stress levels. At higher stress levels (approx. 50 ksi and above) they are equal. Like most stainless steels, Nitronic® 33 is prone to pitting and crevice corrosion in seawater and other aggressive environments, and should not be used under these conditions unless cathodically protected.

Although Nitronic® 33 is considerably stronger than the conventional austenitic stainless steels, the same fabricating equipment and techniques can generally be used.

APPLICATIONS:

Cryogenic Service – tanks, valves, piping, flanges and structural supports.

Abrasion/Wear Resistance – screens, racks and wear plates.

Electrical (low magnetic permeability) – conduit shielding, MRI scanner supports, fittings, underground transmission risers and pipe and electronic support members.

Marine – mine sweeper components and perming piers.

Nuclear – spent fuel casks (internal supports).

Process Equipment – heat exchangers, pressure vessels and piping where 304 is borderline with respect to stress corrosion cracking.

CHEMICAL COMPOSITION (NOMINAL ANALYSIS, PERCENT)

Carbon, max.	0.08	Phosphorus, max.	0.060
Manganese	11.50 min. – 14.50 max.	Chromium	17.00 min. – 19.00 max.
Silicon, max.	0.75	Nickel	2.30 min. – 3.70 max.
Sulfur, max.	0.030	Nitrogen	0.20 min. – 0.40 max.

AVAILABLE PRODUCTS*

Plate	3/16" and thicker. Widths to 108", lengths to 480" *For larger dimensions – inquire.*
Plate Products	cut bar, plasma cut or machined rings and discs, heads, rolled and tack-welded cylinders, and special cut shapes

* Bar, billet, ingot and master alloy pigs are available from: ELECTRALLOY, a G.O. Carlson Inc. company, 175 Main Street, Oil City, PA 16301 (800) 458-7273

MECHANICAL AND PHYSICAL PROPERTIES

Tensile Strength, ksi, min.	100 (690 MPa)
Yield Strength (0.2% offset), ksi, min.	55 (380 MPa)
Elongation in 2 in. (50.8 mm), or 4D, %, min.	40
Hardness, Brinell, max.	241
Rockwell B, max.	100
Density, grams per cu. cm	7.775
lbs. per cu. in.	0.280
Electrical Resistivity, at 75˚F (24˚C), microhm-cm	70
Coefficient of Thermal Expansion, in./in./˚Fx10^{-6}	
78˚ to 200˚F	8.93
78˚ to 400˚F	9.17
78˚ to 600˚F	9.68
78˚ to 800˚F	10.07
78˚ to 1000˚F	10.43
78˚ to 1200˚F	10.84
78˚ to 1400˚F	11.15
78˚ to 1600˚F	11.40
78˚ to 1800˚F	11.69

CORROSION RESISTANCE

Immersion Tests In Various Media
Corrosion Rates in IPY Unless Otherwise Indicated (1)

Test Medium	Nitronic® 33	304	409
10% $FeCl_3$ @ 25˚C-plain(2)	.522 gm./in.^{2}	.424 gm./in.^{2}	.772 gm./in.^{2}
10% $FeCl_3$ @ 25˚C-creviced(3)	.450 gm./in.^{2}	.358 gm./in.^{2}	.636 gm./in.^{2}
65% HNO_3 @ Boiling	.024	.010	.671
50% H_3PO_4 @ Boiling	.006	.008	.485
5% Formic @ 80˚C	<.001	<.001	.056(4)
33% Acetic @ Boiling	<.001	<.001	–
1% H_2SO_4 @ 80˚C	<.001 - .089	<.001 - .063	Dissolved
5% H_2SO_4 @ 80˚C	Dissolved	<.001 - .462	Dissolved
1% HCl @ 35˚C	.001	<.001	.535
2% HCl @ 35˚C	.109	<.001 - .014	–
5% Salt Fog @ 35˚C	OK after 500 hrs.	OK after 500 hrs.	Rusting in 24 hrs.

(1) Immersion test of 1" x 2" mill annealed sheet coupons. One heat tested per alloy. Results are the average of duplicate specimens exposed for five 48 hour periods. Those specimens tested at 35˚C and 80˚C were intentionally activated for the third, fourth and fifth periods. Where both active and passive conditions occurred, the averages of both are shown.
(2) Exposed for 48 hours uncreviced.
(3) Exposed for 48 hours with rubber bands to produce crevices.
(4) Average of three 48 hour periods, not activated.

CRYOGENIC PROPERTIES

Nitronic® 33 has excellent cryogenic properties. Compared with aluminum, low alloy steels, Invar, and other stainless steels, Nitronic® 33 has unique economic, fabricating and engineering advantages for cryogenic use. It is easily welded and does not require post or preheat treatments. It is characterized by very high strength at sub-zero temperatures, yet it maintains a high level of ductility and structural stability.

Typical Mechanical Properties at Cryogenic Temperatures*

Test Temperature		UTS		0.2% YS		Elongation
˚F	˚C	ksi	(MPa)	ksi	(MPa)	% in 2"
0	(-18)	142	(979)	85	(586)	64.5
-50	(-46)	152	(1048)	94	(648)	63
-100	(-73)	166	(1145)	104	(717)	60.5
-150	(-101)	179	(1234)	116	(800)	55
-200	(-129)	195	(1345)	132	(910)	49.5
-242	(-152)	208	(1434)	146	(1007)	42.5
-320	(-196)	229	(1579)	176.5	(1217)	20

* Data are the average to triplicate transverse tests.

Magnetic Permeability at Cryogenic Temperatures

Temperature		Magnetic Mass Susceptibility	Magnetic Permeability
˚F	˚C	x, 10^{-6} cm^3g^{-1}	µ
77	25	17.5	1.0017
-9	-23	18.4	1.0018
-99	-73	20.0	1.0020
-126	-88	24.0	1.0023
-189	-123	18.0	1.0018
-279	-173	17.4	1.0017
-320	-196	16.9	1.0016

WEAR RESISTANCE

Nitronic® 33 exhibits improved resistance to wear in sliding metal-to-metal contact compared to 304. Laboratory tests run according to ASTM G83 Crossed Cylinder Geometry gave the results show in the table below.

Nitronic® 33 also exhibits improved galling resistance when compared with 304 and may be considered where 304 is marginal. If galling persists, Nitronic® 60 should be specified.

Metal-to-Metal Wear Properties

Alloy	Hardness (Rockwell)	Weight Loss, mg./1000 revolutions*	
		105 rpm	415 rpm
Nitronic® 33	B94	7.95	4.35
310	B72	10.40	6.49
316	B91	12.50	7.32
304	B99	12.77	7.59
17-4 PH	C43	52.80	12.13
410	C40	192.79	22.50

*16 pound load, 10,000 revolutions, room temperature, duplicate self-mated tests, 0.50" diameter specimens.

FABRICATION DATA

Fabrication
Although Nitronic® 33 is considerably stronger than the conventional 300 series stainless steels, the same fabricating equipment and techniques are generally utilized. There may be occasions where more power is required in forming. In-process annealing should be accomplished between 1900˚ and 2000˚F (1038˚ and 1093˚C). Cooling practices are the same as for 300 series stainless steels. Material should be water quenched as rapidly as possible.

Welding
Nitronic® 33 can be readily welded by all conventional welding techniques. However, caution should be used when Electron Beam Welding any of the high-nitrogen austenitic stainless steels as field reports indicate the possibility of severe outgassing when using a vacuum atmosphere. Also the rapid solidification rates developed during laser and Electron Beam Welding inhibit ferrite formation in austenitic stainless steel welds and may render such weldments more sensitive to solidification cracking than observed with conventional arc welding processes.

Nitronic® 33 is the as-welded condition, contains a small amount of ferrite to assure soundness. This is also true of most other assure soundness. This is also true of most other austenitic stainless steels. Good weld practices should be employed, as with welding all stainless steels, to assure the excellent weld metal properties of the alloy. Nitronic® 33 may be welded with Nitronic® 35W (AWS ER209) as well as the more conventional weld filler metals. Type 308L filler produces matching yield strength and toughness over a wide range of temperature. The 312 weld filler produces matching ultimate and yield strengths as well as corrosion resistance for applications at ambient temperatures. All of these conventional fillers produce sound welds in Nitronic® 33.

SPECIFICATIONS

ASME SA240
ASTM A240
ASTM A312 (Chemistry Only) / ASME SA312 (Chemistry Only)

Information in this product data bulletin is not intended for specification purposes. All data should be considered as typical or average, except when listed as minimum or maximum values.

The applications cited will allow a potential user to consider this Carlson alloy for a particular installation. But none of the information is to be construed as a warranty of fitness for any application.

As with all special-service materials, this alloy must be tested under actual service conditions to determine its suitability for a specific project.

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