

# 304/304L

## STAINLESS STEEL

UNS S30400/UNS S30403



- Minimizes Chromium Carbide Precipitation
- Excellent Corrosion Resistance and Strength
- Readily Welded
- Readily Formed and Drawn

### Applications Potential

High strength, excellent corrosion resistance and minimized carbon content make Types 304 and 304L Stainless Steels useful for applications where welding is required. Uses include architectural mouldings and trim, kitchen equipment, welded components of chemical, textile, paper, pharmaceutical and chemical industry processing equipment.

For severely corrosive environments, Type 304L is preferred because of its greater immunity to intergranular corrosion. These grades are suitable for all applications specifying Type 302.

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Data referring to mechanical properties and chemical analyses are the result of tests performed on specimens obtained from specific locations of the products in accordance with prescribed sampling procedures; any warranty thereof is limited to the values obtained at such locations and by such procedures. There is no warranty with respect to values of the materials at other locations.

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# PRODUCT DESCRIPTION

For severely corrosive environments, Type 304L is preferred because of its greater immunity to intergranular corrosion. These grades are suitable for all applications specifying Type 302.

Type 304 Stainless Steel is a variation of the basic 18-8 grade, Type 302, with a higher chromium and lower carbon content. Its lower carbon minimizes chromium carbide precipitation due to welding and its susceptibility to intergranular corrosion. In many instances, Type 304 can be used in the "as-welded" condition, while Type 302 must be annealed in order to retain adequate corrosion resistance.

Type 304L is an extra low-carbon variation of Type 304 with a 0.03% maximum carbon content that eliminates carbide precipitation due to welding. As a result, this alloy can be used in the "as welded" condition, even in severe corrosive conditions. In many cases it eliminates the necessity of annealing weldments except for applications specifying stress relief. Type 304L has slightly lower mechanical properties than Type 304.

## Composition

	Type 304 %	Type 304L %
Carbon	0.08 max.	0.03 max.
Manganese	2.00 max.	2.00 max.
Phosphorus	0.045 max.	0.045 max.
Sulfur	0.030 max.	0.030 max.
Silicon	0.75 max.	0.75 max.
Chromium	18.00-20.00	18.0-20.0
Nickel	8.00-12.00	8.0-12.0
Nitrogen	0.10 max.	0.10 max.
Iron	Balance	Balance

## Available Forms

AK Steel produces Types 304 and 304L Stainless Steels in thicknesses from 0.01" to 0.25" (0.25 to 6.35 mm) max. and widths up to 48" (1219 mm). For other thicknesses and widths, inquire.

## Metric Practice

Values shown in this bulletin were established in U.S. customary units. The metric equivalents of U.S. customary units shown may be approximate. Conversion to the metric system, known as the International System of Units (SI), has been accomplished in accordance with ASTM E380.

The newton (N) has been adopted by the SI as the metric standard unit of force as discussed in the AISI Metric Practice Guide. The term for force per unit of area (stress) is the newton per square metre (N/m<sup>2</sup>). Since

this can be a large number, the prefix mega is used to indicate 1,000,000 units and the term meganewton per square metre (MN/m<sup>2</sup>) is used. The unit (N/m<sup>2</sup>) has been designated a pascal (Pa). The relationship between the U.S. and the SI units for stress is: 1000 pounds/in<sup>2</sup> = 1 kip/in<sup>2</sup> = 6.8948 meganewtons/m<sup>2</sup> (MN/m<sup>2</sup>) = 6.8948 megapascals (MPa).

## Mechanical Properties

**Table 1**

Typical Room Temperature Properties

	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elongation % in 2" (50.8 mm)	Hardness Rockwell
Type 304L	85 (586)	35 (241)	55	B80
Type 304	90 (621)	42 (290)	55	B82

**Table 2**

Elevated Temperature Properties

Temperature °F (°C)	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elongation % in 2" (50.8 mm)
Room	85 (586)	35.0 (241)	55
400 (204)	72 (496)	23.0 (159)	51
600 (316)	68 (469)	19.5 (134)	45
800 (427)	64 (441)	16.5 (114)	40
1000 (538)	56 (386)	14.0 (97)	36
1200 (649)	44 (303)	12.5 (88)	34
1400 (760)	29 (200)	11.0 (76)	36
1600 (871)	16 (110)	–	40

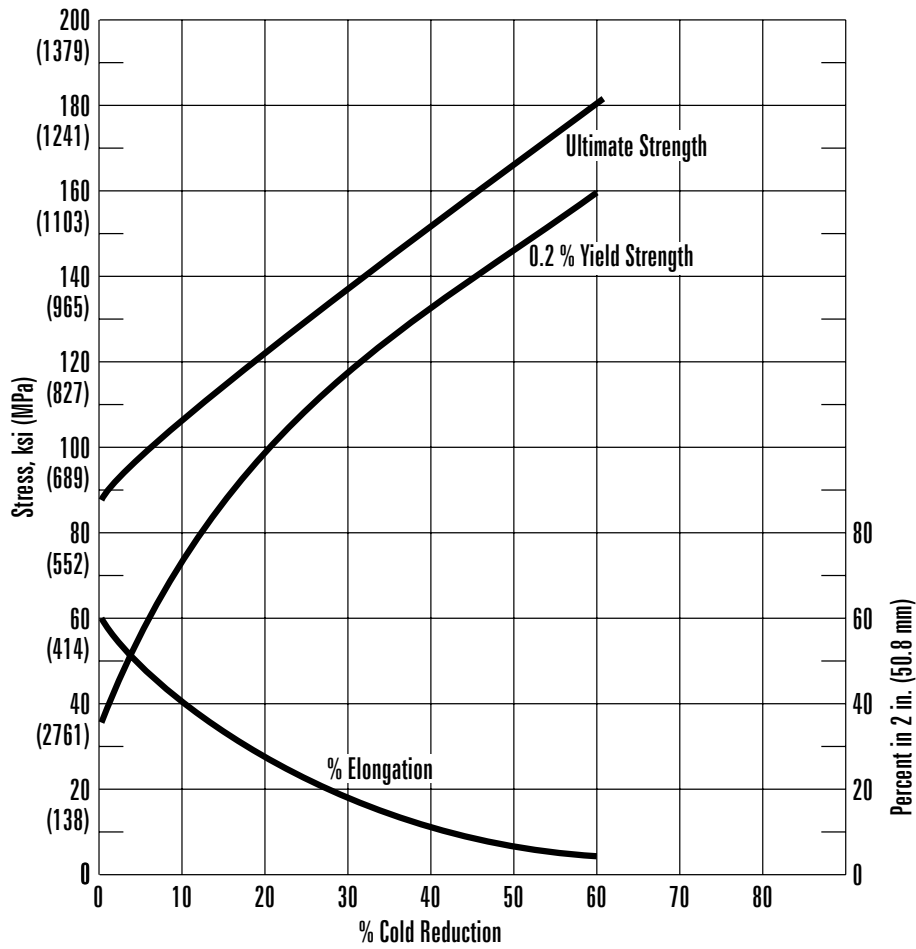
**Table 3**

Sub-Zero Properties

Test Temperature °F (°C)	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elongation % in 2" (50.8 mm)
-320 (-196)	235 (1620)	56 (386)	40
-80 (-62)	161 (1110)	50 (345)	57
-40 (-40)	145 (1000)	48 (331)	60
32 (0)	122 (841)	40 (296)	65
70 (21)	85 (586)	35 (241)	55

**Table 4**  
Fatigue Strength

Condition	Fatigue Strength, ksi (MPa) at $10^8$ Cycles
Annealed - 150 BHN	35 (241)
Cold Drawn - 277 BHN	70 (70)



## Physical Properties

Density, 0.29 lbs/in<sup>3</sup>  
8.03 g/cm<sup>3</sup>

Electrical Resistivity microhm-in (microhm-cm)  
68°F (20°C) – 28.4 (72)  
1200°F (659°C) – 45.8 (116)

Specific Heat, BTU/lb/°F (kJ/kg•K)  
32-212°F (0-100°C) – 0.12 (0.50)

Thermal Conductivity, BTU/hr/ft<sup>2</sup>/ft/°F (W/m•K)  
at 212°F (100°C) – 9.4 (16.2)  
at 932°F (500°C) – 12.4 (21.4)

Mean Coefficient of Thermal Expansion,  
in/in/°F(μm/m•K)  
32 - 212°F (0 - 100°C) –  $9.4 \times 10^{-6}$  (16.9)  
32 - 600°F (0 - 315°C) –  $9.6 \times 10^{-6}$  (17.3)  
32 - 1000°F (0 - 538°C) –  $10.2 \times 10^{-6}$  (18.4)  
32 - 1200°F (0 - 649°C) –  $10.4 \times 10^{-6}$  (18.7)

Modulus of Elasticity, ksi (MPa)  
28.0 x 10<sup>3</sup> (193 x 10<sup>3</sup>) in tension  
11.2 x 10<sup>3</sup> (78 x 10<sup>3</sup>) in torsion

Magnetic Permeability, H = 200 Oersteds  
Annealed – 1.02 max.

Melting Range, °F (°C) – 2550 - 2650 (1399 - 1454)

## Corrosion Resistance

Types 304 and 304L exhibit excellent resistance to a wide range of corrosive media including solutions used in the chemical, textile, petroleum and dairy and food industries, and to atmospheric exposures. The low carbon content of Type 304, and especially 304L, by reducing or eliminating carbide precipitation due to welding, makes these types of stainless suitable for a much wider range of corrosive service than Type 302.

## Oxidation Resistance

The maximum temperature to which Type 304 can be exposed continuously without appreciable scaling is about 1650°F (899°C). For intermittent exposure, the maximum exposure temperature is about 1500°F (816°C).

## Heat Treatments

Type 304 is non-hardenable by heat treatment.

Annealing: Heat to 1900 - 2050°F (1038 - 1121°C), then cool rapidly. Thin strip sections may be air cooled, but heavy sections should be water quenched to minimize exposure in the carbide precipitation region.

Stress Relief Annealing: Cold worked parts should be stress relieved at 750°F (399°C) for 1/2 to 2 hours.

## Cold Working

High hardness and strength are achieved through cold working. In the annealed condition, Types 304 and 304L are very ductile and can be cold worked easily by roll forming, deep drawing, bending, and other common fabricating methods. Since the material work hardens rapidly, in-process annealing may be necessary to restore ductility and to lower hardness.

## Formability

Types 304 and 304L have very good drawability. Their combination of low yield strength and high elongation permits successful forming of complex shapes. However, these grades work harden rapidly. To relieve stresses produced in severe forming or spinning, parts should be full annealed or stress-relief annealed as soon as possible after forming.

## Weldability

The austenitic class of stainless steels is generally considered to be weldable by the common fusion and resistance techniques. Special consideration is required to avoid weld "hot cracking" by assuring formation of ferrite in the weld deposit. Types 304 and 304L are generally considered to be the most common alloys of this stainless class. When a weld filler is needed, AWS E/ER 308, 308L or 347 are most often specified. Types 304 and 304L Stainless Steels are well known in reference literature and more information can be obtained in the following ways:

1. ANSI/AWS A5.9, A5.22 and A5.4 (filler metals, minimum UTS and elongation).
2. "Welding of Stainless Steels and Other Joining Methods," SSINA, (800:982-0355).
3. "Welding Stainless Steels," FDB #SF-1.
4. ANSI/AWS B2.1.009-90 (GTAW 300's @ 0.50" - 0.14").
5. ANSI/AWS B2.1-8-024-94 (GTAW 300's @ 1/8" - 1-1/2").
6. ANSI/AWS B2.1.013-91 (SMAW 300's @ 0.050" - 0.14").
7. ANSI/AWS B2.1-8-023-94 (SMAW 300's @ 1/8" - 1-1/2").
8. ANSI/AWS B2.1.005-90 (GMAW 300's @ 0.050" - 0.14").
9. "High Frequency Pipe and Tube Welding," by R. K. Nichols, Thermatool Corp. (203:468-4100).

## Specifications

Types 304 and 304L Stainless Steels are covered by the following specifications:

Type 304	Type 304L
AMS 5513	AMS 5511
ASTM A 240	ASTM A 240
ASTM A 666	ASTM A 666
	MIL-S-4043

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