Technical Data Sheet

ATI 825™

Nickel-base Alloy

(UNS N08825)

INTRODUCTION

ATI 825 alloy (UNS N08825) is an austenitic nickel-iron-chromium-molybdenum-copper alloy containing high levels of chromium, nickel, molybdenum and copper to provide high levels of corrosion resistance to both moderately oxidizing and moderately reducing environments. The alloy has a high level of nickel, which in combination with the level of molybdenum and copper, produces substantially improved corrosion resistance in reducing environments compared to the standard stainless steels. Higher chromium alloys such as E-BRITE® 26-1 alloy (S44627) or Type 310 should be specified in the most severely oxidizing environments typified by hot nitric acid at concentrations near the azeotrope. The nickel content is sufficiently high to provide superb resistance to chloride stress corrosion cracking. The chromium and molybdenum content of the alloy provides a level of resistance to chloride ion pitting, however, not to the level of other Allegheny Ludlum alloys like AL-6XN® (N08367), AL 29-4C® (S44735) or ATI 625 (N06625) alloys. In addition, the alloy is stabilized against sensitization in the welded condition by the addition of a specified level of titanium. Because of this stabilization, the material is resistant to intergranular attack after exposure in the temperature range which would sensitize unstabilized stainless steels.

The N08825 alloy has a long history of use in many corrosive environments and has been incorporated in ASTM and ASME specifications for many years. As an austenitic, nickel-base alloy, the material is ductile over a wide range of temperatures from cryogenic to well in excess of 1000°F (538°C). Fabricability is typical of nickel-base alloys, with the material readily formable and weldable by a variety of techniques.

PRODUCT FORMS

The ATI 825 alloy is furnished as plate, sheet, strip and long product forms. In flat-rolled forms the alloy is furnished in the solution annealed condition.

SPECIFICATIONS & CERTIFICATES

The ATI 825 alloy is covered by the following specifications.

Product Form	Specification	
	ASTM	ASME
Plate, Sheet and Strip	B424	SB424
Welded Tube or Pipe	B704	
Seamless Tube and/or	B163	SB163
Rod and Bar	B425	SB425

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TYPICAL COMPOSITION

Element	Percent
Carbon	0.02
Manganese	.50
Phosphorus	0.025
Sulfur	0.002
Silicon	0.25
Chromium	21.0
Nickel	40.0
Molybdenum	2.8
Copper	2.3
Titanium	1.0
Aluminum	0.15
Iron	Balance

PHYSICAL PROPERTIES

Density
0.294 lb/in^3
8.14 g/cm^3

Magnetic Permeability
<1.02

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

Electrical Resistivity
70°F (21°C) 113 microhm-cm
200°F (93°C) 114 microhm-cm
400°F (204°C) 118 microhm-cm

Linear Coefficient of Thermal Expansion			
Average from 70°F (21°C) to °F (°C)		10^{-6}/°F	10^{-6}/°C
200	(93)	7.7	13.9
400	(204)	8.3	14.9
600	(315)	8.5	15.5
800	(427)	8.7	15.7

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Thermal Conductivity			
Temperature		Btu/h-ft-°F	W/m•K
°F	°C		
70	21	6.4	11.1
200	93	7.1	12.3
400	204	8.1	14.0
600	316	9.1	15.7
800	427	10.0	17.3

CORROSION RESISTANCE

ATI 825 alloy is an austenitic alloy containing high levels of chromium, nickel, molybdenum and copper to provide high levels of general corrosion resistance to both moderately oxidizing and moderately reducing environments.

Resistance to Laboratory Sulfuric Acid Solutions

Alloy	Corrosion Rate in Boiling Laboratory Sulfuric Acid Solution		
	10%	40%	50%
Type 316	636 (16.2)	>1000 (>25)	>1000 (>25)
ATI 825™	20 (0.5)	11 (0.28)	20 (0.5)
ATI 625™	20 (0.5)	Not Tested	17 (0.4)

The alloy has a high level of nickel to provide superb resistance to chloride stress corrosion cracking. However, in the extremely severe boiling magnesium chloride test, the ATI 825 alloy will crack in long time tests in a percentage of samples tested. In less severe laboratory tests, the alloy resists chloride stress corrosion cracking. In practical service environments, the ATI 825 alloy is a good choice as a material to provide extreme resistance to chloride stress corrosion cracking, comparable to the E- BRITE® alloy.

Resistance to Chloride Stress Corrosion Cracking

Test (U-Bend Samples)	Alloy				
	Type 316	AL-6XN®	ATI 825™	E-Brite®	ATI 625™
42% Magnesium Chloride (Boiling)	Fail	Mixed	Mixed	Resist	Resist
33% Lithium Chloride (Boiling)	Fail	Resist	Resist	Resist	Resist
26% Sodium Chloride (Boiling)	Fail	Resist	Resist	Resist	Resist

The chromium and molybdenum content of the alloy provides a high level of resistance to chloride ion pitting. This has led to the use of the material in high chloride environments such as seawater. Use has generally been adequate if some pitting could be tolerated. However, the alloy content of the ATI 825 alloy is insufficient to provide the level of resistance of other Allegheny Ludlum alloys like AL-6XN® (N08367), AL 29-4C® (S44735) or ATI 625™ (N06625) alloys which are used in seawater in such applications as thin walled condenser tubing where even minor pitting cannot be tolerated. The ATI 825 alloy is judged an improvement, but not a dramatic one, over Type 316 stainless steel in chloride pitting corrosion resistance.

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Resistance to Chloride Pitting and Crevice Corrosion

Alloy	Temperature of Onset of Crevice Corrosion
Type 316	27 (-2.5)
ATI 825™	32 (0.0)
AL-6XN®	113 (45.0)
ATI 625™	113 (45.0)
AL 29-4C®	131 (55.0)
*ASTM Procedure G-48 Practice B, 10% Ferric Chloride	

The ATI 825 alloy is produced to a low carbon content and, in addition, is stabilized against sensitization in the welded condition by a specified addition of titanium.

Resistance to Intergranular Corrosion

Alloy	Corrosion Rate in Mils/Year (mm/a) in Standard	
	Boiling 65% Nitric Acid ASTM	Boiling 50% Sulfuric Acid-Ferric
Type 316	34 (0.85)	36 (0.91)
Type 316L	18 (0.47)	26 (0.66)
ATI 825™	12 (0.30)	1 (0.03)
AL-6XN®	30 (0.76)	19 (0.48)
ATI 625™	37 (0.94)	Not Tested

MECHANICAL PROPERTIES

Typical room temperature properties of the ATI 825 alloy follow.

Yield Strength	Tensile Strength	Elongation	Elastic Modulus
psi (MPa)	psi (MPa)	% in 2 inches	10^6 psi (GPa)
43,500 (300)	100,000 (690)	45	28.3 (195)

Typical elevated temperature tensile properties of ATI 825 alloy in the solution annealed condition follow.

Test Temperature	Yield Strength	Tensile Strength	Elongation
°F (°C)	psi (MPa)	psi (MPa)	% in 2 inches
70 (21)	43,500 (300)	100,000 (690)	45
200 (93)	40,400 (279)	95,000 (655)	45
400 (204)	35,600 (245)	92,400 (637)	43
600 (316)	33,600 (232)	91,700 (623)	45
800 (427)	33,000 (228)	88,500 (610)	45
1000 (538)	32,200 (222)	85,900 (592)	45

The strength of the ATI 825 alloy may be increased by cold deformation, but the ATI 825 alloy is not hardenable by heat treatment.

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FORMABILITY

The ATI 825 alloy is readily cold formed, with forming behavior typical of high nickel materials. The alloy exhibits very good ductility for deep drawing, spinning, and bending. The material is somewhat stronger than carbon steel but does not work harden as rapidly as the familiar stainless steels.

WELDABILITY

ATI 825 alloy is readily welded by inert gas, metal arc, or resistance welding. Preheat or postweld heat treatment is not generally required. Argon or helium are generally used for shielding. A highly alloyed filler material should be chosen to match the corrosion resistance of the base metal.

Even though the material is designed to resist the precipitation of chromium carbides by both the low carbon content and the titanium content of the material, it is best practice to avoid long dwell times in the 1100°F (593°C) to 1500°F (816°C) range.

Surface cleanliness prior to welding is essential to successful fabrication and is also necessary to retain the high level of corrosion resistance designed into the material.

HEAT TREATMENT

The ATI 825 alloy is an austenitic material which cannot be hardened by heat treatment. The anneal cycle used for the AL 825 alloy typically involves heating to the temperature range 1700 to 1900°F (927 to 1038°C), holding until the material has reached uniform temperature and either air cooling or water quenching. The purpose is to soften the material after forming operations while maintaining a relatively fine grain size.

For improved resistance to intergranular corrosion (sensitization), a stabilization treatment of one hour or more at temperatures between 1600 and 1750°F (870-955°C) should be used.

Heat treatment in or exposure to elevated temperature environments containing high levels of sulfur are detrimental to the ATI 825 alloy and should be avoided.

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