Inconel 600 Alloy

Introduction

Inconel 600 alloy is basically purposeful in the engineering operations where resistance to heat and corrosion is essential. It offers excellent mechanical properties and superior combination of strength and workability. The versatile nature of Inconel 600 alloy has made it purposeful in the diverse operations that are conducted at the different temperature ranges from cryogenic temperature to 2000oF. It is implemented in the chemical applications that need high strength and resistance to corrosion features.

Chemical composition of Inconel 600 alloy

Nickel	72.0 %
Chromium	14.0-17.0 %
Iron	6.00-10.00 %
Carbon	0.15 %
Manganese	1.00 %
Sulfur	0.015 %
Silicon	0.50 %
Copper	0.50 %

Inconel 600-Resistance to Corrosion features

The chemical constituents of Inconel 600 make it to resist the diverse corrosive conditions. In the presence of chromium it offers resistance to oxidation and due to high concentration of nickel it resists the reducing and alkaline conditions. The suitable nickel content offers tremendous resistance to varied organic and inorganic compounds and shows inert nature towards chloride ion stress corrosion cracking. The presence of chromium provides resistance to sulfur compounds and oxidizing conditions at the high temperatures. The alloy 600 offers excellent resistance to corrosion of highly pure water and chloride ion stress corrosion cracking in the water equipments.

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Behavior of Inconel 600 against chlorine

The potential of alloy 600 to crack transgranularly in the chloride solutions decreases with an increase in concentration of nickel. Inconel 600 consists of 72% nickel that is highly adequate to resist the stress corrosion cracking in the chloride solutions.

Behavior of Inconel 600 against Sulfur

The Inconel 600 alloy provides excellent resistance to sulfur compounds at the intermediate temperatures though it is susceptible to sulfidation when it is subjected at the elevated temperature in the presence of sulfur. The molybdenum disulfide is a lubricant that is implemented to secure the group of components. It should not be utilized if the alloy is set into temperatures over 800oF.

Behavior of Inconel 600 against Nitrogen

The alloy 600 fits best for using in the nitriding containers as it offers large resistance to nitrogen at the elevated temperatures.

Physical properties of inconel 600 alloy

Density	8.47 Mg/m3
Melting Range	1354-1413oC or 2470-2575oF
Specific Heat	444 J/kg-oC
Electrical Resistivity	1.03 μΩ-m
Curie Temperature	-124oC or -192oF
Permeability at 200 oersted	1.010

Inconel 600-Mechanical properties

Inconel 600 alloy is not easily precipitation hardenable however it can be hardened and reinforced by cold processing. It offers broad strength and hardness on the base of its production conditions. Inconel 600 alloy attains moderate yield strength about 25,000 to 50,000 ksi and it is combined with the elongation 55 to 35% offering fabrication with nominal issues. In the intense cold processing, it provides high tensile strength of 220,000 psi. The Inconel 600 alloy offers excellent impact strength even at the standard room temperature and retains its strength at the low temperatures. It doesn't show tough to brittle conversion with the decreasing temperature.

Mechanical properties of Inconel 600 Alloy:

Form and Condition	Tensile Strength, ksi	Yield Strength, ksi	Elongation, %	Hardness, Rockwell
Wire				
Cold-Drawn				
Annealed	80-120	35-75	45-20	-
No. 1 Temper	105-135	70-105	35-15	-
Spring Temper	170-220	150-210	5-2	-

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Thermal properties of Inconel 600 alloy

Temperature oF	Coefficient of Expansion A 10(-6)in/in•°F	Electrical Resistivity ohm•circ•mil/ft	Thermal Conductivity Btu•in/ft 2•h•°F	Specific Heat Btu/lb•°F
-250	6.0	-	86	0.073
-200	6.3	-	89	0.079
-100	6.7	-	93	0.090
70	5.8	620	103	0.106
200	7.4	625	109	0.111
400	7.7	634	121	0.116

The slight processing can be done at 1600oF or 870oC. The Inconel alloy introduces lower ductility at temperatures of 1200 to 1600oF or 650o to 870oC and it should not be processed in this range.

While heat processing, the nature of Inconel 600 alloy is monitored by the various factors such as amount of cold processing, grain size, chemical constituents and dimensions. Generally, the annealing treatment of 1850oF for 15 minutes produces the soft material. In short, the exposure of alloy for 1900oF or 1040oC offers the supple alloy without causing the coarse grain structure. The development of grain doesn't occur without heating the alloy 600 up to 1800oF or 980oC. At this range, the distributed carbide in the alloy's microstructure can inhibit the grain growth.

The carbide solution initiates at temperature of 1900oF or 1040oC. The processing for one to two hours is accomplished at temperature of 2000oF to 2100oF or 1090oC to 1150oC that dissolves in the carbide solution completely and provides the developed grain size. The solution processing supports in receiving the maximum creep and rupture potential.

Impact Strength

The Inconel 600 alloy introduces excellent impact strength even at the room temperatures and sustains its whole strength at the low temperatures. It doesn't allow the hard to brittle conversion with the reducing temperature.

Grain size development

The grain size is based on the processing. The warm rolled alloy 600 possesses small grain size due to its finishing at the lower temperatures. The annealing shows minimum effect on the grain size of the hot rolled sample. The cold processed material is either annealed or cold drawn to get the smaller grain size. The solution processing gives the coarse grain structure in the hot or cold processing. Basically the alloy with adequate grain size is recommended due to its enhanced resistance to corrosion and extended tensile strength, fatigue strength and impact strength. The superior grain material causes resistance to shock and corrosion. It is recommended for lower to moderate and elevated temperature applications.

Inconel 600-Tensile Strength

To receive the high tensile strength alloy 600 should be processed at temperatures lower than 1200oF or 650oC. The **Inconel 600 alloy** is cold processed by following the normal methods similar as steel and stainless steel production methods. The rate of performance is more than the mild steel however lesser than 304 stainless steel material.

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Effects of annealing and cold processing of Inconel 600

Before heating the **Inconel 600 alloy** is cleaned properly and heating is recommended in the absence of sulfur. The furnace environment for alloy formation or open annealing should be slowly reduced to avoid the extensive oxidation of material. The rate of alloy's quenching has the minor effect on its mechanical properties. When it is set into carbide precipitation at temperature limits of 1000oF to 1400oF, it should be cooled quickly if it is required to be pickled or employed in the environments that need not to be sensitized. The Inconel alloy can be glowing heated in the dry hydrogen or vacuum and often pickled to receive the shiny alloy surface. The hot processing temperature limits of **Inconel 600 alloy** are 1600oF to 2250oF or 870oC to 1230oC. The heavy hot processing of alloy is recommended to perform at temperature ranges of 1900oF to 2250oF or 1040oC to 1230oC.

Machining of Inconel 600

Inconel 600 machining property is more than the stainless steel 304, however lesser than the stainless steel 303. This Inconel alloy is best serviced on the heavy duty device that is used for cutting equipments that are big and heavy to maintain the loads and immediately remove the heat produced. The equipments used should be sharp and possesses complete dimensions.

Welding of Inconel 600

Inconel 600 alloy is easily weldable. It shows superior welding character as compare to the high steel alloys. The precautions should be followed while welding because of tendency of hot fracturing of welds and fractures of cater pipe.

The alloy 600 is readily joined by following the traditional welding methods. The welding materials used for connecting Inconel 600 alloy are INCONEL Welding Electrode 182 that is efficient in providing the shielded metal arc welding. The INCONEL Filler Metal 82 is used for gas tungsten arc and gaseous metal arc welding. The INCONEL Filler Metal 82 and INCOFLUX 4 Submerged Arc Flux are used for the submerged arc method.

Applications of Inconel 600 alloy

Thermocouple Insulation:-

The thermocouples are double insulated with the abrasion resistant Inconel 600 alloy that offers elevated temperature fiber insulation. It offers secured performance up to 1090oC or 2000oF that makes a thermocouple the best material for using in the diverse applications that are conducted at the elevated temperatures. The thermocouples insulated by Inconel 600 are unsurpassed for profiling ovens and incinerators.

Jet Engines:-

The high temperature and corrosion resistant Inconel 600 can be machined at temperature ranges more than 1000oF. It is incomparable in terms of its creeping resistance, oxidation resistance and corrosion resistance at the elevated temperatures.

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Due to these properties, alloy 600 is commonly used in the production of jet engine parts. In the present time, fuel efficiency and competent drive are the essential factors that are considered while aircraft engine design. The engineers for long, trust on the superalloy Inconel for its excellent high temperature and stress corrosion features.

Aerospace Industry

The main engine of space shuttle consists of 65% Inconel alloy in its structure. The Inconel 600 alloy has broad use in the rocket engines due to its significant properties of excellent corrosion resistance, high temperature performance and sustenance of its properties over the wide range of temperatures.

Incinerators

Due to the production of chromic, nitrous acid, iron and copper compounds, nitrites, chromates and urea in an Incinerator, its internal surfaces are oxidized abundantly. To avoid this corrosion, Inconel 600 alloy is used that offers adequate resistance to oxidation and erosion. The content of iron creates an external oxidizing layer on the incinerator's surface. It doesn't allow oxidation more than 6% and provides extensive resistance to corrosion.

The flexibility of inconel alloy 600 has made it usable in the different operations at the cryogenic temperatures of 2000oF or 1095oC. The alloy is utilized in the chemical operations for its high potential and resistance to corrosion. The alloy's operations include the heaters, bubble towers and condensers for treatment of fatty acids, tube sheets and abietic acid treatment systems. The robustness of Inconel 600 is also used in the retorts, muffles, roller hearths and furnaces and heat processing baskets.

Limitations

1. Inconel 600 is not recommended to use in the vacuum furnace and sulfide conditions at temperatures more than 800oF.
2. It can be corroded by mineral acids and high content organic acids.
3. When it is used at the elevated temperatures, it may suffer from stress corrosion cracking in the presence of strong caustic alkalies.
4. It may receive intergranular corrosion when it is used at temperatures between 1000oF to 1400oF.

Manufacturer

Heanjia Super Metals Co., Ltd manufactures high grade Inconel 600 alloy for the elevated temperature applications. We have earned vital experience in the production of high quality Inconel 600 products that we have been serving the needs of global industries since our inception.

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The alloy 600 is offered in the various forms. The specification of the different forms is provided as following:

Wire	0.05mm to 15.0mm
Wire Mesh Screen	Mesh size:0.2 mesh/inch, thickness: 0.1 mm to 5.0mm, aperture rate: 10%-90%
Sheet and Plate	Thickness: above 1mm, width: 100mm-1700mm, length: 800mm-3000mm
Tape/Ribbon	Thickness: 0.05mm above, Width: 2mm above
Pipe and Tubing	Thickness-1-20mm, Out diameter:16-219mm
Strip	Thickness – 0.05mm above, Width- 2mm above
Rod and Bar	Diameter: 3mm above, length: 20mm above

Heanjia Super Metals Co., Ltd

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