

## Incoloy Alloy 800H/800HT (UNS N08810/088011)



Incoloy 800H/HT is an outstanding corrosion resistant alloy that is recommended for use in the high temperature industrial conditions. It has higher strength than Incoloy 800. Outstanding resistance to stress corrosion cracking up to 1100oF, local corrosion and carburization. Incoloy 800H/HT is commonly used in pyrolysis, power production units, superheaters, petrochemical industries, oil processing, heating element shielding and others.

### Chemical Composition

Element	800H	800HT
Aluminum (Al)	0.2 %	0.85 to 1.20 %
Carbon (C)	.05 %	.06 to .10 %
Chromium (Cr)	19.5 to 23.5 %	19 to 23 %
Copper (Cu)	1.5 to 3 %	0.75 %
Iron (Fe)	22 %	39.5 %
Manganese (Mn)	1 %	1.5 %
Molybdenum (Mo)	2.5 to 3.5 %	
Nickel (Ni)	38 to 46 %	30 to 35 %
Sulfur (S)	.03 %	0.015 %
Silicon (Si)	0.5 %	1 %
Titanium (Ti)	0.6 to 1.2 %	0.25 to 0.60 %

### Physical Properties

Temperature		Electrical Resistivity microhm-in.	Electrical Resistivity microhm-m
oF	oC		
70 oF	21 oC	38.9 microhm-in.	0.989 microhm-m
200 oF	93 oC	40.6 microhm-in.	1.03 microhm-m
400 oF	204 oC	43 microhm-in.	1.09 microhm-m
600 oF	316 oC	44.7 microhm-in.	1.13 microhm-m

## Mean Coefficient of Thermal Expansion

Temperature		Inch/inch.oF	Cm/cm.oC
oF	oC		
200 oF	93 oC	7.9 x 10 <sup>(-6)</sup> inch/inch.oF	14.4 x 10 <sup>(-6)</sup> cm/cm.oC
400 oF	204 oC	8.8 x 10 <sup>(-6)</sup> inch/inch.oF	15.9 x 10 <sup>(-6)</sup> cm/cm.oC
600 oF	316 oC	9 x 10 <sup>(-6)</sup> inch/inch.oF	16.2 x 10 <sup>(-6)</sup> cm/cm.oC
800 oF	427 oC	9.2 x 10 <sup>(-6)</sup> inch/inch.oF	16.5 x 10 <sup>(-6)</sup> cm/cm.oC
1000 oF	538 oC	9.4 x 10 <sup>(-6)</sup> inch/inch.oF	16.8 x 10 <sup>(-6)</sup> cm/cm.oC
1200 oF	649 oC	9.6 x 10 <sup>(-6)</sup> inch/inch.oF	17.1 x 10 <sup>(-6)</sup> cm/cm.oC
1400 oF	760 oC	9.9 x 10 <sup>(-6)</sup> inch/inch.oF	17.5 x 10 <sup>(-6)</sup> cm/cm.oC
1600 oF	871 oC	10.2 x 10 <sup>(-6)</sup> inch/inch.oF	18 x 10 <sup>(-6)</sup> cm/cm.oC

## Thermal Conductivity

Temperature		Btu-in/ft <sup>2</sup> -hr-°F	W/m-K
oF	oC		
70 oF	21 oC	80 Btu-in/ft <sup>2</sup> -hr-°F	11.5 W/m-K
200 oF	93 oC	89 Btu-in/ft <sup>2</sup> -hr-°F	12.8 W/m-K
400 oF	204 oC	103 Btu-in/ft <sup>2</sup> -hr-°F	14.8 W/m-K
600 oF	316 oC	115 Btu-in/ft <sup>2</sup> -hr-°F	16.6 W/m-K
800 oF	427 oC	127 Btu-in/ft <sup>2</sup> -hr-°F	18.3 W/m-K

## Mechanical Properties

Alloy	Form	Condition	Tensile strength, ksi	Yield Strength, ksi	Elongation %
800	Sheet, Plate	Annealed	85 ksi (586 Mpa)	40 ksi (276 Mpa)	43 %
800	Sheet, Plate, Strip, Bar	Annealed	75 ksi (520 Mpa)	30 ksi (205 Mpa)	30 %
800H	Sheet, Plate	SHT	80 ksi (552 Mpa)	35 ksi (241 Mpa)	47 %
800H	Sheet, Plate, Strip, Bar	SHT	65 ksi (450 Mpa)	25 ksi (170 Mpa)	30 %

### Annealed Incoloy 800H/800HT properties at 2100oF or 928oC

temperature		Yield Strength		Tensile strength		Elongation
oF	oC	Psi	Mpa	Psi	Mpa	% in 2 inch
70 oF	21 oC	29,000 Psi	200 Mpa	77,000 Psi	531 Mpa	52 %
200 oF	93 oC	24,100 Psi	166 Mpa	71,000 Psi	490 Mpa	53 %
600 oF	316 oC	19,000 Psi	131 Mpa	66,600 Psi	459 Mpa	53 %
800 oF	427 oC	18,100 Psi	125 Mpa	65,900 Psi	454 Mpa	53 %
1000 oF	538 oC	16,500 Psi	114 Mpa	63500 Psi	438 Mpa	51 %
1200 oF	649 oC	14,800 Psi	102 Mpa	55700 Psi	384 Mpa	50 %
1400 oF	760 oC	14,400 Psi	99 Mpa	32300 Psi	223 Mpa	78 %
1600 oF	871 oC	11,600 Psi	80 Mpa	18,600 Psi	128 Mpa	120 %
1800 oF	982 oC	8,900 Psi	61 Mpa	10,200 Psi	70 Mpa	120 %

## Stress Rupture Strength

Temp		10,000 hours		30,000 hours		50,000 hours		100,000 hours	
oF	oC	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa
1200 oF	650 oC	17.5 Ksi	121 Mpa	15 Ksi	103 Mpa	14 Ksi	97 Mpa	13 Ksi	90 Mpa
1300 oF	705 oC	11 Ksi	76 Mpa	9.5 Ksi	66 Mpa	8.8 Ksi	61 Mpa	8 Ksi	55 Mpa
1400 oF	760 oC	7.3 Ksi	50 Mpa	6.3 Ksi	43 Mpa	5.8 Ksi	40 Mpa	5.3 Ksi	37 Mpa
1500 oF	815 oC	5.2 Ksi	36 Mpa	4.4 Ksi	30 Mpa	4.1 Ksi	28 Mpa	3.7 Ksi	26 Mpa
1600 oF	870 oC	3.5 Ksi	24 Mpa	3 Ksi	21 Mpa	2.8 Ksi	19 Mpa	2.5 Ksi	17 Mpa
1700 oF	925 oC	1.9 Ksi	13 Mpa	1.6 Ksi	11 Mpa	1.4 Ksi	10 Mpa	1.2 Ksi	8.3 Mpa
1800 oF	980 oC	1.2 Ksi	8.3 Mpa	1 Ksi	6.9 Mpa	0.9 Ksi	6.2 Mpa	0.8 Ksi	5.5 Mpa

## Corrosion Resistance

The resistance to corrosion in the aqueous media at the intermediate temperatures is excellent. The high concentration of nickel and chromium give the Incoloy alloys superior resistance to oxidation. The concentration of chromium enhances the production of protected surface oxide and the concentration of nickel improves the security during cyclic exposure in the high temperature conditions. The scaling resistance of **Incoloy 800H and 800HT alloy** is noticed in the rigorous cyclic oxidations analysis at the temperature ranges of 1800oF to 2000oF. The analysis are made in the air and consecutive exposures to the above temperatures for 15 minutes and quenched in air for five minutes. The samples are set for 1000 hours for cyclic exposure with the intermittent eradication for the measuring the mass variations.

Alloy	Corrosion Rate	
	mpy	mm/y
INCOLOY alloys 800H/800HT	6.0	0.15
Type 310 Stainless Steel	8.9	0.23
Type 309 Stainless Steel	84.5	2.15
Type 304 Stainless Steel	Complete oxidation	

In the above table, the consequences of oxidation analysis made in the fire box of a filtration furnace are provided. The furnace was set at temperature between 1600oF to 2100oF or 870oC to 1150oC and burnt by fuel in absence of sulfur. The sample was set in to furnace for three months. In the oxidized environments of chromium though reduction to nickel metal, the incoloy alloy can be employed for internal oxidation. The conditions that cause the rigorous embrittlement are due to wider oxidation of chromium that provides highly magnetic alloy. The sensitivity to the internal oxidation is reduced by the inclusion of Ni – Cr alloy. The **Incoloy 800H and 800HT alloy** consist of 46% ferrous that offers high resistance to internal oxidation.

### Carburization

The significant concentration of nickel in **Incoloy 800H and 800HT alloy** provides vital resistance to carburization. In the below table resistance to carburization at the temperature from 1700oF (925oC) and 1800oF (980oC) is shown.

Alloy	Weight Gain, mg/cm(2)	
	1700oF (925oC)	1800oF (980oC)
INCONEL alloy 600	2.66	-
INCONEL alloy 601	2.72	4.32
INCOLOY alloys 800H/800HT	4.94	11.6
Type 330 Stainless Steel	6.42	12.4

The following table describes the superiority of Incoloy 800H and 800HT over the low concentrated nickel alloys in the 25 hours gaseous carburization analysis that is made at temperature of 2000oF or 1095oC.

Alloy	Weight Gain, mg/cm(2)
INCONEL alloy 600	2.78
INCOLOY alloys 800H/800HT	5.33
Type 310 Stainless Steel	18.35
Type 309 Stainless Steel	18.91

An analysis is made in an atmosphere consisting of 2% methane hydrogen and its result are shown in the below table. The sample is kept for 100 hours in the carburizing conditions at the temperature of 2000°F or 1095°C. The results of Incoloy 800H and 800HT alloy are compared with the other alloys. The analysis conditions were comprised of 2% methane and 5% argon in the presence of hydrogen.

Alloy	Weight Gain, mg/cm(2)
INCONEL alloy 600	12.30
INCONEL alloy 601	16.18
INCOLOY alloys 800H/800HT	21.58

### Resistance to Sulfidation

The high concentration of chromium in Incoloy 800H and 800HT alloy is the prime reason of excellent resistance to various sulfiding conditions at the elevated temperatures. In the oxidized environments of chromium though reduction to nickel metal, the Incoloy alloy can be employed for internal oxidation. The conditions that cause the rigorous embrittlement are due to wider oxidation of chromium that provides high magnetic alloy. The sensitivity to the internal oxidation is reduced by the inclusion of Ni – Cr alloy.

### Nitridation

The analysis made on the effect of different nitriding solutions on the resistance of **Incoloy 800H and 800HT alloy** has made it clear that the alloy's resistance increases with an increase in the concentration of nickel. Incoloy 800H and 800HT alloy comprising of 32% nickel offer superior resistance to several nitriding conditions. The specimen is set in the atmosphere containing 65% hydrogen and 35% nitrogen at 11 ksi (75.8 MPa) and 1000°F 540°C) (for three years. The following shows the effects of nitridation:

Material	Depth of Nitriding	
	1 year	3 years

	in.	mm	in.	mm
Type 310 Stainless Steel	0.0088 in.	0.224 mm	0.0092 in.	0.234 mm
Type 309 Stainless Steel	0.0095 in.	0.241 mm	0.0096 in.	0.244 mm
Type 446 Stainless Steel	0.0417 in.	1.059 mm	0.0453 in.	1.151 mm
Type 304 Stainless Steel	0.0427 in.	1.085 mm	0.0440 in.	1.118 mm
INCOLOY alloys 800H/800HT	0.0054 in.	0.137 mm	0.0053 in.	0.135 mm

## Fabrication

The severe forging should not be performed quickly as it makes the metal overheated. In the warm bending processes, the metal should be treated quickly subsequent to removal from the furnace to reduce the surface quenching prior to deformation.

### Heating

The hot preparation temperature range of **Incoloy 800H and 800HT alloy** is 1600oF to 2200oF or 870oC to 1200oC. The severe forging should be performed at temperature below to 1850oF or 1010oC and the slight processing should be done below to 1600oF or 870oC. The quenching rate of alloy subsequent to hot processing is not decisive for Incoloy alloys corresponding to thermal rupturing.

Though the alloys are set for carbide precipitation at temperatures about 1000oF to 1400oF or 540oC to 760oC and should be quenched immediately.

### Quenching

The quenching subsequent to hot processing can be done by the air cooling. The heavy parts may be sensitized while cooling from the hot processing temperature and these become prone to intergranular corrosion in the various corrosive media.

### Welding

**Incoloy 800H and 800HT alloy** has superior welding character like Incoloy 800. Both alloys are widely used for high creep rupture strength oriented operations and welding products with adequate force features for the required operation temperature limits.

For temperature limits of 1450oF or 790oC, a special electrode is used for metal arc welding and inconel 82 filler metal is employed for gas shielded welding. At the processing temperatures of 1450oF or 790oC, an adequate welding option is based on the certain processing temperature limits and the features required in the welding joint.

## Available Forms

Wire, strip, foil, sheet, plate, mesh, pipe, tubing, bar, rod, flanges