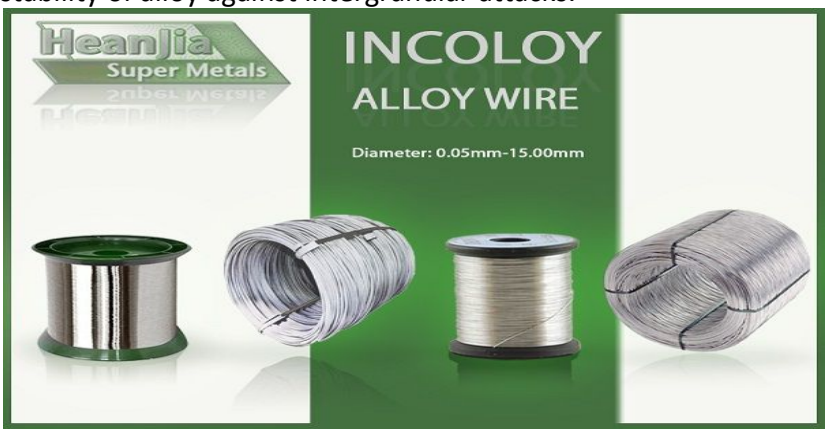
Incoloy 825 Alloy

Introduction

The Incoloy 825 is a nickel-iron-chromium alloy that provides excellent resistance to the diverse corrosion conditions. It also contains molybdenum, copper and titanium. The concentration of nickel provides high resistance to chloride ion stress corrosion cracking. The combination of nickel, molybdenum and copper offers superior resistance to the reducing media that includes sulfuric and phosphoric acids. The alloy 825 also resists the oxidizing media and pitting and crevice corrosion. The content of titanium ensures the stability of alloy against intergranular attacks.



Chemical Composition of Incoloy 825

Ni	Fe	Cr	Mo	Cu	Ti	C	Mn	S	Si	Al
38-46	22	19.5-23.5	2.5-3.5	1.5-3.0	0.6-1.2	0.05	1.0	0.03	0.5	0.2

Physical Properties of Incoloy 825

Density	0.294 lb/in3	8.14 Mg/m3
Melting Point	2500-2550 oF	1370-1400 oC
Specific Heat,	0.105 Btu/lb•°F	440 J/kg•°C
Curie Temperature	<-320 oF	<-196 oC
Permeability at 200 oersted (15.9 kA/m)	1.005	

Thermal and electrical features of Incoloy 825

Temp. oF	Coefficient of Expansion 10-6 °F in/in•°F	Thermal Conductivity Btu-n/ft2oh °F	Electrical Resistivity ohm•circ mil/ft
-250	-	55	-
-200	-	59	-
-100	-	66	-
0	-	72.6	-
78	-	76.8	678
100	-	78.4	680
200	7.8	85	687

Modulus of Elasticity

Temperature, oF	Young's Modulus, 10- 3 ksi	Shear Modulus, 10-3 ksi	Poisson's Ratio
100	28.3	11.0	0.29
200	27.9	10.9	0.28
300	27.5	10.7	0.29
400	27.1	10.4	0.30
500	26.6	10.2	0.30
600	26.1	10.1	0.29

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Mechanical Properties of Incoloy 825

The Incoloy 825 alloy offers superior mechanical characteristics from cryogenic temperatures to elevated temperature limits. When it is kept in the temperatures more than 1000oF, certain microstructural variations have been noticed that tend to decrease its ductility and impact strength. Due to this, Incoloy 825 is not employed in the conditions that need high creep rupturing features.

Room temperature tensile characteristics of Incoloy 825

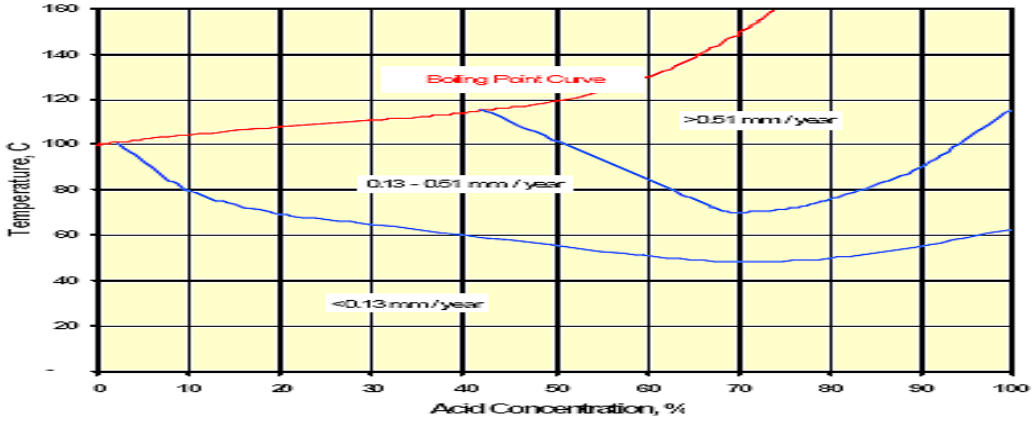
Form and Condition	Tensile Strength		Yield Strength		Elongation,%
	ksi	MPa	ksi	MPa	
Tubing, Annealed	112	772	64	441	36
Tubing, Cold Drawn	145	1000	129	889	15
Bar, Annealed	100	690	47	324	45
Plate, Annealed	96	662	49	338	45

The Incoloy 825 can be reinforced by cold processing. It exhibits high impact strength at the room temperatures and sustains strength at the cryogenic temperatures. The below table shows the charpy key hole analysis on plate.

Temperature		Orientation	Impact Strength	
oF	oC		ft-lb	J
Room	Room	Longitudinal	79.0	107
		Transverse	83.0	113
-110	-43	Longitudinal	78.0	106
		Transverse	78.5	106
-320	-196	Longitudinal	67.0	91
		Transverse	71.5	97

Resistance to corrosion Properties

The resistance to corrosion is one of the excellent features of Incoloy 825 alloy. It offers outstanding resistance to the reducing and oxidizing conditions, pitting and crevice corrosion, stress corrosion cracking and intergranular corrosion. The alloy 825 is certainly purposeful in sulfuric acid, phosphoric acid and sour gas conditions. The following chart shows the corrosion rate of alloy 825 in the presence of sulfuric acid.



Production of Incoloy 825

The alloy 825 is heat processed while production to produce the adequate blend of stability, resistance to corrosion, mechanical characteristics and formability. In order to maintain such features while fabrication, alloy 825 is annealed from 1700oF to 1800oF then quick air cooling or water cooling is performed. The heat processing in the lower end of range is permitted to obtain stability.

Although annealing at temperature in the top end of this temperature is recommended to get soft and grain development while retaining the corrosion resistance features of alloy. Cooling of alloy 825 is often not important for the components that have thin cross section such as Incoloy 825 sheet, wire and strip however it is opposed to prevent sensitization in the alloy forms that have large cross section.

Hot and cold processing

The hot processing temperature of Incoloy 825 is between 1600oF to 2150oF. It is heat processed from 1600oF to 1800oF to get high resistance to corrosion. The quenching subsequent to hot processing is done by quick air cooling. The massive sides may be sensitized while quenching from hot processing temperature, so it may become prone to the intergranular corrosion in the particular conditions. The stable annealing maintains the corrosion resistance features.

When Incoloy 825 is welded or sent to further thermal processing, it may get intergranular corrosion, the stable annealing is done irrespective of quenching rate from hot processing temperature. The cold fabrication features and processes are similar to Inconel 600 alloy. The work processing rate is lesser than the ordinary grades of austenitic stainless steel however it is still higher. The forging device is well powered and well designed to recompense the increased yield strength with plastic bending.

Machining of Incoloy 825

The standard machining methods are implemented on alloy 825. It offers adequate machining features in the annealed form. The traditional machining techniques that are used on iron alloys might be used for machining of alloy 825. It is work toughened while machining and offers more strength than the ordinary steels. The heavy duty machining device and equipments are utilized to reduce the work toughening of alloy after cutting. Different industrial coolants can be used in the machining processes. The water base coolants are recommended for large speed processes like turning, grinding and machining. The heavy lubricants do excellent in drilling, tapping and boring.

During the turning process, the carbide apparatus is preferred for the regular cuts. The large paced steel tools are utilized for irregular cuts and plane finishing to close tolerance. The equipments must have positive rake angle. The cutting pace and inputs are preferred in the following manner:

For large paced Steel Tools For Carbide Tooling Depth Surface Feed Depth Surface Feed of cut speed in inches of cut speed in inches inches feet/min. per rev. inches feet/min. per rev. 0.250" 25-35 0.030 0.250" 150-200 0.020 0.050" 50-60 0.010 0.050" 325-375 0.008.

Drilling: Stable feed rates must be followed to avoid work toughening due to lodging of the drill on the metal. Robust set-ups are important with as short a stub drill as possible. Heavy-duty, high-speed steel drills with a heavy web are preferred. Feeds vary from 0.0007 inch per rev. for holes of less than 1/16" diameter, 0.003 inch per rev. for 1/4" dia., to 0.010 inch per rev. for holes of 7/8"diameter.

Milling: In order to receive accuracy and smooth finish it is important to accompany robust machines and fixtures and sharp cutting equipments. High-speed steel cutters such as M-2 or M-10 work excellent with cutting speeds of 30-40 feet per minute and feed of 0.004"-0.006" per cutting tooth.

Grinding: The alloy should be wet ground and aluminum oxide wheels or belts are preferred.

Welding of Incoloy 825

Incoloy 825 shows excellent welding character and it can be welded through all traditional methods. In many operations, the Inconel welding electrode 112 for shielded metal arc welding and Inconel filler metal 625 for gas shielded methods are utilized. For excellent corrosion resistance purposes, the Inco weld welding electrode 686CPT and inco weld filler metal 686CPT are utilized.

The traditional welding techniques work better with Incoloy 825. The similar alloy filler metal should be utilized. In case it is not available then the closest alloy that constitutes of matching elements should be chosen. The weld beads should be convex. It is not essential to preheat the alloy. The weldable surface should be clean and the clean area should expand two inch at least beyond any side of welded joint.

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Gas Tungsten Arc Welding: For GTAW DC straight polarity is preferred. The length arc is kept as minimum as feasible and the hot end filler metal is always kept in the secured conditions.
Shielded Metal Arc Welding: The electrodes are placed in dry storage. If the electrodes are wet, these should be baked at temperature 600oF for one hour to confirm the dryness. The current flow may change from 60 A to 140 A on the base of thickness of material. The woven electrode is preferred as the weld metal is not prone to expansion. Wire brush is used to clean the slag. The complete slag eradication is essential prior to weld passes and subsequent to welding.
Gas Metals Arc Welding: The DC current with reverse polarity is used and it produces excellent results with the welding gun at 90 degrees to the welding point. For Short-Circuiting-Transfer GMAW standard voltage of 20- 23 is preferred with current flow of 110-130 amps and a wire feed rate of 250-275 inches per minute. For Spray-Transfer GMAW voltage of 26 to 33 and current in the range of 175-300 amps with wire feed rate of 200-350 inches per minute are commonly used.
Submerged-Arc Welding: Matching filler metal as used in the GMAW is recommended. DC current in both polarities can be utilized. Convex weld beads are preferred.

Welding Consumables

	Standard Service	High Strength	Corrosion Resistance
Welding Electrode	Inconel WE 112	Inconel WE 112	Inconel WE 112
Filler Metal	Inconel FM 625	Inconel FM 625	Inconel FM 625
Flux Cored Wire	Inco Cord 625DH	Inco Cord 625DH	Inco Cord 625DH

ASTM Specification for Incoloy 825

B163	Seamless Nickel and Nickel Alloy Condenser and Heat-Exchanger Tubes
B423	Ni-Fe-Cr-Mo-Cu alloy Pipe and Tubing
B424	Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221)* Plate, Sheet, and Strip
B425	Ni-Fe-Cr-Mo-Cu alloy
B704	Welded UNS N06625 and UNS N08825 Alloy Tubes
B705	Nickel alloy welded Pipe
B751	Common Requirements for Nickel and Nickel Alloy Welded Tube

Application of Incoloy 825
Chemical treatment
Pollution Control
Oil and Gas recovery
Acid Preparation and picking processes
Nuclear fuel retreatment and managing radioactive waste

Incoloy 825 Product Forms Available:
Wire, Wiremesh Screen, Strip, Sheet, Rod, Pipe, Bar, Tubing, Plate, Ribbon, Tape