Specification Sheet: Alloy 800, 800H, and 800AT

(UNS N08800) / (UNS N08810) / (UNS N08811)

Nickel-Iron-Chromium Designed to Resist Oxidation and Carburization

Alloy 800 (UNS N08800), Alloy 800H (UNS N08810), and Alloy 800AT (UNS N08811) 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, Alloys 800H and 800AT have superior creep and stress rupture properties. All three versions of the basic Alloy 800 have been approved as materials of construction under ASME Boiler and Pressure Valve Code, Section I-Power Boilers, Section III-Nuclear Vessels, and Section VIII-Unfired Pressure Vessels.

Alloy 800, Alloy 800H, and Alloy 800AT are identical except for the higher level of carbon (0.05 to 0.10 percent) in Alloy 800H, and the addition of up to 1.00 percent aluminum + titanium in Alloy 800AT. Alloy 800 is normally used in this service at temperatures to approximately 1100°F (593°C). Alloy 800H and Alloy 800AT are normally used above approximately 1100°F where resistance to creep and rupture is required.

Applications

- Chemical and petrochemical processing equipment
- Power generation
- Thermal processing fixtures
- Steel production

Standards

ASTM ....B 409
ASME ....SB 409
AMS 5871

Mechanical Properties

Typical room temperature mechanical properties of Alloys 800, 800H, and 800AT are shown. Alloy 800 was annealed at 1800°F (928°C), and Alloys 800H and 800AT were annealed at 2100°F (1149°C). The different anneal temperature used contributed to the difference in strength of the materials.

Mechanical Properties of Alloy 800

Test Temperature °F	°C	0.2 Offset Yield Strength psi	(MPa)	Ultimate Tensile Strength psi	(MPa)	Percent Elongation
70	21	43,000	295	87,700	600	44
200	93	39,700	274	81,700	563	43
500	260	34,000	234	76,200	525	39
800	427	33,300	230	74,600	514	40
1000	538	31,700	219	72,000	496	39
1200	649	29,000	200	54,000	372	56
1400	760	22,600	156	32,100	221	85
1500	816	14,200	98	24,800	171	91

Mechanical Properties of Alloy 800H and Alloy 800AT

Test Temperature °F	°C	0.2 Offset Yield Strength psi	(MPa)	Ultimate Tensile Strength psi	(MPa)	Percent Elongation
70	21	29,000	200	77,000	531	52
200	93	24,100	166	71,000	490	53
600	316	19,000	131	66,600	459	53
800	427	18,100	125	65,800	454	53
1000	538	16,500	114	63,500	438	51
1200	649	14,800	102	55,700	384	50
1400	780	14,400	99	32,300	223	78
1600	871	11,600	80	18,600	128	120
1800	982	8,900	61	10,200	70	120

Short Time Elevated Temperature Properties

The above tables illustrate the short time high-temperature tensile properties of Alloys 800, 800H and 800AT. The strength of Alloys 800H and 800AT is lower because the heat treatment of Alloys 800H and 800AT at 2100°F (1149°C) results in a larger grain size to provide better creep and stress rupture resistance. The 1800°F (982°C) anneal of Alloy 800 results in a finer grain size to provide better cold formability.

Chemical Analysis

Typical Analysis (Weight %)

	C	Mn	P	S	Si	Cr	Ni	Ti	Al	Ti+Al	Cu
Alloy 800	0.02	1.00	0.020	0.010	0.35	21.0	32.0	0.40	0.40	—	0.30
Alloy 800H	0.08	1.00	0.020	0.010	0.35	21.0	32.0	0.40	0.40	—	0.30
Alloy 800HT	0.08	1.00	0.020	0.010	0.35	21.0	32.0	—	—	1.00	0.30

Corrosion Resistance

The chromium and nickel contents of Alloys 800, 800H, and 800AT are higher than those of the familiar Alloy 304 stainless steel alloy. Under many conditions of service, the performance of Alloys 800, 800H, 800AT and Alloy 304 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 Alloys 800, 800H, and 800AT nor Alloy 304 are suggested for sulfuric acid service except at lower concentrations and temperatures. Like the austenitic stainless steels, Alloys 800, 800H, and 800AT 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.

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Alloy 800 is highly resistant, although not totally immune, to stress corrosion cracking. In extensive field experience, Alloy 800 has shown excellent service performance in many types of equipment in the petroleum, chemical, food, and pulp and paper industries. Thus, Alloy 800 may offer a distinct advantage for use in moderately corrosive environments where service experience has indicated a tendency toward stress corrosion cracking of other austenitic stainless steels. However, the alloy is not immune to stress corrosion cracking as judged by the extremely severe magnesium chloride test.

Physical Properties

Density
0.29 lb/in^3 8.03 g/cm^3

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/°F	µm/°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

Oxidation Resistance

The alloys are particularly well suited for high temperature applications such as furnace parts and related heating equipment, for petrochemical reforming units and isocracker tubs, and for handling superheated steam in nuclear and conventional power plants. With the specified high levels of chromium and nickel, the alloys offer superior resistance to oxidation and scaling, and to carburization as well.

The following oxidation data for Alloy 800 was obtained by exposing samples to the indicated temperature for 100 hours in still air and cooling. In general, total weight gains greater than 10mg/cm^2 indicate that additional exposure at these temperatures will lead to failure.

Since oxidation rates are greatly affected by heating and cooling rates as well as by the atmospheres involved, this data can only be used as approximate guidelines.

100 Hour Still Air Continuous Oxidation Tests

Alloy	Sample Weight Gain (mg/cm^2)				
	1700°F (927°C)	1800°F (982°C)	1900°F (1038°C)	2000°F (1093°C)	2100°F (1149°C)
Alloy 800	0.77	1.8	2.09	2.1	5.06
Alloy 309	0.80	1.2	2.1	2.5	4.0
Alloy 310	0.80	1.1	2.6	3.2	5.2

Heat Treatment

The anneal cycle conducted on Alloy 800 is typically in the 1800°-1900°F (982°-1038°C) range. The purpose is to soften the material after forming operations while maintaining a relatively fine grain size.

The heat treatment conducted on Alloys 800H and 800HT 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.

Cold Formability

Alloys 800, 800H, and 800AT exhibit excellent cold forming characteristics normally associated with chromium-nickel stainless steels. The high nickel content prevents the austenite to martensite transformation which can occur when Alloy 301 or Alloy 304 are cold worked. The alloy has a lower work hardening rate than Alloys 301 or 304 and can be used in multiple drawn forming operations where relatively large amounts of deformations occur between anneals.

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

Welding

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

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