Specification Sheet: Alloy 321/321H

(UNS S32100, S32109) W. Nr. 1.4541

A Titanium Stabilized Austenitic Stainless Steel with Excellent Resistance to Intergranular Corrosion After Exposure to Temperatures in the Chromium Carbide Precipitation Range of 800–1500°F (427–816°C)

Alloy 321 (UNS S32100) is a titanium stabilized austenitic stainless steel with good general corrosion resistance. It has excellent resistance to intergranular corrosion after exposure to temperatures in the chromium carbide precipitation range of 800–1500°F (427–816°C). The alloy resists oxidation to 1500°F (816°C) and has higher creep and stress rupture properties than alloys 304 and 304L. It also possesses good low temperature toughness.

Alloy 321H (UNS S32109) is the higher carbon (0.04–0.10) version of the alloy. It was developed for enhanced creep resistance and for higher strength at temperatures above 1000°F (537°C). In most instances, the carbon content of the plate enables dual certification.

Alloy 321 cannot be hardened by heat treatment, only by cold working. It can be easily welded and processed by standard shop fabrication practices.

Applications

- Aerospace—piston engine manifolds
- Chemical Processing
- Expansion Joints
- Food Processing—equipment and storage
- Petroleum Refining—polythionic acid service
- Waste Treatment—thermal oxidizers

Standards

ASTM .... A 240
ASME .... SA 240
AMS 5510

Chemical Analysis

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

Element	321	321H
Chromium	17.00 min.–19.00 max.	17.00 min.–19.00 max.
Nickel	9.00 min.–12.00 max.	9.00 min.–12.00 max.
Carbon	0.08	0.04 min.–0.10 max.
Manganese	2.00	2.00
Phosphorus	0.045	0.045
Sulfur	0.03	0.03
Silicon	0.75	0.75
Titanium	5 x (C + N) min.–0.70 max.	4 x (C + N) min.–0.70 max.
Nitrogen	0.10	0.10
Iron	Balance	Balance

Physical Properties

Density
0.286 lbs/in^3
7.920 g/cm^3

Modulus of Elasticity
28.0 x 10^6 psi
193 GPa

Melting Range
2550–2635°F
1398–1446°C

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

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

Electrical Resistivity
72 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}	16.0 x 10^{-6}
68–1112	20–600	10.5 x 10^{-6}	18.9 x 10^{-6}
68–1832	20–1000	11.4 x 10^{-6}	20.5 x 10^{-6}

Mechanical Properties

Typical Values at 68°F (20°C)

Yield Strength 0.2% Offset		Ultimate Tensile Strength		Elongation in 2 in.	Hardness
psi (min.)	(MPa)	psi (min.)	(MPa)	% (min.)	(max.)
30,000	205	75,000	515	40	217 Brinell

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Corrosion Resistance

Alloy 321 exhibits good general corrosion resistance that is comparable to 304. It was developed for use in the chromium carbide precipitation range of 1800–1500°F (427–816°C) where un-stabilized alloys such as 304 are subject to intergranular attack.

The alloy can be used in most diluted organic acids at moderate temperatures and in pure phosphoric acid at lower temperatures and up to 10% diluted solutions at elevated temperatures. Alloy 321 resists polythionic acid stress corrosion cracking in hydrocarbon service. It can also be utilized in chloride or fluoride free caustic solutions at moderate temperatures.

Alloy 321 does not perform well in chloride solutions, even in small concentrations, or in sulfuric acid service.

Fabrication Data

Alloy 321 can be easily welded and processed by standard shop fabrication practices.

Machining

The cold work hardening rate of 321 makes it less machinable than 410 stainless steel, but similar to 304. The table below provides relevant machining data.

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	12–16	39–52
			3	.11	0.4	.016	18–23	59–75
			1	.04	0.2	.008	23–28	75–92
	Carbide	Dry or Cutting Oil	6	.23	0.5	.019	67–76	220–249
			3	.11	0.4	.016	81–90	266–295
			1	.04	0.2	.008	99–108	325–354
			Depth of cut-m	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	16–21	52–69
			3	.11	0.04–0.06	.0016–.0024	17–22	56–72
			6	.23	0.05–0.07	.0020–.0027	18–23	59–75
			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	9–13	29–42
			3	.11	0.05–0.06	.0020–.0024	11–15	36–49
			6	.23	0.08–0.09	.0031–.0035	11–15	36–49
			12	.48	0.09–0.10	.0035–.0039	11–15	36–49
					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	11–21	36–69

Hot Forming

Working temperatures of 2100–2300°F (1149–1260°C) are recommended for forging, upsetting and other hot working processes. Do not work this alloy at temperatures below 1700°F (927°C). Material must be water quenched or fully annealed after working to re-attain maximum corrosion resistance.

Cold Forming

The alloy is quite ductile and forms easily.

Welding

Alloy 321 can be readily welded by most standard processes. A post weld heat treatment is not necessary.

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