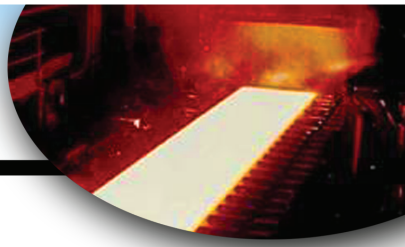
G.O. Carlson Plate



CARLSON ALLOY NITRONIC® 50 (ASTM XM-19, UNS S20910) PRODUCT DATA BULLETIN

Corrosion resistance superior to 316L and 317L with twice the yield strength at ambient temperatures. Possesses good mechanical properties at both elevated and sub-zero temperatures. Retains low magnetic permeability even after severe cold working or at sub-zero temperatures.

GENERAL PROPERTIES AND TYPICAL APPLICATIONS

Nitronic® 50 is a nitrogen-strengthened austenitic stainless steel that possesses corrosion resistance superior to 316, 316L, 317 and 317L plus approximately twice the yield strength at room temperature. It has very good mechanical properties at both elevated and sub-zero temperatures. The alloy retains low magnetic permeability even after severe cold working or exposure to sub-zero temperatures and excellent mechanical properties up to 1200˚F (629˚C).

Nitronic® 50 provides outstanding corrosion resistance in many process streams. Annealed at 2025˚F, Nitronic® 50 exhibits excellent resistance to highly corrosive environments where the material will be used in the as-welded condition. It has outstanding resistance to sulfide stress cracking and to intergranular attack.

Nitronic® 50 will withstand prolonged exposure to marine atmospheres. It has also been found to perform somewhat better than EC400 (UNS N04400) in quiet seawater. Like most stainless steels, Nitronic® 50 may suffer stress corrosion cracking in hot chloride environments. It is ranked between 304 and 316 in resistance to cracking.

Nitronic® 50 does not become magnetic when severely cold worked. This makes it useful for applications requiring a combination of excellent corrosion resistance and low magnetic permeability. Although the magnetic permeability of Nitronic® 50 remains very low at cryogenic temperatures, it does not approach the levels of Nitronic® 33 and Nitronic® 40.

Nitronic® 50 is considerably stronger than the conventional 300 series stainless steels but the same fabrication equipment and techniques are utilized.

APPLICATIONS:

Nitronic® 50 is ideal where 316, 316L, 317 and 317L are marginal. It has found wide use in petroleum, petrochemical, chemical, pulp and paper, textile, food, nuclear and marine industries.

Marine – seawater pumps, gate valves for seawater ballast systems on tankers, high-pressure (microbial) deep-sea sampler and incubation chambers and underwater robotic arms.

Chemical – urea production, ammonium carbamate pumps, pressure vessels, tanks, heat exchangers, piping, fittings, valves and pumps.

Pulp & Paper – valves for sulfite liquors.

Nuclear Waste Disposal – waste calcination systems, aqueous fluoride handling systems and waste canisters.

Oil & Gas Production – oil field production and down-hole equipment.

CHEMICAL COMPOSITION (NOMINAL ANALYSIS, PERCENT)

Carbon, max.	0.06
Manganese	4.00 min. – 6.00 max.
Silicon, max.	0.75
Sulfur, max.	0.030
Phosphorus, max.	0.040
Chromium	20.50 min. – 23.50 max.
Nickel	11.50 min. – 13.50 max.
Nitrogen	0.20 min. – 0.40 max.
Molybdenum	1.50 min. – 3.00 max.
Columbium	0.10 min. – 0.30 max.
Vanadium	0.10 min. – 0.30 max.

ALLOY NITRONIC® 50 (ASTM XM-19, UNS S20910) PRODUCT DATA BULLETIN

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

* 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.	35
Hardness, Brinell, max.	241
Rockwell B, max.	100
Density, grams per cu. cm	7.68
lbs. per cu. in.	0.285
Electrical Resistivity, at 70˚F (21˚C), microhn-cm	82
Modulus of Elasticity, tension, psi x 10^6	28.0
Typical Magnetic Permeability (annealed)	
Field Strength Oersteds / **Permeability**	
50 / 1.004	
100 / 1.004	
200 / 1.004	
Coefficient of Thermal Expansion, in./in./˚F x10^{-6}	
70˚ to 200˚F	9.0
70˚ to 400˚F	9.2
70˚ to 600˚F	9.6
70˚ to 800˚F	9.9
70˚ to 1000˚F	10.2
70˚ to 1200˚F	10.5
70˚ to 1400˚F	10.8
70˚ to 1600˚F	11.1

FABRICATION DATA

Fabrication: Although Nitronic® 50 is considerably stronger than the conventional 300 series stainless steels, the same fabricating equipment and techniques can be used. In-process annealing should be done at 2025˚F (1105˚C). Cooling practices are the same as those required for the 300 series stainless steels. Forging temperatures of 2150˚F (1175˚C) to 2250˚F (1230˚C) are recommended. Slower speeds and higher feeds are to be employed during machining operations.

Machinability: Nitronic® 50 has machining characteristics similar to other austenitic stainless steels. It is more susceptible to cold work hardening than 304 and 316. Also, the alloy has higher strength. Machining tests show the alloy to machine at approximately 21% of the cutting rate for B1112. This means Nitronic® 50 can be machined at approximately 1/2 the cutting rate (SFM) used for 304 and 316. Due to the high strength of Nitronic® 50, greater rigidity than used for 304 and 316 should be utilized in holding the work and tools. Care should be taken to prevent tools from sliding over the alloy. Nitronic® 50 produces a good surface finish.

Welding: In addition to the improved mechanical properties and corrosion resistance, Nitronic® 50 can be welded successfully by using any one of the usual arc welding processes that are normally employed with conventional austenitic stainless steels. As with most austenitic stainless steels, good weld joint properties can be obtained without the necessity of preheat or post-weld annealing. The weld metal of Nitronic® 50 is similar to many of the regular austenitic stainless steel filler metals in that a small percentage of magnetic, ferrite phase has been introduced to assure sound weld deposits. The small quantity of second phase usually produces a magnetic permeability value of approximately 1.2 in shielded metal arc weld deposits.

CORROSION RESISTANCE

Laboratory Corrosion Test Data
Corrosion Rates in Inches Per Year (IPY) Unless Otherwise Indicated (1)

Test Medium	Nitronic® 50 Annealed 2025˚F (1107˚C)	Types 316 and 316L Annealed	Types 317 and 317L Annealed
10% $FeCl_3$, 25˚C – plain (2)	<.001 g/in^2	0.011 g/in^2	–
10% $FeCl_3$, 25˚C – creviced (2)	<.001 g/in^2	0.186 g/in^2	–
1% H_2SO_4 @ 80˚C	<.001	0.002	<.001
2% H_2SO_4 @ 80˚C	<.001	0.011	<.001
5% H_2SO_4 @ 80˚C	<.001	0.060	0.036
10% H_2SO_4 @ 80˚C	0.028	0.10	0.049
20% H_2SO_4 @ 80˚C	0.133	0.48	0.155
1% H_2SO_4 @ Boiling	0.027	–	0.013
2% H_2SO_4 @ Boiling	0.064	0.12	0.027
5% H_2SO_4 @ Boiling	0.131	0.26	0.093
10% H_2SO_4 @ Boiling	0.356	0.73	0.465
20% H_2SO_4 @ Boiling	1.64	2.20	1.30
1% HCl @ 35˚C	<.001	0.012	0.002
2% HCl @ 35˚C	<.001	0.021	0.023
1% HCl @ 80˚C	<.001	–	0.148
2% HCl @ 80˚C	0.439	–	0.263
65% HNO_3 @ Boiling	0.007	0.012	0.012
70% H_3, PO_4, @ Boiling	0.154	0.202	0.201
33% Acetic Acid @ Boiling	<.001	<.001	<.001
20% Formic Acid @ Boiling	<.001	0.027	–
40% Formic Acid @ Boiling	0.032	0.034	–
10% HNO_3, + 1% HF, @ 35˚C	0.007	0.064	–
10% HNO_3, + 1% HF, @ 80˚C	0.069	0.442	–

(1) Immersion tests performed on 5/8" dia. x 5/8" (15.9 x 15.9 mm) long machined cylinders. Results are average of five 48-hour periods. Specimens tested at 35˚C and 80˚C were intentionally activated for third, fourth, and fifth periods. Where both active and passive conditions occurred, only active rates are shown.

(2) Exposure for 50 hours with rubber bands on some specimens to product crevices.

INTERGRANULAR ATTACK

The resistance of Nitronic® 50 to intergranular attack is excellent even when sensitized at 1250˚F (675˚C) for one hour to simulate the heat-affected zone of heavy weldments. Material annealed at 1950˚F (1065˚C) has adequate resistance to intergranular attack for most applications, but when Nitronic® 50 is to be used in the as-welded condition in certain strongly corrosive media, the 2025˚F (1105˚C) condition should be specified.

The resistance of Nitronic® 50 to intergranular attack is illustrated by the following data obtained by following ASTM A262:

Condition	Practice B Ferric Sulfate - Sulfuric Acid	Practice E Copper-Accelerated Copper Sulfate
Annealed 2025˚F (1105˚C)	.0009 in./mo.	Passed
Annealed 2025˚F (1105˚C)	.0022 in./mo.	Passed
+ 1250˚F (675˚C) – 1 hr. – A.C.		

STRESS CORROSION CRACKING RESISTANCE

Most stainless steels under certain conditions, as well as Nitronic® 50, may stress corrosion crack in hot chloride environments. When tested in boiling 42% $MgCl_2$ solution, a very accelerated test, Nitronic® 50 is about as resistant to cracking as 316. This is illustrated by the following comparative data using the direct-loaded tensile-type test method:

Time to Failure, Hours Under Stress

Alloy	Condition	75 ksi (517 MPa)	50 ksi (345 MPa)	25 ksi (172 MPa)
304	Annealed	0.2	0.3	0.8
Nitronic® 50	Annealed	0.4	1.2	5.0
316	Annealed	0.8	2.5	7.0

SPECIFICATIONS

ASME SA240 / ASTM A240
ASME SA312 (Chemistry Only) / 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 Plate Products

Unsurpassed experience with specialty metals

350 Marshallton-Thorndale Road • Downingtown, PA 19335-2063 • Toll Free (800) 338-5622 (All USA & Canada)
Telephone (610) 384-2800 • Fax (610) 383-3429

 Printed in U.S.A. 04/2016