ATI 13-8™

Precipitation Hardening Alloy

(UNS S13800, ASTM Type XM-13)

INTRODUCTION

ATI 13-8™ alloy (UNS S13800) is a martensitic precipitation-hardening stainless steel that has excellent strength, high hardness, superior toughness, and good corrosion resistance. Good transverse toughness properties are achieved by tight chemical composition control, low carbon content, and vacuum melting. The alloy is produced by vacuum induction melting (VIM) followed by electro-slag remelting (ESR). This melt practice promotes excellent macro- and microcleanliness, and tight compositional control. The strengthening mechanism (precipitation hardening in a martensitic matrix) makes it possible to achieve uniform strengthening in heavy sections. Strength and ductility levels can be tailored to the application by varying the aging temperature. Typical applications are large airframe structural components, injection molding equipment and slide gates to control water flow.

The S13800 alloy is martensitic in structure in the solution annealed condition and is further strengthened by a relatively low temperature heat treatment, which precipitates a strengthening phase in the alloy. Like the S17400 alloy, the S13800 alloy requires only a simple heat treatment, a one step process conducted at a temperature in the range 950°F (510°C) to 1150°F (620°C) depending on the combination of strength and toughness desired. A wide range of properties can be produced by this one step heat treatment. Heat treatment at about 950°F (510°C) produces the highest strength.

FORMS AND CONDITIONS

The ATI 13-8™ Precipitation Hardening alloy is furnished by ATI as plate. Long products are also produced by ATI. In all forms, the material typically is furnished in the solution annealed condition.

Element	Composition limits (Weight Percent)
Carbon	0.05 max
Manganese	0.20 max
Phosphorus	0.010 max
Sulfur	0.008 max
Silicon	0.10 max
Chromium	12.25-13.25
Nickel	7.5-8.5
Molybdenum	2.00-2.50
Aluminum	0.90-1.35
Iron	Balance

SPECIFICATIONS

The ATI 13-8™ Precipitation Hardening Alloy (S13800) is covered by the following wrought product specifications.

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	Product Form
AMS 5629	Bars, Forgings, Rings and Extrusions
AMS 5864	Plate
ASTM A 564 ASME SA564	Bars, Wires and Shapes
ASTM A 693 ASME SA693	Sheet, Plate and Strip
ASTM A 705 ASME SA705	Forgings

CORROSION AND OXIDATION RESISTANCE

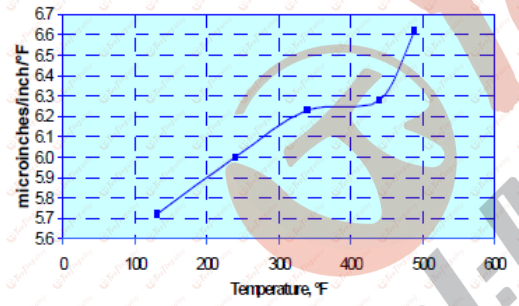
ATI 13-8™ alloy has excellent oxidation resistance up to 1,500°F (815°C). Resistance to stress corrosion cracking improves as aging temperature increases. This alloy has the best resistance to stress corrosion cracking of all of the precipitation hardenable stainless steels. Its resistance to general corrosion is greatest in the fully-hardened condition. The alloy shows very little rusting when exposed to a 5 percent salt fog at 95°F (35°C).

PHYSICAL PROPERTIES

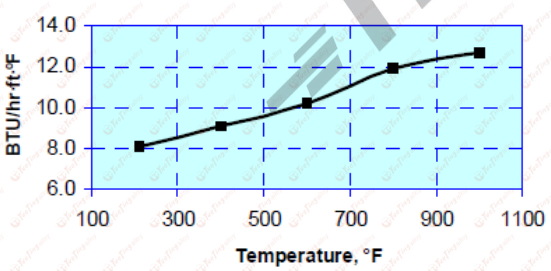
Melting Range: 2560 to 2680°F
1405 to 1470°C

Density: 0.279 lbs/in^3
7.76 g/cm^3

Coefficient of Thermal Expansion for ATI 13-8™ Alloy



Thermal Conductivity



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HEAT TREATMENT

The ATI 13-8™ Precipitation Hardening Alloy is produced in the annealed condition. This is also called the solution heat treated condition, or Condition A. Solution treat from 1675 to 1725°F (910 to 940°C) for 15 to 30 minutes at temperature. Air cool or oil quench to below 60°F (15°C) to effect complete transformation to martensite. Aging is normally carried out from 950 to 1150°F (510 to 620°C), depending upon the desired final properties. Heat treatment is usually performed in air. Heat treatment of brazed components may be done in inert atmospheres. Reducing atmospheres should not be used because of the potential for hydrogen contamination.

HEAT TREATING PARAMETERS FOR ATI 13-8™ Alloy

Condition	Temperature	Time
H 950	950 °F ± 10 (510 °C ± 5)	4 hrs. ± 0.25 hr.
H 1000	1000 °F ± 10 (540 °C ± 5)	4 hrs. ± 0.25 hr.
H 1025	1025 °F ± 10 (550 °C ± 5)	4 hrs. ± 0.25 hr.
H 1050	1050 °F ± 10 (565 °C ± 5)	4 hrs. ± 0.25 hr.
H 1100	1100 °F ± 10 (595 °C ± 5)	4 hrs. ± 0.25 hr.
H 1150	1150 °F ± 10 (620 °C ± 5)	4 hrs. ± 0.25 hr.

HARDNESS

Hardness in the solution annealed condition is approximately Rockwell C 33. See the table below for typical hardness in the various aged conditions.

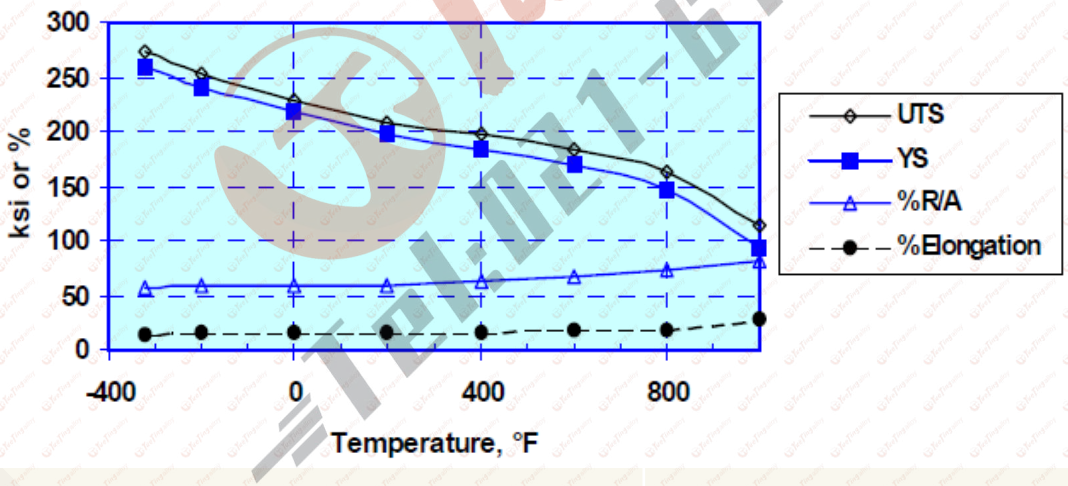
Condition	H 950	H 1000	H 1050	H 1100	H 1150
Hardness, Rockwell C	47	45	43	35	33

MECHANICAL PROPERTIES

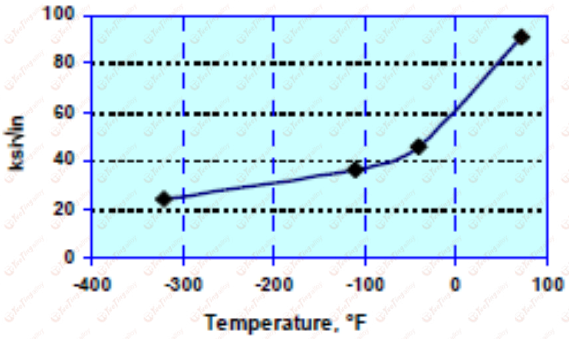
Strength varies with heat treatment condition. The following table shows minimum mechanical properties for the various aged conditions, per AMS 5864. Subsequent figures show typical data.

	Condition H950	Condition H1000	Condition H1025	Condition H1050	Condition H1100	Condition H1150
0.2% Offset Yield Strength psi (MPa)	205,000 1,413	190,000 1,310	175,000 1,207	165,000 1,138	135,000 931	90,000 621
Ultimate Tensile Strength psi (MPa)	220,000 1,517	205,000 1,413	185,000 1,276	175,000 1,207	150,000 1,034	135,000 931
Elongation (percentage in 2")	10	10	11	12	14	14
Reduction of Area, % (Longitudinal)	45	50	50	50	50	50
Reduction of Area, % (Transverse)	45	50	50	50	50	50
Reduction of Area, % (Short-Trans.)	35	40	45	45	50	50

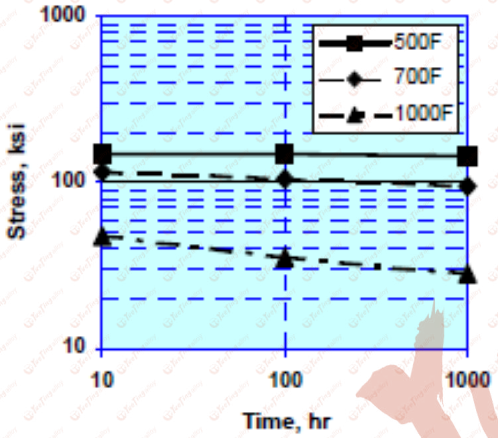
Effect of Temperature on Tensile Properties of ATI 13-8™ Alloy



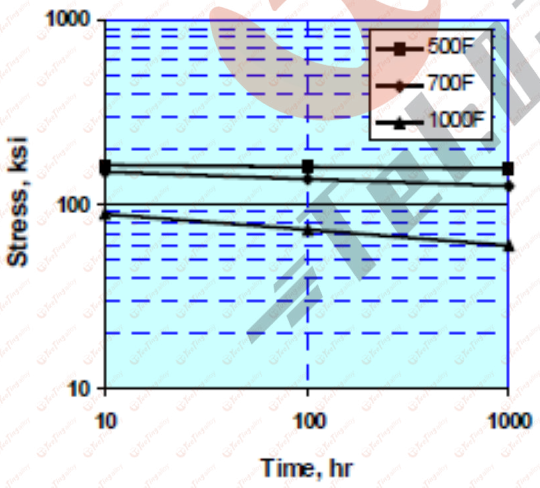
Fracture Toughness of ATI 13-8™ Alloy



Time to 0.2% Creep for ATI 13-8™ Alloy



Time to Rupture for ATI 13-8™ Alloy



WELDING

ATI 13-8™ alloy is normally welded using inert gas tungsten arc techniques, although most other welding processes may be used. These include plasma arc, electron beam, gas metal arc, and shielded metal arc processes. Helium is the preferred shielding gas.

HOT WORKABILITY/FORMABILITY

ATI 13-8™ alloy has good hot working characteristics, and can be hot worked over a wide temperature range. Temperatures up to 2200°F (1204°C) may be used. For optimum properties, intermediate and final hot working temperatures should not exceed 1900°F (1038°C). Hot working should not be done below 1700°F (927°C). After hot working, parts should be cooled to room temperature, then solution treated prior to aging. The alloy can be cold formed in the annealed condition, utilizing conventional cold forming techniques.

MACHINABILITY

ATI 13-8™ alloy can be machined in both the annealed and hardened conditions. In the annealed condition use machine speeds 20 to 30 percent lower than those used on 304 stainless steel.

SPECIAL PRECAUTIONS

All lubricants and coolants, particularly sulfur-bearing, should be removed prior to heat treatment, brazing and pickling.

APPLICATIONS

- Aerospace components

- Injection molding equipment

- Dam slide gates