Incoloy 800H and 800HT

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The Incoloy 800, 800H and 800HT alloys comprise of same concentration of nickel, chromium and iron and they show similar resistance to corrosion at the given temperature. The **Incoloy 800H and 800HT** are basically employed for high temperature strength and resistance to various corrosive media in the elevated temperature reactions including carburization and oxidation.

Chemical composition of Incoloy 800H alloy

Ni	Fe	Cr	Cu	Ti	Al	C	Mn	S	Si
30-35	39.5	19-23	.75	.15-.60	.15-.60	.05-.10	1.5	.015	1

Chemical composition of Incoloy 800HT alloy

Ni	Fe	Cr	Cu	Ti	Al	C	Mn	S	Si
30-35	39.5	19-23	.75	.25-.60	.85-1.20	.06-.10	1.5	.015	1

ASTM Specification for Incoloy 800/800H/800HT Series

Alloy	Pipe Smls	Pipe Welded	Tube Smls	Tube Welded	Sheet	Bar	Forging	Fitting
Incoloy 800	B407	B154	B163	B515	B409	B408	B564	B366
800H	B407	B154	B163	B515	B409	B408	B564	B366
800HT	B407	B154	B163	B515	B409	B408	B564	B366

Mechanical Properties of Incoloy 800H/800HT alloy

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

Corrosion resistance Features

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 the **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 embrittelment 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 the **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 embrittelment 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.

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Resistance to 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. Though the incoloy 600 alloy consisting of 76% nickel is recommended for nitridation applications, 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	0.224	0.0092	0.234
Type 309 Stainless Steel	0.0095	0.241	0.0096	0.244
Type 446 Stainless Steel	0.0417	1.059	0.0453	1.151
Type 304 Stainless Steel	0.0427	1.085	0.0440	1.118
INCOLOY alloys 800H/800HT	0.0054	0.137	0.0053	0.135

Heating and Pickling

For heating and pickling, the sample should be clean that the unnecessary materials like oil, paint, grease and shop soil should be properly removed before the heating process. The heating should be done in the lower sulfur conditions. The open heating should be performed with a fuel consisting of lower concentration of sulfur and the furnace should have reducing conditions to avoid the wider oxidation. Alloy 800 cannot be intensely annealed in the common annealing furnaces due to oxidation of chromium in the presence of air, CO2 and water vapors. Within the restricted conditions, the incoloy alloys can be intensely annealed in the presence of pure hydrogen.

The **Incoloy 800H and 800HT alloy** are generally annealed in the box or muffle shaped furnaces under the reducing conditions. The suitable atmosphere is maintained by the burning of low sulfur natural gas in the absence of air. It forms thin, adherent and green black layer of oxide on the alloy. The oxidizing conditions create a severe black scale that cannot be removed easily. The eradication of this scale needs the suitable grinding process. The alloy should be pickled after heating if it needs the bright outer layer. Due to inherent resistance to the chemical treatments, the particular pickling methods are followed for **Incoloy 800H and 800HT alloy.** The complete temperature control in bending is the very crucial factor in obtaining the warm malleability. The advanced heating of all equipments and dies at temperatures of 500oF or 260oC is preferred to prevent the cooling of **Incoloy 800H and 800HT alloy** during processing.

Forging of Incoloy 800H/800HT

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 completion of 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.

Quenchig

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.

Structure

The incoloy alloys similar to stainless steel alloys are austenitic and possess face centered cubic structure. The austenitic alloys need larger force for deformation as compare to the ferritic alloys. This is due to the presence of crystallographic planes in incoloy and high ductility. During annealing, the ratio of tensile to the yield force is higher and more than two. Therefore the incoloy alloys need large cold processing prior to annealing. The work toughing rate of **Incoloy 800H and 800HT alloy** is slightly lower as compare to popular classes of austenitic steels.

Annealing of Incoloy 800/800HT

The special annealing processes are followed for incoloy 800H and 800HT alloys on the base of amount of cold processing required to obtain the grain size of alloy. The mechanical properties of highly cold processed alloy are nominally influenced at temperatures lower than 1000oF or 540oC. The stress freedom is also started at the same temperature and it is virtually accomplished after1600°F (870°C) for an adequate time with required width. For example a general guideline for the stress relief for the plate products is 1 hour per inch width. The stress relief normally takes more time as compare to recrystallization annealing.

The **Incoloy 800H and 800HT alloy** are produced for applications at the high temperatures. The appropriate resistance to creeping at the high temperatures is received by heating for grain development. The heating temperature is 2100oF to 2200oF. The dimensions and furnace features are adjusted to receive the grain size. The temperature and time are also adjusted to restrict the wider grain development because small creeping strength is obtained with the more grain development.

The sample **Incoloy 800H and 800HT alloy** cold treated more than 20% should be ordered in the refined grain environment. The alloy heated for hot processing should be in the annealed condition. To obtain the adequate creep rupturing strength after formation, the alloy is annealed to receive the least grain size of ASTM. The benefit in the bending material is the decreased surface hardness that is basically known as orange peel. Second benefit of annealing is the decreased thermal rupturing capacity of the better grain as compare to the coarse grain. The large cold processed parts that avoid spring back are more sensitive to rupturing upon heating. The driving force for such ruptures is the wider tensile stress. The fine grain material reduces the stress quicker upon heating than the annealing condition, so it reduces the cracking significantly.

In such conditions, heat processing is not viable subsequent to fabrication due to the alloy size. The below mentioned instructions are used for operations in which the coarse grain material is kept in the high temperature service:

First is to limit the cold processing lower than 20% strain and second is to control the processing temperature and period to avoid the recrystallization. The recrystallization starts after the cold straining of 10% to 20% against the processing and annealing time. In Brief, the post production heat processing depends on the quantity of produced strain via formation and the service environments.

Machining of Incoloy 800H/800HT

The **Incoloy 800H and 800HT alloy** are readily machined by following the standard procedures.

Incoloy 800H and 800HT

The turning processes can be followed with the large metal exclusion rates, extended tool life and the better surface finish shielded carbide equipments. The successful outcomes have been received with the large steel speed equipments that are better for intermittent cutting. The coated carbide tools have demonstrated the good life at the cutting speeds of 110-190 sfpm (33.5-57.9 m/min) and feeding of 0.008-0.035 ipr (0.20-0.89 mm/rev.). The higher speed steel equipments have described the extended tool life at the cutting pace of 35 - 95 sfpm (10.7-29.0 m/min) and feed of 0.008-0.035 ipr (0.20-0.89 mm/rev.).

Welding of Incoloy 800H/800HT

The **Incoloy 800H and 800HT alloy** has superior welding character like incoloy 800 alloy. 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.

Applications of Incoloy 800H/800HT

1. Pressure Vessels
2. Heat ExchangerChemical and petrochemical treatment
3. Commercial furnaces
4. Valves, fittings
5. Hydrocarbon rupturing
6. Heat processing devices

The Incoloy 800H/800HT is utilized in the different applications that are conducted in the corrosive conditions and elevated temperatures that include heat processing, nuclear power plants and paper pulp. The heat processing devices like baskets, trays and fixtures are made of Incoloy 800H/800HT. The chemical and petrochemical treatment houses employ Incoloy 800H/800HT alloy in the heat exchanger and pipes in the nitric acid media when the alloy is required to adhere in the chloride ion stress corrosion cracking conditions.

Incoloy 800H and 800HT Product Forms Available:

Wire, Wiremesh Screen, Strip, Sheet, Rod, Pipe, Bar, Tubing, Plate, Ribbon, Tape

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