# Specification Sheet: Alloy 825 (UNS N08825) W.Nr. 2.4858

## An Austenitic Nickel-Iron-Chromium Alloy Developed for Exceptional Corrosion Resistance In Both Oxidizing and Reducing Environments

Alloy 825 (UNS N08825) is an austenitic nickel-iron-chromium alloy with additions of molybdenum, copper and titanium. It was developed to provide exceptional resistance to numerous corrosive environments, both oxidizing and reducing.

The nickel content of Alloy 825 makes it resistant to chloride stress-corrosion cracking, and combined with molybdenum and copper, provides substantially improved corrosion resistance in reducing environments when compared to conventional austenitic stainless steels. The chromium and molybdenum content of Alloy 825 provides resistance to chloride pitting, as well as resistance to a variety of oxidizing atmospheres. The addition of titanium stabilizes the alloy against sensitization in the as-welded condition. This stabilization makes Alloy 825 resistant to intergranular attack after exposure in the temperature range which would typically sensitize un-stabilized stainless steels.

Alloy 825 is resistant to corrosion in a wide variety of process environments including sulfuric, sulfurous, phosphoric, nitric, hydrofluoric and organic acids and alkalis such as sodium or potassium hydroxide, and acidic chloride solutions.

The fabrication of Alloy 825 is typical of nickel-base alloys, with material readily formable and weldable by a variety of techniques.

## Standards

**ASTM**..........B 424
**ASME**..........SB 424

## Applications

- Air Pollution Control
  - Scrubbers
- Chemical Processing Equipment
  - Acids
  - Alkalis
- Food Process Equipment
- Nuclear
  - Fuel Reprocessing
    - Fuel Element Dissolvers
  - Waste Handling
- Offshore Oil and Gas Production
  - Seawater Heat Exchangers
  - Piping Systems
  - Sour Gas Components
- Ore Processing
  - Copper Refining Equipment
- Petroleum Refining
  - Air-cooled Heat Exchangers
- Steel Pickling Equipment
  - Heating Coils
  - Tanks
  - Crates
  - Baskets
- Waste Disposal
  - Injection Well Piping Systems

## Chemical Analysis

**Typical analysis (Weight %)**

| Ni | Fe | Cr | Mo |
|---|---|---|---|
| 38.0 min. – 46.0 max. | 22.0 min. | 19.5 min. – 23.5 max. | 2.5 min. – 3.5 max. |

| Cu | Ti | C | Mn | S | Si | Al |
|---|---|---|---|---|---|---|
| 1.5 min. – 3.0 max. | 0.6 min. – 1.2 max. | 0.05 max. | 1.00 max. | 0.03 max. | 0.5 max. | 0.2 max. |

## Physical Properties

**Density**
0.294 lb/in$^3$
8.14 g/cm$^3$

**Magnetic Permeability**
1.005 Oersted (μ at 200H)

**Thermal Conductivity**
76.8 Btμ-ft/hr-ft$^2$ - °F (78°F)
11.1 W/m-k (26°C)

**Linear Coefficient of Thermal Expansion**
7.8 x 10$^{-6}$ in / in°F (200°F)
4 m / m°C (93°F)

**Specific Heat**
0.105 BTU/lb - °F
440 Joules/kg°K

**Electrical Resistivity**
678 Ohm circ mil/ft (78°F)
1.13 μ cm (26°C)

**Melting Range**
2500 – 2550°F
1370 – 1400°C

**Modulus of Elasticity**
28.3 psi x 10.6 (100°F)
196 MPa (38°C)

## Mechanical Properties

**Typical Room Temperature Mechanical Properties, Mill Annealed**

| Properties Applicable to Plate | | | | | |
|---|---|---|---|---|---|
| 0.2% Offset Yield Strength psi | (MPa) | Ultimate Tensile Strength psi | (MPa) | Elongation percent in 2" (50mm) | Hardness Rockwell B |
| 49,000 | (338) | 96,000 | (662) | 45 | 135 - 165 |

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## Mechanical Properties

Alloy 825 has good mechanical properties from cryogenic to moderately high temperatures. Exposure to temperatures above 1000°F (540°C) can result in changes to the microstructure that will significantly lower ductility and impact strength. For that reason, Alloy 825 should not be utilized at temperatures where creep-rupture properties are design factors. The alloy can be strengthened substantially by cold work. Alloy 825 has good impact strength at room temperature, and retains it's strength at cryogenic temperatures.

**Table 6 - Charpy Keyhole Impact Strength of Plate**

| Temperature | | Orientation | Impact Strength* | |
|---|---|---|---|---|
| °F | °C | | ft-lb | J |
| Room | Room | Longitudinal | 79.0 | 107 |
| | | Transverse | 83.0 | 113 |
| -110 | -43 | Longitudinal | 78.0 | 106 |
| | | Transverse | 78.5 | 106 |
| -320 | -196 | Longitudinal | 67.0 | 91 |
| | | Transverse | 71.5 | 97 |
| -423 | -253 | Longitudinal | 68.0 | 92 |
| | | Transverse | 68.0 | 92 |

* Average of three tests.

## Corrosion Resistance

The most outstanding attribute of Alloy 825 is its excellent corrosion resistance. In both oxidizing and reducing environments, the alloy resists general corrosion, pitting, crevice corrosion, intergranular corrosion and chloride stress-corrosion cracking.

### Resistance to Laboratory Sulfuric Acid Solutions

| Alloy | Corrosion Rate in Boiling Laboratory Sulfuric Acid Solution Mils/Year (mm/a) | | |
|---|---|---|---|
| | 10% | 40% | 50% |
| 316 | 636 (16.2) | >1000 (>25) | >1000 (>25) |
| 825 | 20 (0.5) | 11 (0.28) | 20 (0.5) |
| 625 | 20 (0.5) | Not Tested | 17 (0.4) |

## Stress-Corrosion Cracking Resistance

The high nickel content of Alloy 825 provides superb resistance to chloride stress-corrosion cracking. However, in the extremely severe boiling magnesium chloride test, the alloy will crack after long exposure in a percentage of samples. Alloy 825 performs much better in less severe laboratory tests. The following table summaries the alloys performance.

### Resistance to Chloride Stress Corrosion Cracking

| Test (U-Bend Samples) | Alloy | | | |
|---|---|---|---|---|
| | 316 | SSC-6MO | 825 | 625 |
| 42% Magnesium Chloride (Boiling) | Fail | Mixed | Mixed | Resist |
| 33% Lithium Chloride (Boiling) | Fail | Resist | Resist | Resist |
| 26% Sodium Chloride (Boiling) | Fail | Resist | Resist | Resist |

Mixed - A portion of the samples tested failed in the 2000 hour of test. This is an indication of a high level of resistance.

## Pitting Resistance

The chromium and molybdenum content of Alloy 825 provides a high level of resistance to chloride pitting. For this reason the alloy can be utilized in high chloride environments such as seawater. It can be used primarily in applications where some pitting can be tolerated. It is superior to conventional stainless steels such as 316L, however, in seawater applications Alloy 825 does not provide the same levels of resistance as SSC-6MO (UNS N08367) or Alloy 625 (UNS N06625).

## Crevice Corrosion Resistance

### Resistance to Chloride Pitting and Crevice Corrosion

| Alloy | Temp. of Onset of Crevice Corrosion Attack* °F (°C) |
|---|---|
| 316 | 27 (-2.5) |
| 825 | 32 (0.0) |
| SSC-6MO | 113 (45.0) |
| 625 | 113 (45.0) |

*ASTM Procedure G-48, 10% Ferric Chloride

## Intergranular Corrosion Resistance

### Resistance to Intergranular Corrosion

| Alloy | Boiling 65% Nitric Acid ASTM Procedure A 262 Practice C |
|---|---|
| 316 | 34 (.85) |
| 316L | 18 (.47) |
| 825 | 12 (.30) |
| SSC-6MO | 30 (.76) |
| 625 | 37 (.94) |
| **Alloy** | **Boiling 50% Sulfuric Acid-Ferric Sulfate ASTM Procedure A 262 Practice B** |
| 316 | 36 (.91) |
| 316L | 26 (.66) |
| 825 | 1 (.03) |
| SSC-6MO | 19 (.48) |
| 625 | Not Tested |

### NOTE

This technical data and information represents our best knowledge at the time of printing. However, it may be subject to some slight variations due to our ongoing research program on corrosion resistant grades.

We, therefore, suggest that information be verified at time of inquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here is only for the purpose of description and may only be considered as guarantees when our Company has given written formal approval.

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