304 / 304L
STAINLESS STEEL

Architectural Moldings

Kitchen Equipment

Industrial Processing Equipment

High strength, excellent corrosion resistance and excellent formability make **Type 304 and 304L** useful for many applications. Typical uses include architectural moldings and trim, kitchen equipment and processing equipment for the chemical, textile, paper, and pharmaceutical industries.

For severely corrosive environments, or when welding is required, Type 304L is preferred because of its greater immunity to intergranular corrosion.

Product Description

Type 304 is a variation of the base Cleveland-Cliffs 18-8, with a higher chromium and lower carbon content. The lower carbon content minimizes chromium carbide precipitation due to welding and its susceptibility to intergranular corrosion. In some instances, Type 304 can be used in the "as-welded" condition.

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 (wt %)	Type 304L (wt %)
Carbon	(C)	0.08 max.	0.03 max.
Manganese	(Mn)	2.00 max.	2.00 max.
Phosphorus	(P)	0.045 max.	0.045 max.
Sulfur	(S)	0.030 max.	0.030 max.
Silicon	(Si)	0.75 max.	0.75 max.
Chromium	(Cr)	18.0 – 20.00	18.0 – 20.00
Nickel	(Ni)	8.00 – 12.00	8.00 – 12.00
Nitrogen	(N)	0.10 max.	0.10 max.
Iron	(Fe)	Balance	Balance

AVAILABLE FORMS

Cleveland-Cliffs produces Type 304 and 304L in thicknesses from 0.01 – 0.25 in. (0.25 – 6.35 mm) and widths up to 60 in. (1524 mm). For other thicknesses and widths, contact your Cleveland-Cliffs sales representative.

METRIC PRACTICE

Values shown in this bulletin were established in U.S. customary units. The metric equivalents may be approximate.

Mechanical Properties

TABLE 1 – TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES

	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)	Rockwell Hardness, B
Type 304	95 (655)	42 (290)	55	84
Type 304L	95 (655)	40 (276)	55	82

TABLE 2 – ELEVATED TEMPERATURE MECHANICAL PROPERTIES

Temperature, °F (°C)	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)
Room	85 (586)	35 (241)	55
400 (204)	72 (496)	23 (159)	51
600 (316)	68 (469)	20 (134)	45
800 (427)	64 (441)	17 (114)	40
1000 (538)	56 (386)	14 (97)	36
1200 (649)	44 (303)	13 (88)	34
1400 (760)	29 (200)	11 (76)	36
1600 (871)	16 (110)	—	40

TABLE 3 – LOW TEMPERATURE MECHANICAL PROPERTIES

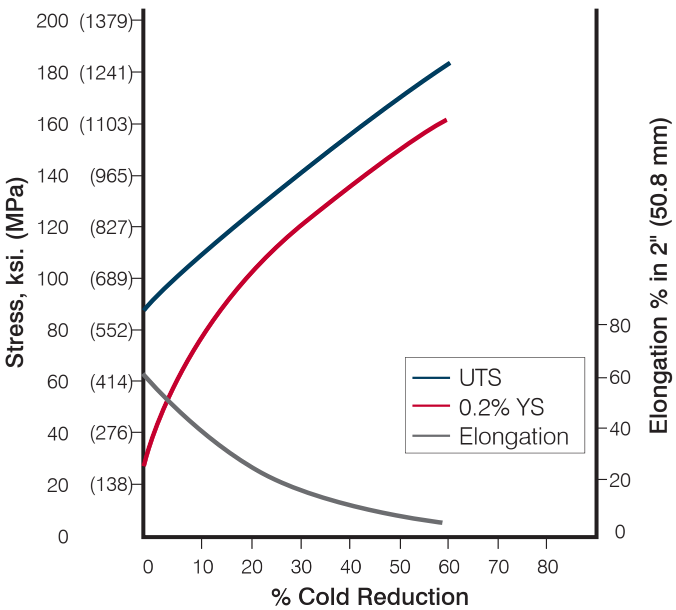
Condition	Temperature, °F (°C)	UTS, ksi. (MPa)	0.2% YS, ksi. (MPa)	Elongation % in 2 in. (50.8 mm)
Annealed	-320 (-196)	235 (1620)	56 (386)	40
	-80 (-62)	161 (1110)	50 (345)	57
	-40 (-40)	145 (1000)	48 (331)	60
	32 (0)	122 (841)	40 (296)	65
	70 (21)	85 (586)	35 (241)	55

TABLE 4 – FATIGUE STRENGTH

Condition	Fatigue Strength, ksi. (MPa)
Annealed – 150 BHN	35 (241)
Cold Drawn – 277 BHN	70 (70)

Mechanical Properties

FIGURE 1 – EFFECT OF COLD WORK ON TENSILE PROPERTIES



PHYSICAL PROPERTIES

Density, lbs/in.³ (g/cm³)	0.29 (8.03)
Electrical Resistivity, μΩ•in. (μΩ•cm) 68 °F (20 °C) 1200 °F (659 °C)	28.4 (72) 45.8 (116)
Thermal Conductivity, BTU/hr./ft./°F W/(m•K) 212 °F (100 °C) 932 °F (500 °C)	9.4 (16.2) 12.4 (21.4)
Coefficient of Thermal Expansion, in./in./°F (μm/m/K) 32 – 212 °F (0 – 100 °C) 32 – 600 °F (0 – 315 °C) 32 – 1000 °F (0 – 538 °C) 32 – 1200 °F (0 – 649 °C)	9.4×10^{-6} (16.9) 9.9×10^{-6} (17.3) 10.2×10^{-6} (18.4) 10.4×10^{-6} (18.7)
Modulus of Elasticity, ksi. (MPa) in tension in torsion	28.0×10^{3} (193×10^{3}) 11.2×10^{3} (78×10^{3})
Magnetic Permeability Annealed, (H/m at 200 Oersteds)	1.02 max.
Specific Heat, BTU/lbs./°F (kJ/kg/K) 32 – 212 °F (0 – 100 °C)	0.12 (0.50)
Melting Range, °F (°C)	2550 – 2650 (1399 –1454)

CORROSION RESISTANCE

Types 304 and 304L exhibit excellent resistance to corrosive environments, such as can be found in the chemical, textile and petroleum industries. Type 304 and 304L are suitable for the food and dairy industries, and excel in rural and industrial atmospheric exposure. By reducing the carbon content in Type 304L, welding operations will not cause carbide precipitation that can lead to intergranular corrosion.

OXIDATION RESISTANCE

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

HEAT TREATMENT

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

Type 304 and 304L can be readily formed and drawn. The higher nickel versions of Type 304 are well suited to severe forming applications involving multi-draw operations and forming of complex shapes. This is largely due to its combination of lower strength and lower work hardening rate. As with all austenitic stainless steels, annealing or stress-relieving can be performed following fabrication.

304 / 304L STAINLESS STEEL

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 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 (Stainless Steel Welding Electrode Specifications).
2. "Welding of Stainless Steels and Other Joining Methods," SSINA, (www.ssina.com).
3. ANSI/AWS B2.1.009:2002 (GTAW 300's @ 0.50 – 0.14 in.).
4. ANSI/AWS B2.1-8-024:2001 (GTAW 300's @ 0.125 – 1.5 in.).
5. ANSI/AWS B2.1-8-013:2002 (SMAW 300's @ 0.050 – 0.14 in.).
6. ANSI/AWS B2.1-8-023:94 (SMAW 300's @ 0.125 – 1.5 in.).
7. ANSI/AWS B2.1.005:2002 (GMAW 300's @ 0.050 – 0.14 in.).
8. "High Frequency Welding of Stainless Steel Tubes" by H.N. Udall and R.K. Nichols.
9. ANSI/AWS D1.6/D1.6M:2007 (Structural Welding Code – Stainless Steel).

SPECIFICATIONS

Type 304 and 304L are covered by the following specifications:

Type 304	Type 304L
AMS 5513	AMS 5511
ASTM A240	ASTM A240
ASTM A666	ASTM A666

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials and direct reduced iron to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest steel supplier to the automotive industry in North America. Headquartered in Cleveland, Ohio, Cleveland-Cliffs employs approximately 25,000 people across its mining, steel and downstream manufacturing operations in the United States and Canada.

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