

Alloy 800H/800HT - Nickel-base Alloys

(UNS N08810/N08811)

INTRODUCTION

Alloy 800H/800HT are nickel-iron-chromium alloys designed to resist oxidation and carburization at elevated temperatures. The nickel content, 32%, makes the alloys highly resistant both to chloride stress-corrosion cracking and to embrittlement from precipitation of sigma phase. The general corrosion resistance is excellent. In the solution annealed condition, Alloy 800H/800HT have superior creep and stress rupture properties. Alloy 800H/800HT have been approved as materials of construction under ASME Boiler and Pressure Vessel Code, Section I-Power Boilers, Section III-Nuclear Vessels, and Section VIII-Unfired Pressure Vessels.

Alloy 800H/800HT are identical except for the higher level of carbon (0.05 to 0.10 percent) in the Alloy 800H, and the addition of up to 1.00 percent aluminum + titanium in the Alloy 800HT. Alloy 800H/800HT are normally used above approximately 1100°F where resistance to creep and stress rupture is required.

SPECIFICATIONS & CERTIFICATES

The following widely published specifications are applicable to Alloy 800H/800HT.

Product Form	Specification		
	ASTM	ASME	AMS
Plate, Sheet and Strip	B409	SB-409	5871
Welded Pipe	B514*	SB-514*	
Welded Tube	B515	SB-515	
Seamless Tube and/or Pipe	B163	SB-163	
	B407	SB-407	
Rod and Bar	B408	SB-408	
Forgings	B564	SB-564	
Welded Fittings	B366*		

* Alloy 800H only

Alloy 800H/800HT are assigned maximum allowable stresses in the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Table UNF 23.2 up to 1500°F (816°C). These alloys are assigned maximum allowable stresses to higher temperatures than almost all other alloys covered in the ASME Code.

Comparing the three alloys Alloy 800H/800HT are assigned higher maximum allowable stresses above 1200°F (649°C), compared to the standard Alloy 800 which is assigned higher maximum allowable stresses below 1100°F (593°C). This corresponds to the temperature range where short time tensile properties become less important design criteria than resistance to creep and stress rupture.

TYPICAL ANALYSIS

Typical Chemical Composition in Weight Percent		
Element	Alloy 800H	Alloy 800HT
Carbon	0.08	0.08
Manganese	1.00	1.00
Phosphorus	0.020	0.020
Sulfur	0.010	0.010
Silicon	0.35	0.35
Chromium	21.0	21.0
Nickel	32.0	32.0
Titanium	0.40	
Aluminum	0.40	1.00
Ti + Al		0.30
Copper	0.30	

PHYSICAL PROPERTIES

Density

0.29 lb./in³ 8.03 g/cm³

Magnetic Permeability

<1.02

Specific Heat

0.12 BTU/lb-°F (32-212°F)
500 Joules/kg•K (0-100°C)

Electrical Resistivity

99 microhm-cm at 70°F(21°C)

Linear Mean Coefficient of Thermal Expansion			
Temperature Range			
°F	°C	μm/m•°F	μm/m•°C
70-200	21-93	7.9	14.2
70-300	21-149	8.4	15.1
70-400	21-204	8.6	15.5
70-500	21-260	8.8	15.8
70-600	21-316	9.0	16.2
70-800	21-427	9.2	16.6
70-1000	21-538	9.4	16.9
70-1200	21-649	9.6	17.3
70-1400	21-760	9.9	17.8

Thermal Conductivity			
Temperature Range			
°F	°C	BTU/h-ft-°F	W/m•K
70	21	6.7	11.6
70-800	21-427	10.6	18.3
70-1800	21-982	17.8	30.8

CORROSION RESISTANCE

The chromium and nickel contents of the Alloy 800H/800HT are higher than those of the familiar Type 304 stainless steel alloy. Under many conditions of service, the performance of Alloy 800H/800HT and Type 304 alloys are similar. For example, comparable behavior can be expected in most rural and industrial atmospheres and in chemical media such as nitric acid and organic acids. Neither Alloy 800H/800HT nor Type 304 alloys are suggested for sulfuric acid service except at lower concentrations and temperatures. Like the austenitic stainless steels,

Alloy 800H/800HT alloys are subject to sensitization (precipitation of chromium carbides at grain boundaries) if heated for excessive time in the 1000-1400°F (538-760°C) temperature range. The sensitized metal may be subject to intergranular attack by certain corrosive agents including pickling acids or the boiling 65% nitric acids (Huey) test.

MECHANICAL PROPERTIES

Typical room temperature mechanical properties Alloy 800H/800HT are shown below. The Alloy 800H/800HT was annealed at 2100°F (1149°C). The different anneal temperature used contributed to the difference in strength of the materials.

Mechanical Properties of Alloy 800H/800HT						
Test Temperature		0.2 Offset Yield Strength		Ultimate Tensile Strength		Elongation
°F	°C	psi	(MPa)	psi	(MPa)	%
70	21	29000	200	77000	531	52
200	93	24100	166	71000	490	53
600	316	19000	131	66600	459	53
800	427	18100	125	65800	454	53
1000	538	16500	114	63500	438	51
1200	649	14800	102	55700	384	50
1400	760	14400	99	32300	223	78
1600	871	11600	80	18600	128	120
1800	982	8900	61	10200	70	120

Short Time Elevated Temperature Properties

The above tables illustrate the short time high temperature tensile properties of the Alloy 800H/800HT. The strength of the Alloy 800H/800HT is lower because the heat treatment of Alloy 800H/800HT at 2100°F (1149°C) results in a larger grain size to provide better creep and stress rupture resistance.

As a consequence of the anneal cycle used on the Alloy 800H/800HT the large grain size produces a visibly undulated surface called “orange peel” after forming.

WELDING

The Alloy 800H/800HT alloys can be joined by gas tungsten arc (GTAW), gas metal arc (GMAW), or by stick electrode welding (SMAW) techniques commonly used on stainless steels. A number of welding rods and wires are commercially available for joining the ATI 800 alloys. Since these alloys form tightly adhering scales, which can be removed only by grinding, inert gas shielding is desirable.

HEAT TREATMENT

The heat treatment conducted on Alloy 800H/800HT alloys is typically in the range of 2050-2150°F (1121-1177°C). In addition to softening the material after forming operations, an additional purpose of this heat treatment is the development of larger grains for improved resistance to creep and stress rupture.

COMMON APPLICATIONS

Alloy 800H and Alloy 800 HT have a wide range of applications in areas of elevated temperatures in furnace construction, in the chemical industry, in environmental protection equipment, in the automotive industry and in power plants.

Typical applications include furnace muffles, containers, bins, holders in various heat treatment plants and burner components.

Because of their resistance to carburization and nitriding, the alloys are furthermore used in the areas of: steam/hydrocarbon reformers, ethylene pyrolysis and equipment for acetic anhydride and ketone production.