Applications of Inconel 718 Super-alloy in aircraft industry

Modern aircraft engines offer more reliability than their traditional versions with the advancement in technology. Today engineers follow fuel efficiency and reliability as the major factors in the aircraft design. These engines can be maintained and used for several years and a single couple is adequate to power big jetliners to travel across sea. In addition of industrial applications, mission based defense applications also depend on the peak functionalities offered by engines.

Additional enhancements are being introduced with increasing interest of aerospace sector to the additional layer manufacturing or ALM of highly crucial parts. Aerospace operations concentrate on composite parts that are made of efficient and worthy metals. For this Heanjia Super-Metals produces original quality **718 Inconel** to meet the needs of aerospace engineering. It is an easily available in all forms and cost-effective option for use in the production of jet engines that need a material to withstand high temperature severe corrosive conditions.

Aerospace engineers rely on superalloys for warm compartments of turbo reactors. Super alloys are also called as heat resistant or high temperature alloys that can withstand intense mechanical stresses and pressures in extreme conditions while retaining consistent corrosion and creep resistance properties.

Nickel-Iron based super alloys are well suitable for applications in high temperature conditions that need creeping, corrosion and thermal shock resistance. These can be hardened by solid solution strengthening or precipitation of intermetallic compounds within the metal matrix.

Inconel 718- A base of Hot structural aerospace applications

Invented in 1965, Inconel 718 is a recent yet widely used industrial metal in the present time. It is taken as a refractory super alloy as it can be employed at temperatures above 600 oC. It is used by 50% of weight only in aircraft turbojet engines in the form of major parts of discs, blades and casing of high pressure part of compressor and discs and blades of turbines. It is also used in rocket engines and cryogenic conditions as it offers high toughness and secures components from brittle transformation.

Chemistry

Inconel 718 comprises of considerable magnitudes of iron that makes it cheap while providing precipitation hardening properties. The basic purpose of development of Inconel 718 was to overcome the problem of poor welding properties of this class of metals. The presence of special metals provides excellent corrosion resistance up to 1000oC. Nickel prevents chloride ion stress corrosion cracking and secures from corrosion in various organic and inorganic oxidizing media, in the variety of acidic and alkaline media. Chromium prevents corrosion in oxidizing and sulfidizing conditions while molybdenum enhances resistance to pitting.

Similar to Nickel based super alloys, Inconel 718 is also hardenable. It is important for structural parts functioning at the elevated temperatures. The strengthening forms are paired: solid solution hardening and hardening by precipitation of intermetallic phases, gamma prime and double gamma prime.

Titanium and aluminum produce precipitated intermetallic phase gamma prime, metastable and hardenable through solid solution of Niobium and Titanium at room temperature and of tungsten or molybdenum at the elevated temperature.

At temperatures near 650oC, Niobium interacts with Nickel to produce precipitation gamma double prime phase that has excellent mechanical characteristics at the small and medium temperatures. However gamma prime and double gamma prime phases are available in the aged forms, the extent of gamma prime is very small and gamma double prime is identified as the basic reinforcing agent.

The mechanical characteristics of a metal are based on the production of specific phases and their extent. **In 718** is annealed as the precipitation mechanism takes place after the dissolution of aging elements like aluminum, titanium and niobium. If these are precipitated or combined in advanced, the precipitation won't occur completely to provide the whole strength to alloy.

Limitations of Inconel 718

For excellent stress and creeping resistance, the application temperature should be kept lower than 700oC as gamma double prime is meta stable, and it quickly ages in a prolonged use up to or beyond this limit. A quick coarsening of gamma double prime, solution of these phases and microstructural shift, from the coherent disk-like gamma prime phase to the consistent, delta phase that result into low strength, particularly creeping resistance.

Mechanical Behavior

Inconel 718 offers high strength, hardness and work hardening that tend to produce loads for room temperature forging that may result into production issues. Inconel 718 is easily machinable above 540oC.

The production issues with the composite structures are generally common in the aerospace applications, causing hardly producible components that are expensive as well. While machining, elevated temperature is achieved on the cutting edge of the insert because of low thermal conductivity of alloy and abrasive elements in chemistry of alloy. It improves wear rates, chipping, notching and cutting edge rupture.

The work hardening subsequent to machining causes plastic deformation of material or the apparatus during after passes. The material is machined if it is in solution annealed form and only in the annealed form and when finishing steps are performed after aging treatment.

A sluggish but hostile cut with a hard apparatus is used to reduce the count of passes needed.

Investment casting

The investment casting is not useful because of sensitivity of Inconel 718 to metallurgical defects like porosity, segregation and coarse grain sizes that decrease performance level and need after processing steps resulting in increased cost to finish the components. For non-structural applications, it is utilized in cast and heat processed form, however for structural applications, investment cast Inconel 718 is hot isostatically pressed to reduce contraction porosity and casting segregation.

Benefits of Inconel 718 to aeronautic engineering

Conventional manufacturing methods are complicated for Inconel 718 and these usually tend to reduce the great properties of this metal such as elevated temperature corrosion and creeping resistance to get the required shapes. The processing such as machining, forging and welding also need basic annealing of material to enhance ductility and deformation resistance. We offer straightforward processing of In 718 and ensures retaining its properties. ALM has shown directional solidification that offer equal or better mechanical properties of cast and wrought parts.

ALM offers more design versatility to aerospace engineers. They can combine internal and external attributes at the same time from the base, merge an assembly into parts to decrease the downstream operations and push lightweight parts to limits by lattice structuring design.

Heanjia Super-metals understands the role of In 718 in heavy aerospace applications. We release the potential of metal to meet the industrial needs in high functionality, consistency and economy.