# Hastelloy G-30 (UNS N06030)


Hastelloy G-30 is commonly used for providing excellent resistance to chemical conditions. It offers resistance to nitric acid, phosphoric acid, hydrochloric acid and hydrofluoric acid. Corrosion resistance properties are also retained even in welded form. High ductility. It is used in chemical treatment plants, agitator blades, nuclear plants etc.

The corrosion resistance offered by alloy G-30 to the production of grain precipitates in the heated area enables it for using in the chemical operations in the welded conditions.

## Chemical Composition

| | |
|---|---|
| Nickel (Ni) | 43 % |
| Chromium (Cr) | 28 to 31.5 % |
| Iron (Fe) | 13 to 17 % |
| Cobalt (Co) | 5 % |
| Molybdenum (Mo) | 4 to 6 % |
| Tungsten (W) | 1.50 to 4 % |
| Manganese (Mn) | 1.50 % |
| Copper (Cu) | 1 to 2.40 % |
| Silicon (Si) | 0.8 % |
| Phosphorous (P) | 0.040 % |
| Carbon (C) | 0.030 % |
| Sulfur (S) | 0.020 % |

## Physical Properties

| | |
|---|---|
| Density | 8.22 g/cm3 or 0.297 lb/inch3 |
| Melting temperature | 1371oC or 2500oF |
| Tensile Strength | 1096 MPa or 159000 psi |
| Yield strength | 1000 Mpa or 145000 psi |
| Modulus of elasticity | 202 GPa or 293000 ksi |
| Elongation % | 12 % |
| Area reduction | 57 % |
| Linear coefficient of thermal expansion | 14.4 micro-m/moC or 8 micro-inch/inchoF |
| Thermal conductivity | 10.2 W/mK or 70.8 BTU inch/hr.ft2.oF |

## Electric Resistivity

| Of | oC | µΩ-inch | µΩ-m |
|---|---|---|---|
| 75 of | 24 oC | 45.7 | 1.16 |
| 212 of | 100 oC | 46.1 | 1.17 |
| 392 of | 200 oC | 46.9 | 1.19 |
| 572 of | 300 oC | 47.6 | 1.21 |
| 752 of | 400 oC | 48.4 | 1.23 |
| 932 of | 500 oC | 48.8 | 1.24 |
| 1112 of | 600 oC | 49.2 | 1.25 |

## Thermal Conductivity

| Of | oC | Btu-in./ft.2- h r . - ° F | W/m.K |
|---|---|---|---|
| 75 of | 24 oC | 71 | 10.2 |
| 212 of | 100 oC | 83 | 11.9 |
| 392 of | 200 oC | 100 | 14.4 |
| 572 of | 300 oC | 116 | 16.7 |
| 752 of | 400 oC | 130 | 18.7 |
| 932 of | 500 oC | 141 | 20.3 |
| 1112 of | 600 oC | 149 | 21.4 |

## Mean Coefficient of Thermal Expansion

| Temperature, oF | Temperature, oC | µinch/in.oF | x 10(6) m/m.K |
|---|---|---|---|
| 86 of to 200 of | 39 oC to 93 oC | 7.1 | 12.8 |
| 86 of to 400 of | 30 oC to 204 oC | 7.7 | 13.9 |
| 86 of to 600 of | 30 oC to 316 oC | 8 | 14.4 |
| 86 of to 800 of | 30 oC to 427 oC | 8.3 | 14.9 |
| 86 of to 1000 of | 30 oC to 538 oC | 8.6 | 15.5 |
| 86 of to 1200 of | 30 oC to 649 oC | 8.9 | 16 |
| 86 of to 1400 of | 30 oC to 760 oC | 8.9 | 16 |

## Mechanical Properties

**Room temperature Tensile Properties**

| Alloy form | thickness | | Tensile strength, ksi | Yield strength, 0.2 % offset, ksi | Elongation %, 2 inch | Reduction area % |
|---|---|---|---|---|---|---|
| Alloy G30 sheet | 0.028 in | 0.71 mm | 100 | 47 | 56 | - |
| Alloy G30 sheet | 0.125 in | 3.2 mm | 100 | 51 | 56 | - |
| Alloy G30 plate | 0.250 in | 6.4 mm | 98 | 46 | 55 | - |
| Alloy G30 plate | 0.375 in | 9.5 mm | 100 | 45 | 65 | 68 |
| Alloy G30 plate | 0.500 in | 12.7 mm | 100 | 46 | 64 | 77 |
| Alloy G30 plate | 0.750 in | 19.1 mm | 98 | 47 | 65 | 67 |
| Alloy G30 plate | 1.250 in | 31.8 mm | 99 | 45 | 60 | - |
| Alloy G30 plate Bar | 1 inch | 25.4 mm | 100 | 46 | 60 | - |

**High temperature tensile properties,**

| Temperature | | Tensile strength | Yield strength | Elongation %, 2 inch |
|---|---|---|---|---|
| of | oC | | | |
| Room temp | Room temp | 103 | 49 | 53 |
| 200 of | 93 oC | 95 | 42 | 54 |
| 400 of | 204 oC | 88 | 36 | 59 |
| 600 of | 316 oC | 83 | 33 | 59 |
| 800 of | 427 oC | 80 | 31 | 60 |
| 1000 of | 538 oC | 76 | 29 | 62 |

## Corrosion Resistance

Hastelloy G-30 provides very high resistance to the hydrofluoric acid and nitric acid solutions that are utilized in the stainless steel pickling. This specific application includes dilute 15% nitric acid and 5% hydrofluoric acid at temperature of 140oF or 60oC. It also offers superior resistance to the industrial phosphoric acid. The use of alloy has been increasing in the fertilizer industry for acid evaporators.

The relative resistance offered by alloy G-30 and alloy G or alloy 625 to the industrial acids is described in the varied concentrations, temperatures and pollution levels. The significant difference in the rate of corrosion is possible in the acids of equal amount though from dissimilar sources. The corrosion evaluation in the acids obtained from the different sources and functionality of G-30 alloy as compare to 625 alloy is described. Normally Hastelloy G-30 provides improved performance in the corrosive conditions.

**Mean Corrosion Resistance**

| Media | Temp | | Average corrosion rate, mills per year | | | |
|---|---|---|---|---|---|---|
| | | | G-30 Alloy | Alloy 625 | Alloy G3 | Sanicro 28 |
| 28 % P2O5 + 2000 ppm Cl- | 185 of | 85 oC | 1 | 1.5 | 0.9 | 31 |
| 42 % P2O5 + 2000 ppm Cl- | 185 of | 85 oC | 0.9 | 1.3 | 11 | 121 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 44 % P2O5 | 241 of | 116 oC | 7 | 23 | 22 | - |
| 44 % P2O5 + 2000 ppm Cl- | 241 of | 116 oC | 7.7 | 25 | 22 | - |
| 44 % P2O5 + 0.5 % HF | 241 of | 116 oC | 16 | 60 | 49 | - |
| 52 % P2O5 | 241 of | 116 oC | 3.9 | 12 | 11 | 48 |
| 52 % P2O5 | 300 of | 149 oC | 28 | 79 | 64 | 248 |
| 54 % P2O5 | 241 of | 116 oC | 8 | 16 | 16 | 55 |
| 52 % P2O5 + 2000 ppm Cl- | 241 of | 116 oC | 7 | 15 | 16 | 92 |

| Chemical | Content wt % | Temperature | | Mean corrosion rate, mpy | | |
|---|---|---|---|---|---|---|
| | | of | oC | Alloy G30 | Alloy G3 | Alloy 625 |
| Acetic Acid | 99 | boiling | boiling | 1 | 0.6 | Below 1 |
| Formic acid | 88 | boiling | boiling | 2 | 5 | 9 |
| Nitric acid | 10 | boiling | boiling | 0.4 | 0.9 | 1 |
| Nitric acid | 60 | boiling | boiling | 5.3 | 8.5 | 16 |
| Nitric acid | 65 | boiling | Boiling | 5 | 11 | 20 |
| Nitric Acid + 1% HF | 20 | 176 of | 80 oC | 31 | 74 | 123 |
| Nitric Acid + 6% HF | 20 | 176 of | 80 oC | 177 | 540 | 2400 |
| Nitric Acid + 1% HF | 50 | 176 of | 80 oC | 192 | 420 | - |
| Nitric Acid + 0.5% HF | 56 | 230 of | 110 oC | 47 | 110 | - |
| Nitric Acid + 1% HF + 2000 ppm Cl- | 56 | 230 of | 110 oC | 50 | 113 | - |
| Sulfuric acid + 10% Nitric acid | 50 | boiling | Boiling | 16 | 30 | - |
| Sulfuric acid | 2 | boiling | Boiling | 8 | 6 | 6 |
| Sulfuric acid | 10 | boiling | Boiling | 31 | 19 | 46, 25 |
| Sulfuric acid | 20 | boiling | Boiling | 54 | 30 | 124, 91 |
| Sulfuric acid | 50 | 225 of | 107 oC | 37 | 37 | 223 |
| Sulfuric acid | 80 | 125 of | 52 oC | 12 | 23 | 33 |
| Sulfuric acid | 99 | 266 of | 130 oC | 43 | 74 | - |
| Sulfuric acid | 99 | 284 of | 140 oC | 46 | 57 | - |
| Sulfuric acid + 42 g/l Fe2(SO4)3 | 50 | Boiling | Boiling | 7 | 11 | 23, 17 |
| Sulfuric acid + 5% Nitric Acid | 70 | Boiling | Boiling | 133 | 240 | - |
| Sulfuric acid + 5% Nitric Acid | 60 | Boiling | Boiling | 45 | 84 | 105 |
| Sulfuric acid + 8% Nitric Acid + 4% HF | 77 | 129 of | 54 oC | 0.4 | 1.5 | - |
| Nitric Acid + 8% HCl | 18 | 176 of | 80 oC | 2 | 18 | 6 |
| Nitric Acid + 11% HCl | 25 | 176 of | 80 oC | 23 | 914 | 126 |
| Nitric Acid + 3% HCl | 59 | 176 of | 80 oC | 5 | 34 | 20 |

**Aging influence on corrosion resistance of Alloy G30**

| Aging temperature | | Corrosion rate in 20% nitric acid + 6 % HF at 176oF or 80oC mills per year, | |
|---|---|---|---|
| oF | oC | Aging hours | |
| | | 1 hour | 10 hours |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1200 of | 649 oC | 860 | 438 | 223 | 3890 | 575 | 272 |
| 1400 of | 760 oC | 12000 | 860 | 230 | 19000 | 2660 | 1600 |
| 1600 of | 871 oC | 19000 | 2145 | 177 | 20000 | 4375 | 454 |
| 1800 of | 982 oC | 19000 | 577 | 338 | 19000 | 640 | 427 |

## Fabrication

The wrought forms of alloy G-30 are subjected to heat processing until the other condition is suggested. The standard mixture and heat processing comprises of heating of alloy up to 2150oF or 1177oC subsequent to quick air or water quenching. The portions that are not hot produced are subjected to heat treatment before fabrication accomplished.
Since Hastelloy G-30 is comprised of superior forming features, cold formation is a recommended method for fabrication. Due to superior ductility of alloy, it can be conveniently cold processed. Alloy G-30 is normally more rigid as compare to austenitic stainless steel alloys. So more energy is needed while cold processing.

**Machining**
Consisting of Nickel and Cobalt, temperature and wear resistance alloys are classified as moderate to hard during machining. However, it should be taken care that Hastelloy G-30 is machined through conventional fabrication methods at the affordable rates. While machining these alloys work hardened rapidly, producing large heat while cutting, weld to the cutting to surface and has superior resistance to metal eradication due to high shear strength. Following are basic factors that should be chosen while machining:

Capacity: Machine should be solid and overpowered.
Rigidity: Working material and apparatus should be solid. Reduce tool projection.
Apparatus Sharpness: Get the apparatus sharp regularly instead of unnecessarily. 0.015 inch wear land is called as dull equipment.
Apparatus: Utilize positive rake angles for the machining operations. Negative rake angle equipments can be chosen for irregular cuts and heavy stock removal. The carbide tipped equipments are preferred for various operations. The high speed equipments can be utilized, low formation rates and generally preferred for intermittent cuts.
Positive Cuts: Utilize massive, constant feeds to preserve positive cutting action. If the feed rate is slow and equipment dwell in the cuts, work toughening occurs, tool life deteriorates and approximate tolerances become unfeasible.
Lubrication: Lubricants are enviable, soluble oils are preferred especially while utilizing carbide equipments.

**Welding**
Hastelloy G-30 alloy is easily weldable through Gas Tungsten Arc welding, Gas Metal Arc welding and shielded metal arc welding methods. The welding features are similar to Hastelloy G-3 alloy. Submerged arc welding is not preferred because this procedure includes extensive heating of base metal and slows weld quenching.

Basic Metal: The joining surface and around space is cleaned properly for welding. Every kind of contaminant and foreign material like oil crayon marks, sulfur compounds and grease and other materials are removed.

Filter metals: Machining work filer metal is preferred for welding. For Gas Tungsten Arc welding, Gas Metal Arc welding, Hastelloy G-30 filler wire is recommended. For shielded metal arc welding, G-30 alloy covered electrodes are preferred.

## Avaialble Forms

Wire, mesh, strip, foil, plate, sheet, flanges, rod, bar, tubing, pipe