Nickel-Chrome Alloy Inconel 625 (UNS N06625)

Inconel Alloy 625 is a corrosion and oxidation resistant nickel alloy that is employed for its high strength and good aqueous corrosion resistance properties. It prevents stress corrosion cracking due to chloride ions. Nickel 625 is a preferably used material in chemical processing, jet engines, aerospace and marine industry and nuclear power plants.

Inconel 625 alloy offers high fatigue strength, tensile strength and resistance to chloride ion stress corrosion cracking. 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.

Chemical Composition

Carbon (C)	0.10 %
Nickel (Ni)	Rem %
Chromium (Cr)	20 to 23 %
Iron (Fe)	5 %
Silicon (Si)	0.50 %
Manganese (Mn)	0.50 %
Sulfur (S)	0.015 %
Phosphorous (P)	0.015 %
Molybdenum (Mo)	8 to 10 %
Titanium (Ti)	0.40 %
Cobalt (Co)	1 %
Niobium + Tantalum	3.15 to 4.15 %
Aluminum (Al)	0.40 %

Physical Properties

Temperature		**Electrical Resistivity**	
oC	oF	Micro-ohm-meter	Micro-ohm-inches

23 oC	74 oF	1.26	49.6
100 oC	212 oF	1.27	50
200 oC	392 oF	1.28	50.4
300 oC	572 oF	1.29	50.8
400 oC	1.30 oF	752	51.2
500 oC	1.31 oF	932	51.6
600 oC	1.32 oF	1112	52

Thermal Properties

Temperature		Thermal conductivity W/M-°C	Thermal conductivity Btu-in./ft².-hr.-°F
oC	oF		
23 oC	74 oF	9.8	68
100 oC	212 oF	11.4	79
200 oC	392 oF	13.4	93
300 oC	572 oF	15.5	108
400 oC	752 oF	17.6	122
500 oC	932 oF	19.6	136
600 oC	1112 oF	21.3	148

Specific Heat Capacity

Temperature		J/kg-°C	Btu/lb-°F
oC	oF		
0 oC	32 oF	429	0.102
100 oC	212 oF	446	0.107
200 oC	392 oF	463	0.111
300 oC	572 oF	480	0.115
400 oC	752 oF	496	0.118
500 oC	932 oF	513	0.123
600 oC	1112 oF	560	0.134

Mena Coefficient of Thermal Expansion

Temperatures		x 10(-6)m/m-°C	microinches/in.-
oC	oF		
20 oC -204 oC	13.1 oF	68-400	7.3
20 oC -316 oC	13.5 oF	68-600	7.5
20 oC -427 oC	13.9 oF	68-800	7.7
20 oC -538 oC	14.4 oF	68-1000	8.0
20 oC -649 oC	15.1 oF	68-1200	8.4
20 oC -760 oC	15.7 oF	68-1400	8.7
20 oC -871 oC	16.6 oF	68-1600	9.2
20 oC -982 oC	17.3 oF	68-1800	9.6

Mean Dynamic Modulus of Elasticity

Alloy form	Processing	Temperature		Average dynamic modulus of elasticity	
		oF	oC	psi	Mpa
Inconel 625 plate	Annealed at 1925oF or 1052oC quickly quenched	RT	RT	30.2 x 10(6) psi	208,000 Mpa
		200 oF	93 oC	29,2 x 10(6) psi	201,000 Mpa
		400 oF	242 oC	28.8 x 10(6) psi	199,000 Mpa
		600 oF	316 oC	27.7 x 10(6) psi	191,000 Mpa
		800 oF	427 oC	26.7 x 10(6) psi	184,000 Mpa
		1000 oF	538 oC	25.6 x 10(6) psi	176,000 Mpa
		1200 oF	649 oC	24.3 x 10(6) psi	168,000 Mpa
		1400 oF	760 oC	22.8 x 10(6) psi	157,000 Mpa
		1600 oF	871 oC	21.2 x 10(6) psi	146,000 Mpa
		1800 oF	982 oC	18.7 x 10(6) psi	129,000 Mpa

Fabrication

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 for 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 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 Inconel 625 alloy. 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 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.

Corrosion Resistance

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.

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.

Scaling Resistance

The metal that resists one of such acids is often corroded by the other components. Inconel 625 alloy also offers better resistance to oxidation and scaling at the elevated temperature.

Average corrosion rate in Phosphoric acid

Media	temperature		Test time	Corrosion rate	
	oF	oC	days	Mpy	Mm/a
28% wet process phosphoric acid (20% P2O5) 20-22% sulfuric acid, about 1-1.5% fluorideas fluosilicic acid. Aeration, moderate. Agitation,	180 oF to 230 oF	82 oC to 110 oC	42 days	1.4 Mpy	0.04 Mm/a
55% wet process phosphoric acid (40% P2O5 equivalent containing 3% sulfuric acid and suspended calcium sulfate slurry. Aeration, none. Agitation, 50 ft/min (15 m/min)	230 oF to 234 oF	110 oC to 112 oC	112 days	59 Mpy	1.50 Mm/a
99% wet process phosphoric acid (72% P2O5), 3.7% sulfuric acid (3% SO3), 0.5% fluoride. Aeration, moderate. Agitation	60 oF to 600 oF	15 oC to 315 oC	20.8 days	14.8 Mpy	0.38 Mm/a
Exhaust gases from evaporator, entrained phosphoric acid, sulfuric acid vapor, sulfur trioxide, nitrous acid, silicon tetrafluoride, water vapor; sprayed with water containing 0.1% phosphoric acid, 0.06% sulfuric acid, 0.1% combined fluoride. Aeration, extensive. Agitation, constantly sprayed with water	50 oF to 355 oF	10 oC to 180 oC	20.8 days	12.9 Mpy	0.33 Mm/a
Gases containing hydrofluoric acid, silicon fluoride sulfur dioxide with entrained phosphoric acid (72% P2O5), 3.7% sulfuric acid (3% SO3). Aeration, broad, Agitation, fast-moving gas stream	60 oF to 650 oF	15 oC to 343 oC	20.8 days	2.1 Mpy	0.05 Mm/a

Average Corrosion rate in salt containing conditions

Media	temperature		Exposure time	Corrosion rate		Highest pitting depth	
	oF	oC		Mpy	Mm/a	Mill	mm
40% calcium chloride, pH 2, 35% of time; 40% zinc sulfate pH 1.8, 35% of	70 oF to 200 oF	21 oC to 93	73 days	0.1 Mpy	0.003 Mm/a	1 Mill	0.03 mm

time; 3-30% aluminum sulfate, pH 3, 15% of time; 40% magnesium sulfate pH 3, 10% of time; 40% zinc chloride, pH 1.8 5% of time. Aeration, moderate. Agitation, lightnin' mixer.		oC					
Cuprous chloride, cuprous cyanide, p-chlorophenol-N-methyl pyrolidone, p-cyanophenol. Aeration, none. Agitation, by boiling only.	455 oF	235 oC	43 hours	0.5 Mpy	0.013 Mm/a	-	-
5-20% cyanuric chloride in carbon tetrachloride or toluene, 0.5% chlorine, 0.3% cyanogen chloride, hydrogen chloride and phosgene	-	-	-	0.5 Mpy	0.013 Mm/a	1 Mill	0.03 mm
Zinc chloride up to 71% (72° Be). Aeration, none; under 28 in. (71 cm) vacuum. Agitation.	255 oF	107 oC	35 days	0.3 Mpy	0.008 Mm/a	3 Mill	0.008 mm
51% magnesium chloride, 1% sodium chloride, 1% potassium chloride, 2% lithium chloride as concentrated from natural Bonneville brines of 33% solubles. Aeration, little. Agitation, moderate. Liquid phase Vapor phase	 330 oF to 335 oF 330 oF to 355oF	 165 oC to 168 oC 165 to 180	100 h with brine only, 20 h with 0.2% fluosilicic acid and 0.1% HF	 2 Mpy 3 Mpy	 0.05 Mm/a 0.08 Mm/a	 - -	 - -
53% magnesium chloride, 1% sodium chloride, 1% potassium chloride, 2% lithium chloride as concentrated from natural Bonneville brines of 33% solubles. Aeration, little. Agitation, moderate to considerable.	335 oF to 355 oF	168 oC to 180 oC	200 hours	0.5 Mpy	0.013 Mm/a	-	-
Vapor phase above 53% magnesium chloride with 8,000-10,000 ppm hydrochloric acid in condensate. Aeration, air-free after start-up.	335 oF to 345 oF	168 oC to 174 oC	200 hours	4 Mpy	0.10 Mm/a	-	-
Vapors over 50% magnesium chloride with 500-4000 ppm hydrochloric acid in condensate and 1000 ppm magnesium chloride. Aeration, moderate after start-up. Agitation.	310 oF	154 oC	45 hours	2 Mpy	0.05 Mm/a	Dispersed pits	Dispersed pits
50% magnesium chloride solution plus 1% sodium chloride, 1%	310 oF	154 oC	45 hours	0.8 Mpy	0.020 Mm/a	Dispersed pits	Disperse

potassium chloride, 2% lithium chloride, concentrating natural Bonneville brine from 33% soluables to 50%. Aeration, little. Agitation, moderate							d pits

Applications

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 a highly significant material 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

Inconel 625 alloy is used in the production of underwater communication wire as it shows the least corrosion under sea water. It resists pitting and crevice corrosion in all conditions.

Other applications range includes seawater auxiliary propulsion motors, motor gunboats, security covers for underwater communication wires, propeller blades and nuclear plants

Available Forms

Wire, Mesh, Flanges, Tubing, Pipe, Strip, Plate, Foil, Sheet, Rod, Bar