Technical Data Sheet

ATI 800™/ATI 800H™/ATI 800AT™

Nickel-base Alloys

(UNS N08800/N08810/N08811)

INTRODUCTION

ATI 800™ (UNS N08800), ATI 800H™ (UNS N08810), and ATI 800AT™ (UNS N08811) alloys 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, the ATI 800H™ and ATI 800 AT™ alloys have superior creep and stress rupture properties. All three versions of the basic ATI 800™ alloy 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.

ATI 800™, ATI 800H™ and ATI 800AT™ alloys are identical except for the higher level of carbon (0.05 to 0.10 percent) in the ATI 800H™ alloy, and the addition of up to 1.00 percent aluminum + titanium in the ATI 800 AT™ alloy. The ATI 800™ alloy is normally used in service at temperatures to approximately 1100°F (593°C). The ATI 800H™ and ATI 800 AT™ alloys 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 ATI 800™, ATI 800H™ and ATI 800AT™ alloys.

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 B407	SB-163 SB-407	
Rod and Bar	B408	SB-408	
Forgings	B564	SB-564	
Welded Fittings	B366*		

* ATI 800™ and ATI 800H™ only

ATI 800™, ATI 800H™ and ATI 800AT™ alloys 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 ATI 800H™ and ATI 800AT™ alloys are assigned higher maximum allowable stresses above 1200°F (649°C), and ATI 800™ 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.

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TYPICAL ANALYSIS

Typical Chemical Composition in Weight Percent			
Element	**ATI 800™**	**ATI 800H™**	**ATI 800AT™**
Carbon	0.02	0.08	0.08
Manganese	1.00	1.00	1.00
Phosphorus	0.020	0.020	0.020
Sulfur	0.010	0.010	0.010
Silicon	0.35	0.35	0.35
Chromium	21.0	21.0	21.0
Nickel	32.0	32.0	32.0
Titanium	0.40	0.40	
Aluminum	0.40	0.40	1.00
Ti + Al			0.30
Copper	0.30	0.30	

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/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

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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 ATI 800™, ATI 800H™ and ATI 800AT™ alloys are higher than those of the familiar Type 304 stainless steel alloy. Under many conditions of service, the performance of ATI 800™, ATI 800H™, ATI 800AT™ 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 ATI 800™, ATI 800H™ and ATI 800AT™ nor Type 304 alloys are suggested for sulfuric acid service except at lower concentrations and temperatures. Like the austenitic stainless steels, ATI 800™, ATI 800H™ and ATI 800AT™ 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.

The ATI 800™ alloys are highly resistant, although not totally immune, to stress-corrosion cracking. In extensive field experience, the ATI 800™ alloys have shown excellent service performance in many types of equipment in the petroleum, chemical, food, and pulp and paper industries. Thus, the ATI 800™ alloys 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.

OXIDATION RESISTANCE

The ATI 800™ alloys are particularly well suited for high temperature applications such as furnace parts and related heating equipment, for petrochemical reforming units and isocracker tubes, 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 ATI 800™ alloy were obtained by exposing samples to the indicated temperature for 100 hours in still air and cooling. In general, total weight gains greater than 10 mg/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, these 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)
ATI 800™	0.77	1.8	2.09	2.1	5.06
T 309	0.80	1.2	2.1	2.5	4.0
T 310	0.80	1.1	2.6	3.2	5.2

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MECHANICAL PROPERTIES

Typical room temperature mechanical properties ATI 800™, ATI 800H™ and ATI 800AT™ alloys are shown below. The ATI 800™ alloy was annealed at 1800°F (982°C) and the ATI 800H™ and ATI 800AT™ alloys were annealed at 2100°F (1149°C). The different anneal temperature used contributed to the difference in strength of the materials.

Mechanical Properties of AL 800™ Alloy						
Test Temperature		0.2 Offset Yield Strength		Ultimate Tensile Strength		Elongation
°F	°C	psi	(MPa)	psi	(MPa)	%
70	21	43000	295	87700	600	44
200	93	39700	274	81700	563	43
500	260	34000	234	76200	525	39
800	427	33300	230	74600	514	40
1000	538	31700	219	72000	496	39
1200	649	29000	200	54000	372	56
1400	760	22600	156	32100	221	85
1500	816	14200	98	24800	171	91

Mechanical Properties of AL 800H™ and AL 800AT™ Alloys						
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 ATI 800™, ATI 800H™ and ATI 800AT™ alloys. The strength of the ATI 800H™ and ATI 800AT™ alloys is lower because the heat treatment of ATI 800H™ and ATI 800AT™ alloys 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 the ATI 800™ alloy results in a finer grain size to provide better cold formability.

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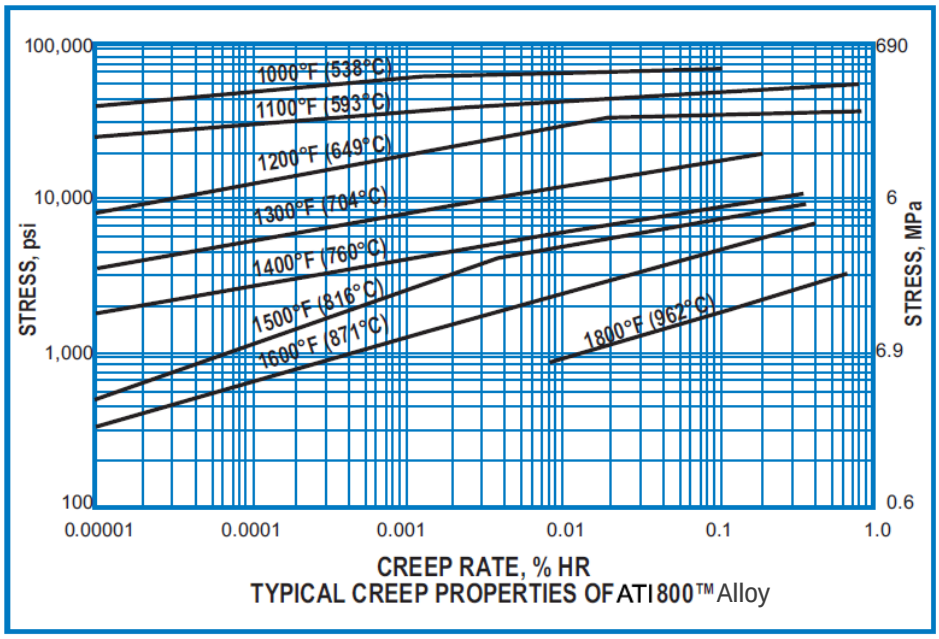
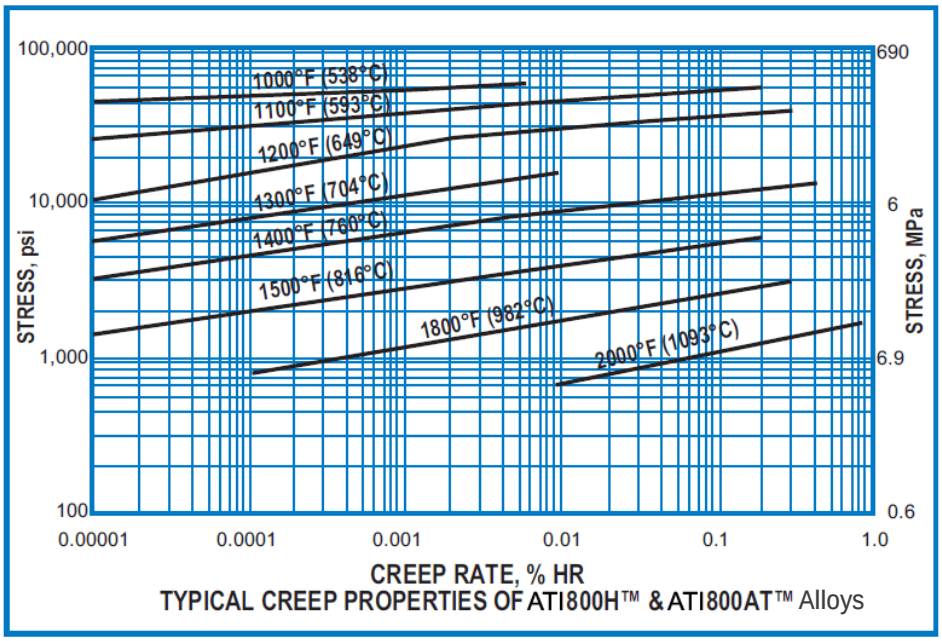
Creep and Stress Rupture Properties

The creep and stress rupture data indicate that ATI 800™, ATI 800H™ and ATI 800AT™ alloys are stronger in the elevated temperature range than the common stainless steels such as Types 301, 304, 309, 310; yet not as strong as superalloys such as ATI A286™, ATI HX™, ATI 625™, or ATI 718™ alloys.



TYPICAL CREEP PROPERTIES OF ATI 800™ Alloy



TYPICAL CREEP PROPERTIES OF ATI 800H™ & ATI 800AT™ Alloys

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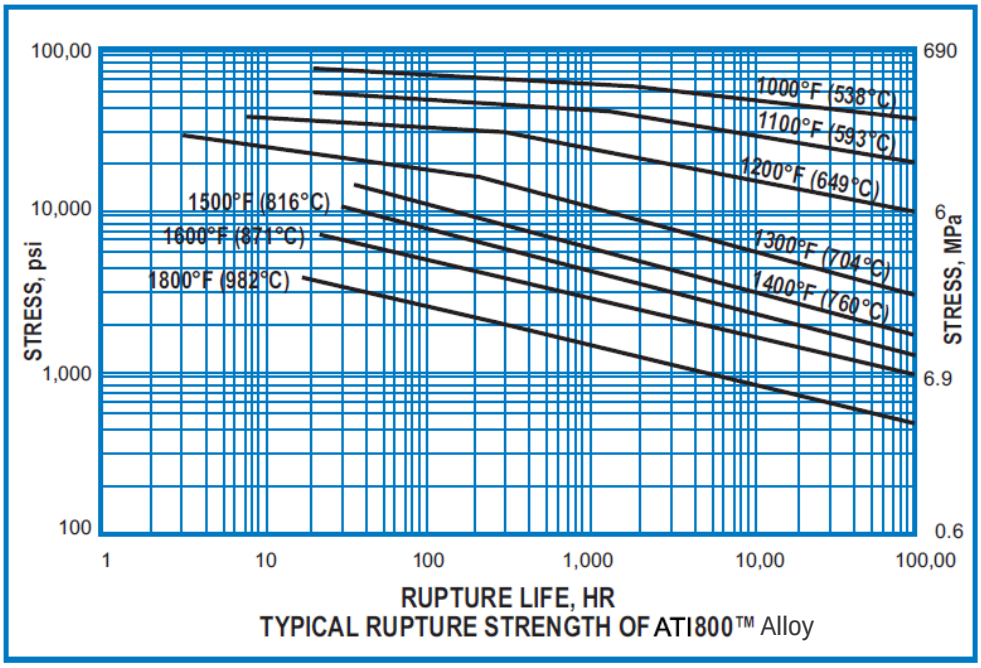
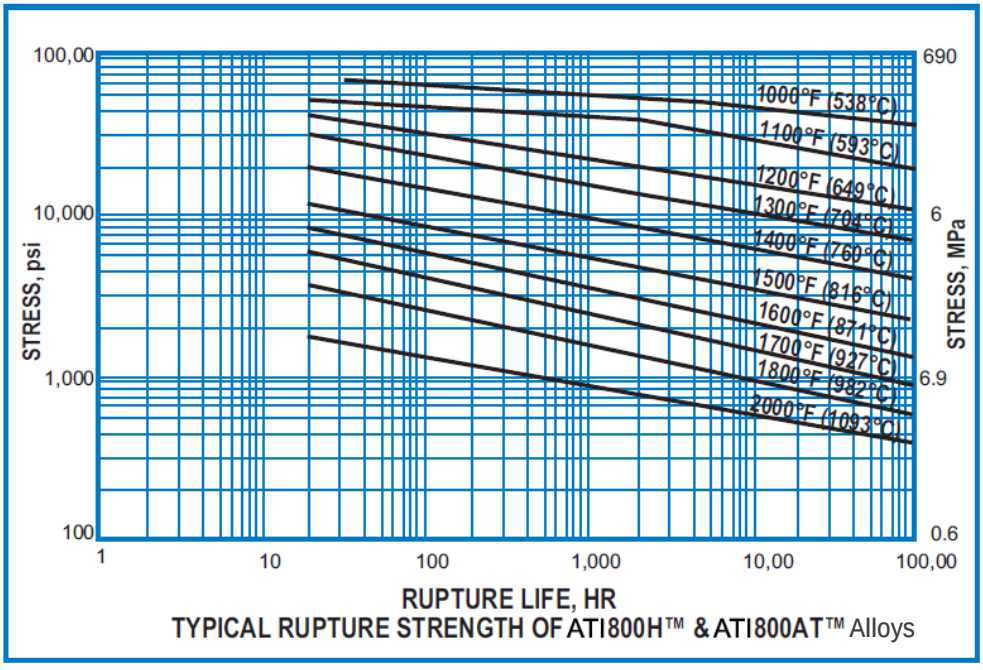


TYPICAL RUPTURE STRENGTH OF ATI800™ Alloy



TYPICAL RUPTURE STRENGTH OF ATI800H™ & ATI800AT™ Alloys

COLD FORMABILITY

The ATI 800™, ATI 800H™ and ATI 800AT™ alloys 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 Type 301 or Type 304 are cold worked. The alloy has a lower work hardening rate than Types 301 or 304 and can be used in multiple draw forming operations where relatively large amounts of deformation occur between anneals.

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

WELDING

The ATI 800™, ATI 800H™ and ATI 800AT™ 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 anneal cycle conducted on the ATI 800™ alloy 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 ATI 800H™ and ATI 800AT™ 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.

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