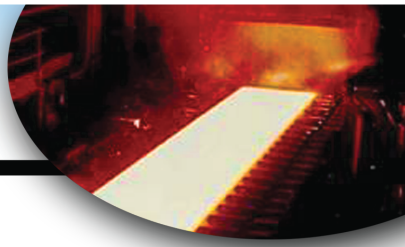
# G.O. Carlson Plate



## CARLSON ALLOY NITRONIC® 60 (UNS S21800) PRODUCT DATA BULLETIN

Galling and wear resistant austenitic stainless steel that provides a significantly lower cost alternative to cobalt-bearing and high nickel alloys. Corrosion resistance superior to 304 in most media. Approximately twice the yield strength of 304 and 316. Possesses excellent high temperature oxidation resistance and low temperature impact resistance.

## GENERAL PROPERTIES AND TYPICAL APPLICATIONS

Nitronic® 60 is an anti-galling and wear resistant austenitic stainless steel. It provides a significantly lower cost alternative to combat wear and galling when compared with cobalt-bearing and high nickel alloys. The uniform corrosion resistance of Nitronic® 60 is superior to 304 in most media. Chloride pitting resistance is superior to 316. Room temperature yield strength is nearly twice that of 304 and 316. Nitronic® 60 also possesses excellent high temperature oxidation resistance and low temperature impact resistance.

Due to its grain structure, the galling resistance of Nitronic® 60 is superior to that of any other stainless steel. It resists wear, tearing or freeze up of both the primary and contact materials over a wide range of service temperatures. The elevated temperature wear resistance of Nitronic® 60 is excellent despite its relatively low hardness when compared with cobalt and nickel-base wear alloys. It also performs well in metal-to-metal wear in nominally inert atmospheres. The cavitation erosion resistance of Nitronic® 60 is superior to the austenitic stainless steels as well as high strength duplex (ferritic-austenitic) stainless steels.

The general corrosion resistance of Nitronic® 60 falls between 304 and 316. However, in a wear system, a galling or seizure failure occurs first followed by dimensional loss due to wear and finally corrosion. Although the general corrosion resistance of Nitronic® 60 is not as good as 316, it does offer better chloride pitting, stress corrosion cracking and crevice corrosion resistance.

In high temperature service, Nitronic® 60 exhibits carburization superior to 316L and 309. It's oxidation resistance is far superior to 304 and 316 and comparable to 309.

**APPLICATIONS:**

Infrastructure bridge pin and hanger expansion joints, parking deck expansion joint wear plates.

Hydroelectric Power – stems, wicket gate wear rings.

Oil and Gas Production – pump wear rings, bushings, valve trim, seals, fittings, logging equipment and screens.

Food Processing and Pharmaceuticals – galling resistant applications in sanitary equipment where lubricants can not be used.

Chemical and Petrochemical – process valve stems, seats and trim, pump wear rings.

## CHEMICAL COMPOSITION (NOMINAL ANALYSIS, PERCENT)

| | |
|---|---|
| Carbon, max. | 0.10 |
| Manganese | 8.00 min. – 9.00 max. |
| Silicon | 3.50 min. – 4.50 max. |
| Sulfur, max. | 0.030 |
| Iron | Balance |
| Phosphorus, max. | 0.060 |
| Chromium | 16.00 min. – 18.00 max. |
| Nickel | 8.00 min. – 9.00 max. |
| Nitrogen | 0.08 min. – 0.18 max. |

## AVAILABLE PRODUCTS*

| | |
|---|---|
| **Plate** | 3/16" and thicker. Widths to 126", 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.** | 95 |
| **Yield Strength (0.2% offset), ksi, min.** | 50 |
| **Elongation in 2 in. (50.8 mm), or 4D, %, min.** | 35 |
| **Hardness, Brinell, max.** | 241 |
| **Rockwell B, max.** | 100 |
| **Density, grams per cu. cm** | 7.62 |
| **Electrical Resistivity, mirohm-cm** | 98.2 |
| **Modulus of Elasticity, tension, psi x $10^6$** | 26.2 |
| **Coefficient of Thermal Expansion, in./in./°F x$10^{-6}$** | |
| **75° to 200°F** | 8.8 |
| **75° to 400°F** | 9.2 |
| **75° to 600°F** | 9.6 |
| **75° to 800°F** | 9.8 |
| **75° to 1000°F** | 10.0 |
| **75° to 1200°F** | 10.3 |
| **75° to 1400°F** | 10.5 |
| **75° to 1600°F** | 10.7 |
| **75° to 1800°F** | 11.0 |

## GALLING RESISTANCE

**Unlubricated Galling Resistance of Stainless Steels**
**Threshold Galling Stress in ksi (MPa) (Stress at which galling began)**

| Condition Nominal Hardness (Brinell) | 410 | 416 | 430 | 440C | 303 | 304 | 316 | 17-4 | Nitronic® 32 | Nitronic® 60 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Hardened & Stress Relieved (352) – 410** | 3 (21) | 4 (28) | 3 (21) | 3 (21) | 4 (28) | 2 (14) | 2 (14) | 3 (21) | 46 (317) | 50+ (345) |
| **Hardened & Stress Relieved (342) – 416** | 4 (28) | 13 (90) | 3 (21) | 21 (145) | 9 (62) | 24 (165) | 42 (290) | 2 (14) | 45 (310) | 50+ (345) |
| **Annealed (159) – 430** | 3 (21) | 3 (21) | 2 (14) | 2 (14) | 2 (14) | 2 (14) | 2 (14) | 3 (21) | 8 (56) | 36 (248) |
| **Hardened & Stress Relieved (560) – 440C** | 3 (21) | 21 (145) | 2 (14) | 11 (76) | 5 (34) | 3 (21) | 37 (255) | 3 (21) | 50+ (345) | 50+ (345) |
| **Annealed (153) – 303** | 4 (28) | 9 (62) | 2 (14) | 5 (34) | 2 (14) | 2 (14) | 3 (21) | 3 (21) | 50+ (345) | 50+ (345) |
| **Annealed (140) – 304** | 2 (14) | 24 (165) | 2 (14) | 3 (21) | 2 (14) | 2 (14) | 2 (14) | 2 (14) | 30 (207) | 50+ (345) |
| **Annealed (150) – 316** | 2 (14) | 42 (290) | 2 (14) | 37 (255) | 3 (21) | 2 (14) | 2 (14) | 2 (14) | 3 (21) | 38 (262) |
| **H 950 (415) – 17-4 PH** | 3 (21) | 2 (14) | 3 (21) | 3 (21) | 2 (14) | 2 (14) | 2 (14) | 2 (14) | 50+ (345) | 50+ (345) |
| **Annealed (235) Nitronic® 32** | 46 (317) | 45 (310) | 8 (55) | 50+ (345) | 50 + (345) | 30 (207) | 3 (21) | 50+ (345) | 30 (207) | 50+ (345) |
| **Annealed (205) Nitronic® 60** | 50+ (345) | 50+ (345) | 36 (248) | 50+ (345) | 50+ (345) | 50+ (345) | 38 (262) | 50+ (345) | 50+ (345) | 50+ (345) |

+ Did Not Gall (Note: Condition and Harness apply to both horizontal and vertical axes.)

## WEAR RESISTANCE

**Wear Compatibility of Stainless Steel Couples**
**Weight Loss, mg./1000 cycles**

| Alloy | vs. 304 | 316 | 17-4PH | Nitronic®32 | Nitronic® 50 | Nitronic® 60 | 440C |
|---|---|---|---|---|---|---|---|
| Hardness Rockwell | B99 | B91 | C43 | B95 | B99 | B95 | C57 |
| 304 | 12.8 | | | | | | |
| 316 | 10.5 | 12.5 | | | | | |
| 17-4 | 24.7 | 18.5 | 52.8 | | | | |
| Nitronic® 32 | 8.4 | 9.4 | 17.2 | 7.4 | | | |
| Nitronic® 50 | 9.0 | 9.5 | 15.7 | 8.3 | 10.0 | | |
| Nitronic® 60 | 6.0 | 4.3 | 5.4 | 3.2 | 3.5 | 2.8 | |
| 440C | 4.1 | 3.9 | 11.7 | 3.1 | 4.3 | 2.4 | 3.8 |

## CORROSION RESISTANCE

| Media | Nitronic® 60 Annealed | 304 Annealed | 316 Annealed | 17-4 PH (H 925) |
|---|---|---|---|---|
| 65% Boiling $HNO_3$ | 0.060 in./yr. | 0.012 in./yr. | 0.012 in./yr. | 0.132 in./yr. |
| 1% HCl @ 35˚C | 0.010 in./yr. | 0.053 in./yr. | – | 0.024 in./yr. |
| 2% $H_2SO_4$ @ 80˚C<br>5% $H_2SO_4$ @ 80˚C | 0.045 in./yr.<br>0.521 in./yr. | 0.243 in./yr.<br>1.300 in./yr. | 0.011 in./yr.<br>0.060 in./yr. | 0.021 in./yr.<br>– |
| 10% $FeCl_3$ @ room temp (pitting test) 50 Hours | 0.004 g./in.$^2$<br>No Pits | 0.065 g./in.$^2$<br>Pitted | 0.011 g./in.$^2$<br>Pitted | 0.154 g./in.$^2$<br>Pitted |
| 10% $FeCl_3$ @ R T with artificial crevices 50 Hours | 0.024 g./in.$^2$<br>Slight | 0.278 g./in.$^2$<br>Heavy | 0.186 g./in.$^2$<br>Heavy | –<br>– |
| 5% Formic Acid @ 80˚C | < .001 in./yr. | 0.081 in./yr. | < .001 in./yr. | 0.001 in./yr. |
| 33% Boiling Acetic Acid | 0.011 in./yr. | 0.151 in./yr. | < .001 in./yr. | 0.006 in./yr. |
| 70% Hydrazine 168˚F (76˚C), 72 Hours | No reaction – Passed | | | |
| 5% Salt Spray @ 95˚F (35˚C) 120 Hours | Nitronic® 60 exhibited resistance to general rusting comparable to 304 | | | |

## CARBURIZATION RESISTANCE

| Alloy | | UTS ksi (MPa) | 0.2% YS ksi (MPa) | Elongation % in 4xD | Reduction of Area % | Bend 1.5T |
|---|---|---|---|---|---|---|
| Nitronic® 60 | Unexposed | 116.0 (800) | 49.5 (341) | 74.0 | 66.3 | 180° |
| | Exposed | 91.5 (630) | 58.0 (400) | 19.0 | 21.6 | 100° |
| 316L | Unexposed | 76.0 (524) | 30.0 (207) | 68.0 | 74.4 | 180° |
| | Exposed | 65.0 (448) | 36.0 (248) | 24.0 | 21.3 | 100° |
| 309 | Unexposed | 99.0 (683) | 41.0 (283) | 54.0 | 64.7 | 180° |
| | Exposed | 85.5 (589) | 45.5 (313) | 14.0 | 11.9 | 75° |

Conditions: Duplicate tests exposed at 1800ºF (982ºC) for 2 hours in packed 90% graphite + 10% sodium carbonate.

## OXIDATION RESISTANCE

| Static Oxidation Resistance Weight Loss, mg./cm² | | | | |
|---|---|---|---|---|
| Test Temperature, F (C) | RA 333 | 310 | Nitronic® 60 | 304 |
| 2100 (1149) Before Descaling | 3.1 | 4.6 | 16.5 | 1220 |
| After Descaling | 12.2 | 15.7 | 23.2 | 1284 |
| 2200 (1204) Before Descaling | 10.1 | 10.1 | 26.1 | 2260 |
| After Descaling | 16.7 | 20.6 | 35.4 | 2265 |

## SPECIFICATIONS

**ASME SA240 / ASTM A240**
**ASTM A276 (Chemistry Only) / ASME SA276 (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*

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