

Carlson Alloy

Nitronic 33[®] (ASTM XM-29, UNS S24000)

Product Data Bulletin Nitronic 33

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. It's magnetic permeability remains very low after severe cold working and at cryogenic temperatures.

The alloy is superior to 304 stainless in at 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	2.25 min - 3.75 max.
Sulfur, max.	0.030	Nitrogen	0.20 min. - 0.40 max.

Carlson Alloy

Nitronic 33[®] (ASTM XM-29, UNS S24000)

Mechanical and Physical Properties

AVAILABLE PRODUCTS*

Plate:

3/16" and thicker.
Widths to 108",
lengths to 480"
For larger dimensions -
inquire

Plate Products:

plasma cut or machined rings
and discs, cut bar, heads,
rolled and tack-welded
cylinders, and special cut
shapes

Tensile Strength, ksi., min.	100
Yield Strength (0.2% offset), ksi., min.	55
Elongation in 2 in., (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./°F x 10 ⁻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 ₃ PO ₄ @ Boiling	.006	.008	.485
5% Formic @ 80°C	< .001	< .001	.056 ⁽⁴⁾
33% Acetic @ Boiling	< .001	< .001	--
1% H ₂ SO ₄ @ 80°C	< .001 - .089	< .001 - .063	Dissolved
5% H ₂ SO 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 tests 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.

Carlson Alloy Nitronic 33[®]

(ASTM XM-29, UNS S24000)

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 of triplicate transverse tests.

Magnetic Permeability at Cryogenic Temperatures

Temperature		Magnetic Mass Susceptibility	Magnetic Permeability
°F	(°C)	$\times 10^{-6} \text{ cm}^3\text{g}^{-1}$	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 shown 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

Carlson Alloy

Nitronic 33[®] (ASTM XM-29, UNS S24000)

Product Data Bulletin Nitronic 33

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 in the as-welded condition, contains a small amount of ferrite to 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)

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.



G.O. CARLSON Inc.

unsurpassed experience with specialty metals

P.O. Box 526

Thorndale, PA 19372-0526

Telephone (610) 384-2800

Toll Free (800) 338-5622 (All USA & Canada)

Toll Free Customer Service (800) 972-3780 Fax (610) 383-3429