Inconel 625 Alloy

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The Inconel 625 alloy provides high strength, excellent fabrication character and resistance to corrosion. It offers service temperature up to 1800oF. Its excellent properties make it useful in the sea water operations as it shows inert nature against the local corrosion factors such as pitting and crevice corrosion. Inconel 625 alloy offers high fatigue strength, tensile strength and resistance to chloride ion stress corrosion cracking.

Chemical composition of inconel 625 alloy

NI	Cr	Fe	Mo	No	C	Mn	Si	P	S	Al	Ti	Co
58%	20-23%	5%	8-10%	3.15-4.15%	0.10%	0.50%	0.50%	0.015%	0.015%	0.40%	0.40%	1%

Physical properties of Inconel 625 alloy:

Density	8.44 gram/cc
Melting Range, oF or oC	2350-2460 or 1290 - 1350
Specific heat at 21oC	410(J/kg°C)
Permeability at 200 Oersted (15.9 kA/m)	1.0006
Curie Temperature, oF or oC	-320 or -196

Due to its superior resistance to corrosion features it is purposeful in the various temperatures and pressures while chemical processing. The fabrication character of alloy is useful in the commercial houses. Inconel 625 alloy offers high strength and resistance to corrosion that make it suitable for using in the different application areas.

Processing of Inconel 625 alloy

The alloy 625 is produced from the hardening effect of molybdenum and niobium on the Nickel-Chromium alloy therefore precipitation hardening is not important. The combination elements offer superior resistance to the diverse corrosive media and elevated temperature corrosion such as oxidation and carburization. The service of alloy at temperature of 1200oF, hot finishing, cold processing and annealing is done. The service of alloy at temperature more than 1200oF both annealing and solution processing are considered as the best processing. The solution processing condition is suggested for the parts that need to be subjected at the high resistance to creeping or rupturing. The fine graining of alloy is beneficial at temperature more than 1500oF corresponding to the fatigue strength, toughness and high tensile strength and yield strength. The below table shows the effect of exposure on alloy at the various temperatures for 2000 hours:

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Exposure Temp, °F (°C)	Properties at Room Temperature			Properties at Exposure Temperature		
	Tensile Strength, ksi	Yield Strength, ksi	Elongation	Tensile Strength, ksi	Yield Strength, ksi	Elongation
1200, 649	176.0	126.5	30 %	146.5	106.5	54 %
1400, 760	163.0	107.0	26 %	84.8	79.0	62 %
1600, 871	144.0	76.7	34 %	41.2	40.0	80 %

The impact and tensile strength of alloy 625 at -320oF are provided in the below table:

Test Temperature		Orientation	Impact Strength	
oF	oC		ft•lb	J
85	29	Longitudinal	48, 49, 50	65, 66, 68
		Transverse	46, 49, 51.5	62, 66, 70
-110	-79	Longitudinal	39, 44, 49	53, 57, 60
		Transverse	39, 42, 44	53, 57, 60
-320	196	Longitudinal	35, 35, 35.5	47, 47, 48
		Transverse	31, 32, 36	42, 43, 49

Structure of Inconel 625 alloy

Inconel 625 alloy is a solid solution matrix toughened face centered cubic lattice. It includes carbides that are one of the parts of this solution. The carbides included in MC and M6C consist of nickel, niobium, molybdenum and carbon.

Besides of M23C6, the carbides consist of solution processed material are implemented at the low temperature limits. The hardening effect occurs in alloy while it is subjected at temperatures up to 1200oF. It is caused by the sluggish precipitation of nickel and niobium phase in gamma prime. It keeps on changing to orthorhombic Ni3Nb when it is heated at temperatures for the long periods.

The mechanical properties of **Inconel 625 alloy** at the room temperature are provided below:

Form And Condition	Tensile Strength, ksi	Yield Strength, ksi	Elongation %	Reduction of Area, %
Rod, bar, plate	120-160	60-110	60-30	60-40
Annealed	120-150	60-95	60-30	60-40
Solution-Treated	105-130	42-60	65-40	90-60
SHEET and STRIP, annealed	120-150	60-90	55-30	-
TUBE and PIPE, Cold drawn, Annealed	120-140	60-75	55-30	-
Solution-Treated	100-120	40-60	60-40	-

Inconel 625 alloy-Resistance to corrosion features

Inconel 625 alloy offers excellent resistance to the oxidizing chemicals and non oxidizing conditions. It strictly resists the pitting and crevice corrosion and reacts against sensitization during welding process. It also avoids the intergranular cracking. The high concentration of nickel also offers freedom from chloride ion stress corrosion cracking. This blend of features makes **Inconel 625 alloy** purposeful in the wide range of corrosive media such as this alloy is highly preferred in manufacturing storage containers for chemical garbage that

incorporates hydrochloric acid, nitric acid. These are the chemicals that immediately cause adverse effects and corrosion issues.

Scaling Resistance

The metal that resists one of such acids is often corroded by the other components. The **Inconel 625 alloy** also offers better resistance to oxidation and scaling at the elevated temperature. The analysis is performed to determine the performance of alloy in the extremely rigorous conditions. In such analysis the periodic weight loss values determine the competency of Inconel alloy to preserve the security oxide layer formed in the terrific cyclic environments. The temperature of 1800oF at which the large scaling resistance occurs is an important aspect.

Stability of Inconel 625

The broad analysis is conducted on the stability of Inconel 625 when it subjected at the high temperatures from 1000oF to 1800oF for the prolonged periods. The Inconel alloy 625 is capable to withstand the varied corrosive conditions. It also acts effectively in the natural and sea waters, salts and alkaline solutions. Inconel 625 alloy offers high fatigue strength and resistance to local corrosion attack such as pitting and crevice corrosion. It attains high tensile strength and inert nature to the stress corrosion cracking in the chloride solutions.

Heating and cooling of Inconel 625 alloy

The high temperature ranges like 2000oF to 2200oF are the processing temperatures of Inconel 625 alloy on the group operations that cannot be applied for permanent annealing. It usually incorporates minor exposure in the warm area of the furnace that is at the very high temperatures. The quenching rate after heating has no major effect on the Inconel 625 alloy.

The below table can be considered as a reference to evaluate the recommended temperature for decreasing the stress level of alloy:

Annealing Temperature, oF	Tensile Strength, ksi	Yield Strength, ksi	Elongation,%	Reduced Area,%	Hardness,Rb
1400	145.5	90.8	43.0	49.5	98
1500	143.5	85.0	42.0	45.7	101
1600	145.5	87.2	39.0	41.5	101
1700	147.0	86.0	40.0	48.0	101
1800	143.5	83.6	44.0	48.0	103
1850	142.5	78.6	46.0	53.0	101

The hot and cold processing of **Inconel 625 alloy** is done to conserve the large strength at the high temperatures; it opposes the bending of alloy during elevated temperature processing. The alloy is readily formed by the hot processing though offered with sufficiently strong devices. When the **Inconel 625 alloy** is hot processed, it is heated in the furnace that has temperature up to 2150oF but not more than this. The processing is done to temperature nearly 2150oF as per the conditions allowed. The massive forging can be performed between 1850oF to 2150oF. The minor reductions are made at temperature lower than 1700oF. The below table shows the effects of annealing for one hour on the features of **Inconel 625 alloy** at the room temperature:

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Annealing Temperature, oF	Tensile Strength, ksi	Yield Strength, ksi	Elongation ,%	Reduced Area,%	Hardness,Rb
1100	160.5	134.3	28.0	48.3	106
1200	159.5	133.5	28.5	47.2	106
1300	164.0	135.0	26.0	38.8	106
1400	162.5	135.5	27.0	39.0	106
1500	152.0	120.0	29.0	41.5	105
1600	146.5	102.5	35.0	45.2	103

The heating of cold processed alloy at temperature between 1100oF to 1400oF decreases the residual stress. The decrease in stress is completed by heating **Inconel 625 alloy** at temperature of 1600oF. The heating of this alloy just like other categories of Ni - Cr and Ni – Cr –Fe alloys produces the tight oxide or scaling until it is completely annealed to bright in the presence of arid hydrogen or in vacuum. To eradicate the oxide that is caused by heating, the processing in the fused salt bath before pickling is suggested.

Applications of Inconel 625

Aeronautics

The excellent tensile strength, creeping resistance, fatigue strength and resistance to oxidation and superior weldability as well as brazeability are the features of Inconel 625 alloy due to which it is purposeful in the aeronautics sector. It is utilized in the various systems such as aircraft ducting systems, engine exhaust systems, thrust-reverser systems, resistance-welded honeycomb structures for housing engine controls, fuel and hydraulic line tubing, spray bars, bellows, turbine shroud rings, and heat-exchanger tubing in the environmental control systems. It is useful in the burning system transition liners, turbine seals, compressor vanes, and thrust-chamber tubing for rocket motors.

Underwater communication wires

The Inconel 625 alloy is used in the production of underwater communication wire as it shows the least corrosion under sea water. It resists the pitting and crevice corrosion in all conditions. The following table shows the corrosion rate of Inconel 625 in the diverse exposure positions:

Exposure Time (days)	304 SS			316L SS			Incoloy 825		Inconel 625	
	Pit depth (mm)									
Type of Exposure	199	402	740	199	402	740	252	450	252	450
Above sea water level	0.31	0.47	0.93	0.18	0.36	0.65	0.05	0.27	0	0
Semi-Submerged	0.73	1.08	1.38	0.58	0.81	0.15	0.17	0.36	0	0
Submerged	0.52	1.38	1.54	0.21	0.39	0.81	0.08	0.29	0	0

Other applications

1. Seawater auxiliary propulsion motors
2. Motor gunboats

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3. Security covers for underwater communication wires
4. Propeller blades
5. Nuclear plants

Inconel 625 alloy is produced in the following forms and their specifications:

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

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