# CORROSION MATERIALS

*"Your Corrosion Alloy Specialist"*

"ISO 9001-2008 Certified
ISO Registered Since 1993"

# Alloy 22

*UNS N06022 / W.Nr. 2.4602*

Corrosion Material's Alloy 22 is a fully austenitic, nickel-chromium-molybdenum-tungsten alloy with better overall corrosion resistance compared to other nickel-chromium-molybdenum alloys, including C276, C4 and Alloy 625. The high chromium content provides good resistance to oxidizing media while the molybdenum and tungsten content give good resistance to reducing media. Some applications for Alloy 22 include waste incinerators, waste water processing, pollution control (flue-gas desulfurization), nuclear fuel reprocessing/spent fuel containers, pickling systems, chemical manufacturing, just to name a few.

Maximum service temperature for Alloy 22 is 1250°F due to the formation of detrimental phases which form above this temperature.

## Resistance to Corrosion

Alloy 22 displays exceptional resistance to a broad range of corrosive environments. It has excellent resistance to oxidizing aqueous media including wet chlorine and mixtures containing nitric acid or oxidizing acids with chlorine ions. Resistance to reducing acids such as sulfuric and hydrochloric can also be expected. Other corrosive chemicals to which the alloy has resistance are oxidizing acid chlorides, wet chlorine, formic and acetic acids, ferric and cupric chlorides, sea water, brine and many mixed or contaminated chemical solutions, both organic and inorganic. Alloy 22 also offers optimum resistance to environments where reducing and oxidizing conditions are encountered in process streams. This is beneficial in multi-purpose plants where such "upset" conditions occur frequently.

## Fabrication and Heat Treatment

Alloy 22 can be formed using standard processes used for Ni alloys. Although ductile enough to be formed by cold working, intermediate annealing may be necessary due to work hardening. Forging should be between be performed between 1750°F and 2050°F followed by rapid cooling. Annealing can be performed at a temperature range between 2020°F and 2150°F followed by a rapid quench. Cooling at an accelerated rate avoids the formation of detrimental phases which form between 1400°F and 1800°F. Welding can be by gas tungsten-arc, gas metal-arc, and shielded metal-arc processes.

## Mechanical Properties

**Typical Room Temperature Tensile Properties of Annealed Material**

| Product Form | Tensile (ksi) | 0.2% Yield (ksi) | Elongation (%) | Hardness (HRb) |
|---|---|---|---|---|
| Plate (0.25" – 1.75") | 112 | 53 | 62 | 89 |
| Sheet (0.038" – 0.15") | 122 | 63 | 54 | 93 |
| Bar (0.50" – 5.50") | 115 | 55 | 60 | 89 |

## Cold-Worked Sheet Properties

| Percent Cold Reduction | Tensile (ksi) | 0.2% Yield (ksi) | Elongation (%) |
|---|---|---|---|
| 10% | 130 | 93 | 39 |
| 20% | 151 | 127 | 23 |
| 30% | 170 | 151 | 13 |
| 40% | 192 | 174 | 9 |
| 50% | 206 | 183 | 10 |

## Average Impart Strength

| Product Form | Condition | V-Notch Impact Strength |
|---|---|---|
| Plate | Heat-treated at 2050°F, Rapid Quench | Room Temp. – *260 ft.-lb. |
| | | -320°F – *259 ft.-lb. |

* - Specimens did not break.

## Physical Properties

| | |
|---|---|
| **Density@ Room Temp.** | 0.314 lb/in.$^3$ |
| **Elastic Modulus @ 70°F** | 29.9 x 10$^6$ psi |
| **Melting Point** | 2475°F – 2550°F |
| **Specific Heat @ 126°F** | 0.099 Btu/lb·°F |
| **Thermal Conductivity @ 118°F** | 70 Btu·in/ft$^2$·h·°F |
| **Permeability @ 200 oersted (15.9 kA/m)** | ≤1.001 |
| **Electrical Resistivity @ Room Temp.** | 44.8 µΩ·m |

## Coefficient of Thermal Expansion

| Temperature - °F | Coefficient - µin./in.°F |
|---|---|
| 200 | 6.9 |
| 400 | 6.9 |
| 600 | 7.0 |
| 800 | 7.4 |
| 1000 | 7.7 |
| 1200 | 8.1 |

## Chemical Composition

| | | | |
|---|---|---|---|
| Ni..... Balance | S..... 0.02 Max. | W..... 2.5 – 3.5 | V..... 0.35 Max. |
| Cr..... 20.0 – 22.5 | C..... 0.015 Max. | Fe..... 2.0 – 6.0 | Mn..... 0.50 Max. |
| Mo..... 12.5 – 14.5 | P..... 0.02 Max. | Co..... 2.5 Max. | Si..... 0.08 Max. |

## Aqueous Corrosion Data

| Media | Common Name | Temp. °F (°C) | Corrosion Rate (mpy) |
|---|---|---|---|
| 99% $C_2H_4O_2$ | Acetic Acid | Boiling | Nil |
| 10% $FeCl_3$ | Ferric Chloride | Boiling | 1 |
| 88% $CH_2O_2$ | Formic Acid | Boiling | <1 |
| 1% HCl | Hydrochloric Acid | Boiling | 3 |
| 5% HCl | Hydrochloric Acid | 158 (70) | 19 |
| 10% HCl | Hydrochloric Acid | Boiling | 400 |
| 5% HCl + 42 g/l $Fe_2(SO_4)_3$ | Mixed Acid | 150 (66) | 2 |
| 5% HCl + 2% HF | Mixed Acid | 158 (70) | 59 |
| 5% HF | Hydrofluoric Acid | 158 (70) | 14 |
| 85% $H_3PO_4$ | Phosphoric Acid | Boiling | 13 |
| 44% $P_2O_5$ | Phosphoric Oxide | 240 (116) | 21 |
| 38% $P_2O_5$ + 2000ppm Cl | Mixed Acid | 185 (85) | 1 |
| 38% $P_2O_5$ + 0.5% HF | Mixed Acid | 185 (85) | 7 |
| 10% $HNO_3$ | Nitric Acid | Boiling | <1 |
| 65% $HNO_3$ | Nitric Acid | Boiling | 134 |
| 5% $HNO_3$ + 6% HF | Mixed Acid | 140 (60) | 67 |
| 5% $HNO_3$ + 25% $H_2SO_4$ + 4% NaCl | Mixed Acid | Boiling | 12 |
| 5% $HNO_3$ + 1% HCl | Mixed Acid | Boiling | <1 |
| 5% $HNO_3$ + 2.5% HCl | Mixed Acid | Boiling | 2 |
| 8.8% $HNO_3$ +15.8% HCl | Mixed Acid | 126 (52) | 4 |
| 2% $H_2SO_4$ | Sulfuric Acid | Boiling | 5 |
| 10% $H_2SO_4$ | Sulfuric Acid | Boiling | 12 |
| 20% $H_2SO_4$ | Sulfuric Acid | Boiling | 33 |
| 50% $H_2SO_4$ | Sulfuric Acid | 174 (79) | 16 |
| 80% $H_2SO_4$ | Sulfuric Acid | 199 (93) | 68 |
| 10% $H_2SO_4$ + 1% HCl | Mixed Acid | 194 (90) | 94 |
| 25% $H_2SO_4$ + 200 ppm $Cl^-$ | Mixed Acid | 158 (70) | 11 |
| 23% $H_2SO_4$ + 1.2% HCl + 1% $FeCl_3$ + 1% $CuCl_2$ | ASTM G28B | Boiling | 8 |
| 50% $H_2SO_4$ + 42g/l $Fe_2(SO_4)_3$ | ASTM G28A | Boiling | 40 |

## Applicable Specifications

| Alloy 22 - Form | ASTM | ASME | Stahl-Eisen-Profblatt | VdTÜV | European Standard |
|---|---|---|---|---|---|
| **Bar** | B564[1], B574, G28-A/B | SB564[1], SB574 | 1877 Method II | 479[2] | EN10204 - 3.1.B |
| **Plate/Sheet/Strip** | A480[3], B575, G28-A/B | SB 575 | 1877 Method II | 479 | EN10204 - 3.1.B |
| **Seamless Tube/Pipe** | B622, G28-A/B | SB622 | 1877 Method II | / | EN10204 - 3.1.B |
| **Welded Tube** | B626 Class III[4], G28-A/B | SB626 Class III[4] | 1877 Method II | / | EN10204 - 3.1.B |
| **Welded Pipe** | B619[5] Class I or II, B775[6] , G28-A/B | SB619[5] Class I or II, SB775[6] | 1877 Method II | / | EN10204 - 3.1.B |

**1.** Applicable to 3 1/2" diameter and above. **2.** Haynes International Material only. **3.** Specification for flatness. **4.** Bead-worked and annealed. **5.** Up to and including 8" schedule 40. **6.** Above 8" schedule 40, annealed with no filler.

*Please contact Corrosion Materials for a complete list of available items from inventory.*

In-house machine and weld facilities help insure that the most common items will be in stock. Items not in stock can be fabricated in a short period of time either in-house or through our extensive, approved subcontractor and supplier network.

We also supply a complete range of items in the following alloys; Alloy C276, B2, B-3®, F-255, Alloy 22, 625, 200/201, Alloy 400, 405 and 600. Bar products are also available in K500, Alloy 800H/HT®, and Alloy 6B as well as various Ti grades.





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