Technical Data Sheet

ATI 317LMN™

Stainless Steel: Austenitic

(UNS S31726)

INTRODUCTION

ATI 317LMN™ alloy, ATI 317LM™ alloy and ATI 317L alloy are molybdenum-bearing austenitic stainless steels with greatly increased resistance to chemical attack as compared to the conventional chromium-nickel austenitic stainless steels such as ATI 304. In addition, ATI 317LMN, ATI 317LM and ATI 317L alloys also offer higher creep, stress-to-rupture, and tensile strengths at elevated temperatures than conventional stainless steels. These alloys represent significant improvements over conventional ATI 317 stainless. All are low carbon or “L” grades to provide resistance to sensitization during welding and other thermal processes. The “M” and “N” designations indicate that the compositions contain increased levels of molybdenum and nitrogen respectively. The combination of molybdenum and nitrogen is particularly effective in enhancing resistance to pitting and crevice corrosion, especially in process streams containing acids, chlorides and sulfur compounds at elevated temperatures. Nitrogen also serves to increase the strength of these alloys. All three alloys are intended for severe service conditions such as flue gas desulfurization (FGD) systems. ATI 317LMN, ATI 317LM and ATI 317L stainless steels are available in the form of plate, sheet and strip.

TYPICAL COMPOSITION

Chemical Composition in Weight Percent per ASTM A240 for Cited Alloys			
Element	**ATI 317L™**	**ATI 317LM™**	**ATI 317LMN™**
Carbon	0.030 max	0.030 max	0.030 max
Manganese	2.00 max	2.00 max	2.00 max
Silicon	0.75 max	0.75 max	0.75 max
Chromium	18.0-20.0	18.0-20.0	17.0-20.0
Nickel	11.0-15.0	13.5-17.5	13.5-17.5
Molybdenum	3.0-4.0	4.0-5.0	4.0-5.0
Phosphorus	0.045 max	0.045 max	0.045 max
Sulfur	0.030 max	0.030 max	0.030 max
Nitrogen	0.10 max	0.20 max	0.10-0.20
Iron	Balance	Balance	Balance
UNS No.	**S31703**	**S31725**	**S31726**

CORROSION RESISTANCE

ATI 317LMN, ATI 317LM and ATI 317L stainless steels are more resistant to atmospheric and other mild types of corrosion than conventional chromium-nickel stainless steels. In general, environments that are not corrosive to 18Cr-8Ni steels will not attack alloys containing molybdenum, with the exception of highly oxidizing acids such as nitric acid.

ATI 317LMN, ATI 317LM and ATI 317L stainless steels are considerably more resistant than conventional chromium-nickel types to solutions of sulfuric acid. Resistance increases with alloy molybdenum content. These alloys are resistant to sulfuric acid concentrations up to 5 percent at temperatures as high as 120°F (49°C). At temperatures under 100°F (38°C) these alloys have excellent resistance to solutions of higher concentration. However, service tests are recommended to account for the effects of specific operating conditions that may affect corrosion behavior. In processes where condensation of sulfur-bearing gases occurs, these alloys are much more resistant to attack at the point of condensation than conventional ATI 316 stainless. The acid

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concentration has a marked influence on the rate of attack in such environments and should be carefully determined by service tests.

The table below compares the corrosion resistance of annealed strip samples of ATI 317LMN, ATI 317LM and Type 317L stainless steels in a variety of solutions related to the process industries as well as standard ASTM tests. Data on ATI 316L, AL-6XN® and ATI 276™ alloys are presented for comparison.

Corrosion Resistance in Boiling Solutions and ASTM Tests

Test Solution	Corrosion Rate in Mils per Year (mm/y) for Cited Alloys					
	ATI 316L™	ATI 317L™	ATI 317LM™	ATI 317LMN™	AL-6XN®	ATI 276™
20% Acetic Acid*	0.12 (<0.01)	0.48 (0.01)	0.24 (<0.01)	0.12 (<0.01)	0.12 (<0.01)	0.48 (0.01)
45% Formic Acid	23.4 (0.60)	18.4 (0.47)	11.4 (0.29)	11.8 (0.30)	4.56 (0.12)	2.76 (0.07)
10% Oxalic Acid	48.0 (1.23)	44.9 (1.14)	46.7 (1.19)	35.8 (0.91)	10.9 (0.28)	11.2 (0.28)
20% Phosphoric Acid*	0.20 (<0.01)	0.72 (0.02)	0.72 (0.02)	0.24 (<0.01)	0.24 (<0.01)	0.36 (0.01)
10% Sulfuric Acid*	636 (16.2)	298 (7.58)	255 (6.48)	158 (4.01)	84.4 (2.14)	13.9 (0.35)
10% Sodium Bisulfate	71.6 (1.82)	55.8 (1.42)	25.1 (0.64)	15.6 (0.40)	24.0 (0.61)	2.64 (0.07)
50% Sodium Hydroxide	77.7 (1.92)	32.8 (0.83)	69.2 (1.76)	85.7 (2.18)	16.0 (0.41)	17.8 (0.45)
ASTM A262 Practice B ($FeSO_4$•H_2SO_4)	26.0 (0.66)	20.8 (0.53)	23.5 (0.60)	17.3 (0.44)	21.4 (0.54)	265 (6.72)
ASTM A262 Practice C (65% HNO_3)	22.3 (0.56)	19.7 (0.50)	48.2 (1.23)	16.3 (0.42)	29.0 (0.74)	908 (23.1)
ASTM A262 Practice E (Cu•$CUSO_4$•H_2SO_4)	Pass	Pass	Pass	Pass	Pass	Pass

* Samples Activated

The low carbon (less than 0.03%) of these alloys effectively prevents sensitization to intergranular corrosion during thermal processes such as welding or forging. The higher chromium contents of ATI 317LMN, ATI 317LM and ATI 317L stainless steels also provide superior resistance to intergranular attack. It should be noted that prolonged exposure in the range 800 to 1400°F (427-816°C) can be detrimental to intergranular corrosion resistance and may also cause embrittlement due to precipitation of sigma phase. The higher nitrogen content of the ATI 317LMN alloy retards the precipitation of sigma phase as well as carbides.

Pitting Resistance Equivalents

Alloy	PRE
ATI 316™	25
ATI 317L™	30
ATI 317LM™	34
ATI 317LMN™	38
ATI 904L™	36
AL-6XN®	48
ALTEMP® 625	52
ATI 276™	69

PRE = Cr + 3.3Mo + 30N

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High molybdenum and nitrogen contents can significantly improve pitting resistance as illustrated in the preceding table of Pitting Resistance Equivalents (PRE). The PRE is based on the results of corrosion tests in which it was found that nitrogen was 30 times more effective than chromium and approximately 9 times more effective than molybdenum in enhancing chloride pitting resistance.

The temperature of the onset of crevice corrosion as determined in a modified ASTM G48 B test is a useful means of ranking the relative resistance of stainless and nickel-base alloys. The Critical Crevice Corrosion Temperatures table that follows demonstrates that crevice corrosion resistance for austenitic stainless steels increases with the alloy's molybdenum and nitrogen content.

Critical Crevice Corrosion Temperatures

Alloy	°F	°C
ATI 316™	27	-3
ATI 825™	37	3
ATI 317L™	35	2
ATI 317LM™	63	18
ATI 317LMN™	75	24
ATI 904L™	68	20
AL-6XN®	110	43
ALTEMP® 625	113	45
ATI 276™	130	55

ATI 317LMN, ATI 317LM and ATI 317L stainless steels are less susceptible than ATI 316 and lower alloy stainless steels to pitting or crevice corrosion in acidic solutions containing chlorides or other halide ions. Examples are found in flue gas desulfurization (FGD) systems where these alloys are frequently used. The table below compares the resistance of these alloys to crevice corrosion in a simulated FGD system solution.

Crevice Corrosion in a Simulated FGD System Environment

Alloy	Weight Loss (g/Cm^2) for Tests* at Cited Temperatures		
	24°C (75°F)	50°C (122°F)	70°C (158°F)
ATI 317L™	0.0007	0.0377	0.0500
ATI 317LM™	0.0000	0.0319	0.0462
ATI 317LMN™	0.0000	0.0129	0.0462
AL-6XN®	0.0000	0.0000	0.0266
ALTEMP® 625	0.0000	0.0000	0.0149
ATI 276™	0.0000	0.0001	0.0004

*72-hour exposure based on ASTM G-48B procedure using the following solution: 7 vol.%H_2SO_4, 3 vol% HCl, 1wt% $CuCl_2$, 1wt%$FeCl_3$

OXIDATION RESISTANCE

The chromium-nickel-molybdenum steels all have excellent resistance to oxidation and a low rate of scaling in ordinary atmospheres at temperatures up to 1600-1650°F (871-899°C).

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FABRICATION

The physical and mechanical properties of ATI 317LMN, ATI 317LM and ATI 317L stainless steels are similar to those of more conventional austenitic stainless steels and can, therefore, be fabricated in a manner similar to ATI 304 and 316 stainless.

WELDABILITY

The use of an overalloyed filler is suggested to maintain corrosion resistance in the as-welded condition. Filler metals containing at least 6% molybdenum are suggested for welding ATI 317L stainless and a filler metal with at least 8% molybdenum, such as Alloy 625, is suggested for ATI 317LMN and ATI 317LM alloys. In applications where it is not possible to use an overalloyed filler metal or to perform a postweld anneal and pickle treatment, the severity of the service environment should be carefully considered to determine if the properties of autogenous welds (weld made without a filler) are satisfactory. The optimum corrosion resistance of autogenously welded ATI 317LMN, ATI 317LM and ATI 317L stainless steels is obtained by post-weld annealing and pickling. ASTM A380 “Recommended Practice for Descaling and Cleaning Steel Surfaces” is suggested for more information.

MECHANICAL PROPERTIES

The ASTM specified minimum tensile properties and maximum hardness for annealed plate, sheet and strip products are shown in the following table.

Minimum Mechanical Properties per ASTM A240 for Cited Alloys			
Property	**ATI 317L™**	**ATI 317LM™**	**ATI 317LMN™**
Ultimate Tensile Strength, ksi (MPa)	75 (515)	75 (515)	80 (550)
0.2% Yield Strength, ksi (MPa)	30 (205)	30 (205)	35 (240)
% Elongation in 2" (5.1 cm)	40	40	40
Hardness, Maximum	217 BHN, 95 R_B	217 BHN, 95 R_B	223 BHN, 96 R_B
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PHYSICAL PROPERTIES

The physical property data which follows represent the iron-chromium-nickel-molybdenum class of stainless steels. For all practical purposes, the data are applicable to ATI 317LMN, ATI 317LM and ATI 317L stainless steels. All properties are at room temperature (20°C, 68°F) unless stated otherwise.

Density	0.29 8.0	lb/in^3 g/cm^3
Modulus of Elasticity	$29 \cdot 10^6$ 200	Psi GPa
Melting Range	2410 to 2550 1320 to 1400	°F °C
Thermal Conductivity **68 to 212°F** **20 to 100°C**	100.8 14.6	Btu/ft^2-hr-°F-in Watts/m-K
Coefficient of Thermal Expansion **77°F (25°C) to: 212°F (100°C)** **932°F (500°C)** **1832°F (1000°C)**	9.2 (16.5) 10.1 (18.2) 10.8 (19.5)	10^{-6}/°F (10^{-6}/°C) 10^{-6}/°F (10^{-6}/°C) 10^{-6}/°F (10^{-6}/°C)
Specific Heat	0.11 0.46	Btu/lb-°F J/g-K
Electrical Resistivity	31.1 0.79	μ-ohm-in μ-ohm-m
Magnetic Permeability **Fully annealed 0.5" plate** **65% cold-worked 0.5" plate**	1.0028 1.0028	μ at H = 200 oe μ at H = 200 oe

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