

# Specification Sheet: Alloy 304/304L

## (UNS S30400, S30403) W. Nr. 1.4301, 1.4307

### Most Widely Used Austenitic Stainless Steel, a Versatile Corrosion Resistant Alloy for General Purpose Applications

Alloy 304/304L (UNS S30400/S30403) is the most widely utilized "18-8" chromium-nickel austenitic stainless steel. It is an economical and versatile corrosion resistant alloy suitable for a wide range of general purpose applications.

It is common practice for 304L to be dual certified as 304 and 304L. The low carbon chemistry of 304L combined with an addition of nitrogen enables 304L to meet the mechanical properties of 304.

Alloy 304/304L resists atmospheric corrosion, as well as, moderately oxidizing and reducing environments. The alloy has excellent resistance to intergranular corrosion in the as-welded condition. Alloy 304/304L has excellent strength and toughness at cryogenic temperatures.

Alloy 304/304L is non-magnetic in the annealed condition, but can become slightly magnetic as a result of cold working or welding. It can be easily welded and processed by standard shop fabrication practices.

#### Applications

- Chemical and Petrochemical Processing—pressure vessels, tanks, heat exchangers, piping systems, flanges, fittings, valves and pumps
- Food and Beverage Processing
- Medical
- Mining
- Petroleum Refining
- Pharmaceutical Processing
- Power Generation—nuclear
- Pulp and Paper

#### Standards

ASTM ..... A 240  
 ASME ..... SA 240  
 AMS ..... 5511/5513  
 QQ-S ..... 766

#### Chemical Analysis

Weight % (all values are maximum unless a range is otherwise indicated)

Element	304	304L
Chromium	18.0 min.–20.0 max.	18.0 min.–20.0 max.
Nickel	8.0 min.–10.5 max.	8.0 min.–12.0 max.
Carbon	0.08	0.030
Manganese	2.00	2.00
Phosphorus	0.045	0.045
Sulfur	0.030	0.030
Silicon	0.75	0.75
Nitrogen	0.10	0.10
Iron	Balance	Balance

#### Physical Properties

##### Density

0.285 lbs/in<sup>3</sup>  
 7.90 g/cm<sup>3</sup>

##### Specific Heat

0.12 BTU/lb-°F (32–212°F)  
 500 J/kg-°K (0–100°C)

##### Modulus of Elasticity

29.0 x 10<sup>6</sup> psi  
 200 GPa

##### Thermal Conductivity 212°F (100°C)

9.4 BTU/hr/ft<sup>2</sup>/ft/°F  
 16.3 W/m-°K

##### Melting Range

2550–2590°F  
 1398–1421°C

##### Electrical Resistivity

29.1 Microhm-in at 68°F  
 74 Microhm-cm at 20°C

#### Mean Coefficient of Thermal Expansion

Temperature Range			
°F	°C	in/in/°F	cm/cm °C
68–212	20–100	9.2 x 10 <sup>-6</sup>	16.6 x 10 <sup>-6</sup>
68–932	20–500	10.6 x 10 <sup>-6</sup>	18.2 x 10 <sup>-6</sup>
68–1600	20–870	11.0 x 10 <sup>-6</sup>	19.8 x 10 <sup>-6</sup>

#### Mechanical Properties

	ASTM		
	Typical*	Type 304	Type 304L
0.2% Offset Yield Strength, ksi	42	30 min.	25 min.
Ultimate Tensile Strength, ksi	87	75 min.	70 min.
Elongation in 2 inches, %	58	40 min.	40 min.
Reduction in Area, %	70	—	—
Hardness, Rockwell B	82	92 max.	92 max.

\*0.375 inch plate



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## Corrosion Resistance

Alloy 304/304L has good resistance to atmospheric corrosion, foods and beverages and to many organic and inorganic chemicals in moderately oxidizing to moderately reducing environments. The high chromium content of the alloy provides resistance to oxidizing solutions such as nitric acid up to 55% weight and up to 176°F (80°C).

Alloy 304/304L also resists moderately aggressive organic acids such as acetic. The nickel present in the alloy provides resistance to moderately reducing solutions such as pure phosphoric acid, whatever the concentration, in cold solutions and up to 10% diluted hot solutions. The alloy can also operate successfully in caustic solutions free of chlorides or fluorides at moderate temperatures.

Alloy 304/304L does not perform well in more highly reducing environments such as those containing chlorides and sulfuric acid.

Alloy 304/304L performs well in fresh water service with low levels of chlorides (less than 100ppm). At higher chloride levels the grade is susceptible to crevice corrosion and pitting. For successful performance under these more severe conditions, higher molybdenum content is needed such as 316/316L. Alloy 304/304L is not recommended for service in marine environments.

In most instances, the corrosion resistance of Alloys 304, 304L and 304H will be roughly equal in most corrosive environments. However, in environments that are sufficiently corrosive to cause intergranular corrosion of welds and heat-affected zones Alloy 304L should be used because of its low carbon content.

### Lowest Temperature (°F) at Which the Corrosion Rate Exceeds 5 mpy

CORROSION ENVIRONMENT	Type 304	Type 316L	2205 (UNS S32205)	2507
0.2% Hydrochloric Acid	>Boiling	>Boiling	>Boiling	>Boiling
1% Hydrochloric Acid	86p	86	185	>Boiling
10% Sulfuric Acid	—	122	140	167
60% Sulfuric Acid	—	<54	<59	<57
96% Sulfuric Acid	—	113	77	86
85% Phosphoric Acid	176	203	194	203
10% Nitric Acid	>Boiling	>Boiling	>Boiling	>Boiling
65% Nitric Acid	212	212	221	230
80% Acetic Acid	212p	>Boiling	>Boiling	>Boiling
50% Formic Acid	≥50	104	194	194
50% Sodium Hydroxide	185	194	194	230
83% Phosphoric Acid + 2% Hydrofluoric Acid	113	149	122	140
60% Nitric Acid + 2% Hydrochloric Acid	>140	>140	>140	>140
50% Acetic Acid + 50% Acetic Anhydride	>Boiling	248	212	230
1% Hydrochloric Acid + 0.3% Ferric Chloride	68p	77p	113ps	203ps
10% Sulfuric Acid + 2000ppm Cl <sup>-</sup> + N <sub>2</sub>	—	77	95	122
10% Sulfuric Acid + 2000ppm Cl <sup>-</sup> + SO <sub>2</sub>	—	<<59p	<59	104
WPA1, High Cl <sup>-</sup> Content	<<50	≤50	113	203
WPA2, High F <sup>-</sup> Content	<<50	≤50	140	167

ps = pitting can occur

ps = pitting/crevice corrosion can occur

WPA	P <sub>2</sub> O <sub>5</sub>	Cl <sup>-</sup>	F <sup>-</sup>	H <sub>2</sub> SO <sub>4</sub>	Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	CaO	MgO
1	54	0.20	0.50	4.0	0.30	0.20	0.10	0.20	0.70
2	54	0.02	2.0	4.0	0.30	0.20	0.10	0.20	0.70

## Fabrication Data

Alloy 304/304L can be easily welded and processed by standard shop fabrication practices.

### Hot Forming

Working temperatures of 1652–2102°F (750–1150°C) are recommended for most hot working processes. For maximum corrosion resistance, the material should be annealed at 1900°F (1038°C) minimum and water quenched or rapidly cooled by other means after hot working.

### Cold Forming

The alloy is quite ductile and forms easily. Cold working operations will increase the strength and hardness of the alloy and might leave it slightly magnetic.

### Welding

Alloy 304/304L can be readily welded by most standard processes. A post weld heat treatment is not necessary.

### Machining

Alloy 304/304L is subject to work hardening during deformation and is subject to chip breaking. The best machining results are achieved with slower speeds, heavier feeds, excellent lubrication, sharp tooling and powerful rigid equipment.

Operation Tool Lubrication			CONDITIONS					
			Depth-mm	Depth-in	Feed-mm/t	Feed-in/t	Speed-m/min	Speed-ft/min
Turning	High Speed Steel	Cutting Oil	6	.23	0.5	.019	13–18	42.6–59
			3	.11	0.4	.016	20–25	65.6–82
			1	.04	0.2	.008	26–31	85.3–101.7
	Carbide	Dry or Cutting Oil	6	.23	0.5	.019	75–85	246–278.9
			3	.11	0.4	.016	90–100	295.3–328.1
			1	.04	0.2	.008	110–120	360.8–393.7
			Depth of cut-mm	Depth of cut-in	Feed-mm/t	Feed-in/t	Speed-m/min	Speed-ft/min
Cutting	High Speed Steel	Cutting Oil	1.5	.06	0.03–0.05	.0012–.0020	18–23	59–75.5
			3	.11	0.04–0.06	.0016–.0024	19–24	62.3–78.7
			6	.23	0.05–0.07	.0020–.0027	20–25	65.6–82
			Drill ø mm	Drill ø in	Feed-mm/t	Feed-in/t	Speed-m/min	Speed-ft/min
Drilling	High Speed Steel	Cutting Oil	1.5	.06	0.02–0.03	.0007–.0012	10–14	32.8–45.9
			3	.11	0.05–0.06	.0020–.0024	12–16	39.3–52.5
			6	.23	0.08–0.09	.0031–.0035	12–16	39.3–52.5
			12	.48	0.09–0.10	.0035–.0039	12–16	39.3–52.5
Milling Profiling	High Speed Steel	Cutting Oil			Feed-mm/t	Feed-in/t	Speed-m/min	Speed-ft/min
					0.05–0.10	.002–.004	12–22	39.4–72.2

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