Specification Sheet: Alloy 304/304H
(UNS S30400, S30409) W. Nr. 1.4301

Most Widely Used Austenitic Stainless Steel Modified with a Controlled Carbon Chemistry for Increased Strength to 1500°F (816°C)

Alloy 304/304H (UNS S30400/S30409) is a modification of the most widely utilized “18-8” chromium-nickel austenitic stainless steel. The carbon content is controlled in the range of 0.04–0.10% for increased strength at temperatures above 800°F (427°C). It is an economical and versatile corrosion resistant alloy suitable for a wide range of general purpose applications.

It is common practice for 304H to be dual certified as 304 and 304H. The high carbon chemistry of 304H enables 304 to meet the mechanical properties and grain size requirements of 304H.

Alloy 304/304H has general corrosion resistance similar to 304/304L. It resists atmospheric corrosion, as well as, moderately oxidizing and reducing environments. However, because of its high carbon content, Alloy 304/304H is subject to carbide precipitation in the heat affected zone of welds.

Alloy 304/304H 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
- Petroleum Refining

Standards

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

Chemical Analysis

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

Element	304	304H
Chromium	18.0 min.–20.0 max.	18.0 min.–20.0 max.
Nickel	8.0 min.–10.5 max.	8.0 min.–10.5 max.
Carbon	0.08	0.04 min.–0.10 max.
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^3
7.90 g/cm^3

Modulus of Elasticity
29.0 x 10^6 psi
200 GPa

Melting Range
2550–2590°F
1398–1421°C

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

Thermal Conductivity 212°F (100°C)
9.4 BTU/hr/ft^2/ft/°F
16.3 W/m-°K

Electrical Resistivity
29.1 Microhm-in at 68°F
73 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^{-6}	16.6 x 10^{-6}
68–932	20–500	10.0 x 10^{-6}	18.0 x 10^{-6}
68–1600	20–870	11.0 x 10^{-6}	19.8 x 10^{-6}

Mechanical Properties

		ASTM	
	Typical*	Type 304	Type 304H
0.2% Offset Yield Strength, ksi	43	30 min.	30 min.
Ultimate Tensile Strength, ksi	91	75 min.	70 min.
Elongation in 2 inches, %	58	40 min.	40 min.
Reduction in Area, %	68	—	—
Hardness, Rockwell B	83	92 max.	92 max.

0.375 inch plate

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Corrosion Resistance

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

Alloy 304/304H 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 need such as 316/316L. Alloy 304/304H is not recommended for service in marine environments.

In most instances, the corrosion resistance of Alloys 304, 304L and 30H 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 304/304H	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- + N_2	–	77	95	122
10% Sulfuric Acid + 2000ppm Cl- + SO_2	–	<<59p	<59	104
WPA1, High Cl- Content	<<50	≤50	113	203
WPA2, High F- Content	<<50	≤50	140	167

ps = pitting can occur
ps = pitting/crevice corrosion can occur

WPA	P_2O_5	Cl^-	F^-	H_2SO_4	Fe_2O_3	Al_2O_3	SiO_2	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 304/304H 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 304/304H can be readily welded by most standard processes. After welding Alloy 304/304H it may be necessary to anneal the plate to restore the corrosion resistance lost by sensitization to intergranular corrosion when chromium carbides precipitate in the grain boundaries in the weld heat-affected zone.

Machining

Alloy 304/304H 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
					Feed-mm/t	Feed-in/t	Speed-m/min	Speed-ft/min
Milling Profiling	High Speed Steel	Cutting Oil			0.05–0.10	.002–.004	12–22	39.4–72.2

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