Alloy 800, Alloy 800H, Alloy 800HT

The Incoloy 800 group of alloys is an Iron-Nickel-Chromium alloy with high strength and oxidation resistance at high temperatures. The relatively high Chromium content (19-23%) provides the alloy with good aqueous corrosion resistance. The Nickel (30-35%) provides the resistance to stress corrosion cracking (SCC), chloride pitting, and general corrosion. This alloy is capable of retaining its metallurgical stability in a wide range of temperatures.

This group consists of three alloys with slightly different properties and applications:

- **Incoloy 800** is the basic variant, without special Al and Ti content, commonly used in applications up to 600°C.
- **Incoloy 800H** has a higher carbon content (0.05-0.10%) and an annealing process at high temperatures to obtain larger grain sizes, which greatly increases creep and stress rupture strength. The minimum Al and Ti content is 0.15-0.6%.
- **Incoloy 800HT** has an even higher combined Titanium and Aluminum content (0.85-1.20%) which gives the alloy optimal high-temperature properties. Incoloy 800HT also has a carbon range of 0.06-0.10% and is solution annealed.

Applications

Typical applications for Incoloy 800 / 800H / 800HT include:

- Heat exchangers
- Pressure vessels
- Industrial furnaces
- Heat-treatment equipment
- Components for power plants
- Ethylene pyrolysis tubing
- Sheathing for heating elements
- Carburizing equipment
- Chemical and petrochemical processing equipment

Equivalent or Similar Grades - Chemical Composition

Standard	Grade	Fe:	Ni:	Cr:	Ti:	Al:	Mn:	Cu:	Si:	C:	P:	S:	Comments:
UNS	**alloy 800,UNS N08800,Incoloy 800**	>39.5	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<1.5	<0.75	<1.0	<0.1	<0.045	<0.015	-
EN	**1.4876, X10NiCrAlTi32-21**	Balance	30.0-34.0	19.0-23.0	0.15-0.60	0.15-0.60	<2.0	-	<1.0	<0.12	<0.03	<0.015	-
ISO	**FeNi32Cr21AlTi,NW8800**	Balance	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<1.5	<0.7	<1.0	0.05-0.10	-	<0.015	-
UNS	**alloy 800H,N08810,Incoloy 800H**	>39.5	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<1.5	<0.75	<1.0	0.05-0.10	<0.045	<0.015	-

Alloy 800, Alloy 800H, Alloy 800HT

Standard	Grade	Fe:	Ni:	Cr:	Ti:	Al:	Mn:	Cu:	Si:	C:	P:	S:	Comments:
EN	1.4958,X5NiCrAlTi31-20	Balance	30.0-32.5	19.0-22.0	0.2-0.5	0.2-0.5	<1.5	<0.75	<1.0	0.05-0.10	<0.045	<0.015	Al+Ti<0.70; Ni+Co:30.0-32.5
UNS	alloy 800HT,N08811,Incoloy 800HT	>39.5	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<1.5	<0.75	<1.0	0.06-0.10	<0.045	<0.015	Al+Ti: 0.85-1.20
EN	1.4959, X8NiCrAlTi32-21	Balance	30.0-34.0	19.0-22.0	0.25-0.65	0.25-0.65	<1.5	<0.5	<0.7	0.05-0.10	<0.015	<0.01	Ni+Co:30.0-32.5; N<0.03; Co<0.5
EN	1.4558, X2NiCrAlTi32-20	Balance	32.0-35.0	20.0-23.0	<0.6	0.15-0.45	<1.0	-	<0.7	<0.03	<0.02	<0.015	Ti>8*(C+N)
NF	Z10NC32-21	Balance	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<2.0	-	<0.75	<0.1	<0.035	<0.015	-
NF	Z8NC33-21	Balance	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<2.0	-	<0.75	0.05-0.10	<0.035	<0.015	-
BS3072-BS3076	NA15-NA15H	Balance	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<1.5	<0.75	<1.0	<0.1	-	<0.015	Ni:Ni+Co
GOST	Ch20N32T,EP670,ChN32T	Balance	30.0-35.0	19.0-23.0	0.15-0.60	0.15-0.60	<1.5	-	<0.5	0.05-0.10	<0.035	<0.015	-

Mechanical Properties

- Density: 8.03 g/cm3
- First melting temperature: 1350 °C
- Precipitation temperature: 760 °C

Room temperature mechanical properties of Incoloy 800 bar:

- Tensile strength: 520 MPa
- Yield strength: 220 MPa
- Elongation: 45%

Room temperature mechanical properties of Incoloy 800H bar:

- Tensile strength: 550 MPa
- Yield strength: 240 MPa
- Elongation: 45%

Room temperature mechanical properties of Incoloy 800HT bar:

- Tensile strength: 560 MPa
- Yield strength: 250 MPa
- Elongation: 45%

Elevated temperature (870°C) mechanical properties of Incoloy 800H bar:

- Tensile strength: 120 MPa
- Yield strength: 70 MPa
- Elongation: 35%

Rupture strength of Incoloy 800H bar and temperature:

- 760°C: 130 MPa
- 870°C: 60 MPa
- 980°C: 30 MPa

Corrosion behaviour

Aqueous corrosion - good general resistance in oxidizing and reducing environments.

Stress corrosion cracking - generally very good resistance. The list of known environments that cause SCC in alloy 800:

- 155°C 42% MgCl2
- 155°C 42% MgCl2
- Boiling 85% ZnCl2

Incoloy 800 has very good resistance to SCC in polythionic acid solutions, but wrong heat treatment (holding at 650°C) may lead to sensitisation and low scc resistance. It has also exceptional resistance to SCC in high-temperature water and dilute aqueous solutions. alloy 800 may be a better choice for tubing materials in steam generators of pressurized nuclear water reactors.

High-temperature tests - due to iron base, alloy 800 is generally not resistant to temperatures above 670°C, and alloy 800H as well as 800HT are only comparatively better. Nickel-base alloys are much better in this regard.

High-temperature oxidation - medium resistance of alloy 800H and alloy 800HT. Rather poor resistance at temperatures above 925°C, as confirmed by test results:

Average metal affected after 1008h of static oxidation test at indicated temperatures (alloy 800H):

- 980°C: 0.046 mm
- 1095°C: 0.19 mm
- 1150°C: 0.23 mm
- 1205°C: 0.35 mm

Metal loss after 500h of dynamic oxidation test in high-velocity combustion stream at 1090°C equaled 0.77mm (alloy 800H), which is very high.

High-temperature carburization - mediocre resistance, that can be acceptable in some allowances. Nickel based alloys fare noticeably better. Carbon absorption results for alloy 800H in high-temperature tests:

- Ar-5H2-5CO-5CH4 215 h; 870°C: 0.5
- Ar-5H2-5CO-5CH4 215 h; 930°C: 1
- Ar-5H2-5CO-5CH4 55 h; 980°C: 1
- Ar-5H2-5CO-5CH4 24 h; 1090°C: 12.6
- H2-2CH4 100 h (alloy 800); 1000°C: 19

High-temperature nitridation - mediocre resistance. Alloy 800 is not resistant to high temperature nitridation. It corrodes strongly even in pure nitrogen at temperatures above 980°C. Pure nitrogen, however, does not cause problems to alloy 800H and 800 HT. These two alloys, however, are not resistant to high-temperature ammonia. The results of the nitrogen absorption test for the alloy alloy 800H are as follows:

- Ammonia 168 h; 650°C: 4.3
- Ammonia 168 h; 980°C: 4.0
- Ammonia 168 h; 1090°C: 5.5

High-temperature sulfidation - poor resistance. Due to high chromium content and presence of titanium, alloy 800H resists sulfidation for some time, but after few thousand hours rapid breakaway corrosion happens.

High-temperature halogenation - poor resistance, which is evident from the weight-loss experienced after following tests (alloy 800H):

- Ar-30Cl2 500 h; 400°C: 6
- Ar-30Cl2 500 h; 500°C: 13
- Ar-30Cl2 500 h; 705°C: 200-270
- Ar-20O2-0.25Cl2 400 h; 900°C: 26.91
- Ar-20O2-0.25Cl2 400 h; 1000°C: 87.05

Hot corrosion - poor resistance, alloy 800 / 800H / 800HT cannot be used for gas turbines.

Ash/salt deposit corrosion - adequate resistance and alloy 800H is widely used in coal-fired boilers. In a field test when uncooled specimens were exposed in the superheated section at 815°C in a boiler fired with high vanadium Bunker C fuel, measured corrosion rate was 9-12 mm/year.

Physical Properties

- Density: 8.03 g/cm3
- First melting temperature: 1350 °C
- Precipitation temperature: 760 °C

Heat Treatment

Recommended working and heat treatment parameters:

- Hot working: 1205 °C
- Heavy forging: 1010 °C
- Light forging: >870 °C
- First melting temperature: 1260 °C
- Precipitation temperature: 760 °C
- Batch annealing in bell-type furnaces:

Cool rapidly through the range between 760-540°C to ensure freedom from sensitization. Alloy 800 is not susceptible to thermal cracking.

Machining - the alloy 800 / alloy 800H / alloy HT is best machined in the cold-drawn or cold-drawn and stress-relieved conditions.

Processing Performance

Weldability

Weldability - alloy 800 belongs to group 45 according to ISO 15608. For brazing, p-number is equal 111, according to ASME, section IX.

Selection of welding consumables for alloy 800:

- Filler metals: ERNiCr-3

Selection of welding consumables for alloy 800H and alloy 800 HT:

- Coated electrodes: ENiCrCoMo-1
- Filler metals: ERNiCr-3 or ERNiCrCoMo-1

Hot-cracking - the alloy is sensitive to hot-cracking due to high iron content. However, one study has found that reducing the aluminum plus titanium content to <0.06% essentially eliminated hot-cracking. It can further mean that alloy 800H and alloy 800HT are more susceptible to hot-cracking due to typically higher Al+Ti content.

Electropolishing

Electropolishing - electrolyte composition: 37 ml of H3PO4, 56 ml of glycerol. Platinum **cathode**. 3.1 A/cm2.

Alternative Names, Equivalents, and Other Designations

- 1.4558
- alloy 800
- Ch20n32t
- f-3314
- FeNi32Cr21AlTi
- INCOLOY 800
- N08800
- NW8800
- SANICRO 30
- une f-3314
- x2nicralti32-20
- z10nc32-21
- BOHLER H500
- EMVAC 800
- DMV 4958
- DMV 4959
- NY800
- PYRAD 33
- VLX 800
- CHRONIMO 1.4876
- CRONIDUR 4959
- Coralloy 800
- HAYNES 800
- NY 811
- NAS 800
- NCF800
- SINOXX 4876
- UNITEMP 800
- AL800
- F-3314
- Ch20N32T
- EP670
- ChN32T
- NCF800H
- NCF800HTB
- NCF800HTF

- NCF800HTP
- NCF800TB