

Specs:

317LMN & 317L

(UNS S31726) & (UNS S31703)

General Properties

Alloys 317LMN and 317L 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 Alloy 304. In addition, 317LMN and 317L alloys offer higher creep, stress-to-rupture, and tensile strengths at elevated temperatures than conventional stainless steels. 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. Both alloys are intended for severe service conditions such as flue gas desulfurization (FGD) systems.

Composition

<i>Chemical Composition in Weight Percent per ASTM A240 for Cited Alloys</i>		
<i>Element</i>	<i>Alloy 317L</i>	<i>Alloy 317LMN</i>
Carbon	0.03 max	0.03 max
Manganese	2.00	2.00
Silicon	0.75 max	0.75 max
Chromium	18.00-20.00	17.00-20.00
Nickel	11.00-15.00	13.50-17.50
Molybdenum	3.00-4.00	4.00-5.00
Phosphorus	0.04 max	0.04 max
Sulfur	0.03 max	0.03 max
Nitrogen	0.10 max	0.10-0.20
Iron	Balance	Balance
UNS No.	S31703	S31726



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Resistance to Corrosion

Alloys 317L and 317LMN 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.

Alloys 317LMN and 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 affects 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 Alloy 316. The acid 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 317LMN and 317L stainless steels in a variety of solutions related to the process industries as well as standard ASTM tests. Data on Alloys 316L and 276 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			
	Alloy 316L	Alloy 317L	Alloy 317LMN	Alloy 276
20% Acetic Acid	0.12 (<0.01)	0.48 (0.01)	0.12 (<0.01)	0.48 (0.01)
45% Formic Acid	23.41 (0.60)	18.37 (0.47)	11.76 (0.30)	2.76 (0.07)
10% Oxalic Acid	48.03 (1.23)	44.90 (1.14)	35.76 (0.91)	11.24 (0.28)
20% Phosphoric Acid	0.60 (0.02)	0.72 (0.02)	0.24 (<0.01)	0.36 (0.01)
10% Sulfuric Acid	635.7 (16.15)	298.28 (7.58)	157.80 (4.01)	13.93 (0.35)
10% Sodium Bisulfate	71.57 (1.82)	55.76 (1.42)	15.60 (0.40)	2.64 (0.07)
50% Sodium Hydroxide	77.69 (1.92)	32.78 (0.83)	85.68 (2.18)	17.77 (0.45)
ASTM A262 Practice B (FeSO ₄ iH ₂ SO ₄)	26.04 (0.66)	20.76 (0.53)	17.28 (0.44)	264.5 (6.72)
ASTM A262 Practice C (65% HNO ₃)	22.31 (0.56)	19.68 (0.50)	16.32 (0.42)	908.0 (23.06)
ASTM A262 Practice E (CuiCUSO ₄ iH ₂ SO ₄)	Pass	Pass	Pass	Pass

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 317LMN and Alloy 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



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detrimental to intergranular corrosion resistance and may also cause embrittlement due to precipitation of sigma phase. The higher nitrogen content of the 317LMN alloy retards the precipitation of sigma phase as well as carbides.

<i>Pitting Resistance Equivalents</i>	
<i>Alloy</i>	<i>PRE</i>
Alloy 316	25
Alloy 317L	30
Alloy 317LMN	38
Alloy 625	52
Alloy C276	69

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 G-48B 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.

<i>Critical Crevice Corrosion Temperatures</i>		
<i>Alloy</i>	<i>°F</i>	<i>°C</i>
Alloy 316	27	-3
Alloy 317L	35	2
Alloy 317LMN	75	24
Alloy 625	113	45
Alloy C276	130	55

Alloy 317LMN and Alloy 317L stainless steels are less susceptible than Alloy 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.

<i>Crevice Corrosion in a Simulated FGD System Environment</i>			
<i>Alloy</i>	<i>Weight Loss (g/cm²) for Tests* at Cited Temperatures</i>		
	<i>24°C (75°F)</i>	<i>50°C (122°F)</i>	<i>70°C (158°F)</i>
Alloy 317L	0.0007	0.0377	0.0500
Alloy 317LMN	0.0000	0.0129	0.0462
Alloy 625	0.0000	0.0000	0.0149
Alloy C276	0.0000	0.0001	0.0004

*72-hour exposure based on ASTM G-48B procedure using the following solution:

7 vol.%H₂SO₄, 3 vol.%HCl, 1 wt% CuCl₂, 1 wt%FeCl₃



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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).

Fabrication

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

Heat Treatment

Forging

The recommended initial temperature range is 2100-2200°F (1150-1205°C) with a finishing range of 1700-1750°F (927-955°C).

Annealing

Alloy 317LMN and Alloy 317L stainless steels can be annealed in the temperature range 1975-2150°F (1080-1175°C) followed by an air cool or water quench, depending on thickness. Plates should be annealed between 2100°F (1150°C) and 2150°F (1175°C). The metal should be cooled from the annealing temperature (from red/white to black) in less than three minutes.

Hardenability

These grades are not hardenable by heat treatment.

Welding

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 Alloy 317L and a filler metal with at least 8% molybdenum, such as Alloy 625, is suggested for 317LMN. In applications where it is not possible to use an overalloyed filler metal or to perform a post-weld 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 317LMN and Alloy 317L stainless steels is obtained by post-weld annealing and pickling. ASTM A-380 "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.



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Minimum Mechanical Properties per ASTM A-240 for Cited Alloys		
Property	Alloy 317L	Alloy 317LMN
Ultimate Tensile Strength, ksi (MPa)	75 (515)	80 (550)
0.2% Yield Strength, ksi (MPa)	30 (205)	35 (240)
% Elongation in 2" (5.1 cm)	40	40
Hardness, Maximum	217BHN	--
UNS No.	S31703	S31726

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 317LMN and Alloy 317L stainless steels. All properties are at room temperature (68°F, 20°C) unless stated otherwise.

Density	0.29 8.0	lb/in ³ g/cm ³
Modulus of Elasticity	29i10 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-in
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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