321/321H Stainless Steel Pipe &Tube(UNS S32100/WNR 1.4541, UNS S32109/WNR 1.4878)

Stainless Steel 321/321H is a stabilized stainless steel which provides excellent resistance to intergranular corrosion following exposure to temperature in the chromium carbide precipitation range from 800°F to 1500°F. It is stabilized against chromium carbide formation by the addition of titanium.

321/321H Stainless Steel is a titanium-stabilised version of 304 which is used in particular applications within the sensitizing temperature range. It is sensitization resistance coupled with high strength at high temperature makes it suitable in application. When it is exposed to mildly corrosive environments it is not subjected to weld decay intergranular corrosion. It is a much better option in operating temperature environments in excess of 500°C. **Alloy 321/321H** is also advantageous for high temperature service because of its good mechanical properties. It offers higher creep and stress rupture properties also it is considered for exposure where sensitization and intergranular corrosion are concern.

Alloy 321/321H Stainless Steel is basically from 304 stainless steel. Its difference is by the small addition of titanium and carbon content. The higher the carbon content the greater will be its yield strength. It has advantages in high temperature environment due to its excellent mechanical properties. As compared to 304 alloys it has better ductility and resistance to stress fracture.

It has excellent forming and welding characteristics. Post-weld annealing is not required and has excellent toughness, even down to cryogenic temperatures.

321 Stainless Steel Pipe Range

Alloy	UNS Designation	Werkstoff NR.	Specifications*
321	S32100	EN 10216 – 5 1.4541	A269, A249 / SA249, A312 / SA312, A213 / SA213

321/321H 1.454 1.4878 Resistance to Corrosion

General Corrosion
Alloy 321/321H has similar resistance to 347. Heating for long periods of time in the chromium carbide precipitation range may affect the general resistance of it in severe corrosive media. Its annealed condition is somewhat less resistant to general corrosion in strongly oxidizing environments than annealed Alloy 347. Exposure in the 800°F to 1500°F temperature range lowers the overall corrosion resistance of Alloy 321.

Stress Corrosion Cracking
It is susceptible to stress corrosion cracking in halides. This is due to their similarity in nickel content. Conditions which cause SCC are:
(1) presence of halide ion
(2) residual tensile stresses
(3) environmental temperatures in excess of about 120°F

Stresses may result from cold deformation during forming operations or from thermal cycles encountered during welding operations. The levels may be reduced by stress-relieving heat treatments or annealing by following cold deformation. It is a good choice for service in the stress relieved condition in environments which might otherwise cause intergranular corrosion for unstabilized alloys.

It is particularly useful under conditions which cause polythionic acid stress corrosion of non-stabilized austenitic stainless steels. Exposure to temperatures in the sensitizing range will cause the precipitation of chromium carbides at grain boundaries. On cooling to room temperature in a sulfide-containing environment, the sulfide reacts with moisture and oxygen to form polythionic acids which attack the sensitized grain boundaries.

321/321H Mechanical Properties

Minimum Room Temperature Mechanical Properties Per ASTM A 240 and ASME SA-240			
Alloy	**Yield Strength .2% Offset psi (MPa)**	**Ultimate Tensile Strength psi (MPa)**	**Elongation in 2 in. (%)**
321	30,000 (205)	75,000 (515)	40.0

321/321H Fabrication

It is considered to be the most weldable of the high-alloy steel and can be welded by all fusion and resistance welding processes. Two important considerations in producing weld joints in it are preservation of corrosion resistance and avoidance of cracking.

It is important to maintain the level of stabilizing element present during welding. It is more prone to loss of titanium.

Weld metal with a fully austenitic structure is more susceptible to cracking during the welding operation. Hence due to this reason, Alloys 321 are designed to resolidify with a small amount of ferrite to minimize cracking susceptibility.

321/321H Oxidation Resistance

It exhibit oxidation resistance comparable to the other 18-8 austenitic stainless steel.

Oxidation Behavior of Type 321 Stainless Steel Tube

It is an austenitic chromium-nickel stainless steel which contains titanium which applied extensively to the equipment without the risk of intergranular corrosion at the temperature between 430°C and 870°C such as pressure tanks, heat exchanger, etc.

However, severe oxidation occurred to the 321 stainless steel tube in a heat changer at the temperature about 700°C.

321 S32100 Grade Comparison Chart

Countries	Standard Number	Grade
ISO	ISO/PDTS 15510	X6CrNiTi18 -10
USA	ASTM A213	(S32100)321
Japan	JIS G4303-1998	SUS 321
German	DIN 17440-1996	X6CrNiTi18 -10
	DIN EN10088-1	
France	NF EN10088-1	
UK	BS EN10088-1	
	RS970-1:1996	321 S31

321/321H Stainless Steel Chemical Composition

Grade	321	321H
UNS Designation	S32100	S32109
Carbon	0.08 max	0.04–0.10
Manganese	2.00 max	2.00 max
Phosphorous	0.045 max	0.045 max
Sulphur	0.03 max	0.03 max
Silicon	1.00 max	1.00 max
Chromium	17.0–20.0	17.0–20.0
Nickel	9.0–12.0	9.0–12.0
Iron (Fe)	Bal.	Bal.
Other Elements	Ti=5(C+N) to 0.70%	Ti=4(C+N) to 0.70%

Mechanical Properties

Physical Properties of 321 Stainless Steel Pipe in the Annealed Condition at -20°F to +100°F according to ASTM A213

Alloy	UNS	Spec	Tensile Strength	Yield Strength	Elongation in 2 inches (min.) %	Grain Size Req.	Maximum Harndess
321	S32100	ASME SA213	515	205	35	—	—
321H	S32109	ASME SA213	515	205	35	7 or coarser	—

Physical Properties

Physical Properties of 321 Stainless Steel Pipe in the Annealed Condition at -20°F to +100°F according to ASTM A213

Alloy	UNS	Spec	Density kg/dm³	Modulus of Elasticity (x106 psi)	Mean Coefficient of Thermal Expansion (IN./IN./°F x 10-6)	Thermal Conductivity (BTU-in/ft2-h-°F)
321	S32100	—	7.93	29.0	9.2	—
321H	S32109	—	7.93	29.0	9.2	—

321/321H Stainless Steel Thermal Processing

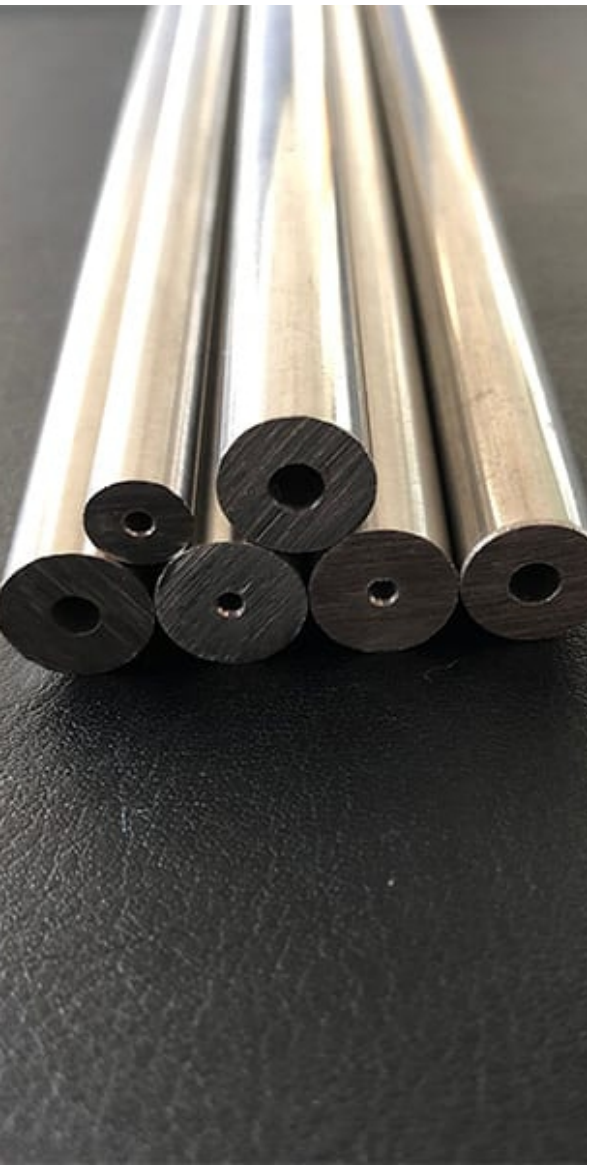
1. Annealing Heat from 1050 to 1150°C and cool in air. This ensures maximum ductility of the steel.
2. Stress Relieving 321 can be stress-relief annealed within the sensitization temperature range 450-800°C without carbide precipitation occurring, thus avoiding the possibility of intergranular corrosion.
3. Hot working Initial
   forging and pressing temperature: 1150–1250°C
   Finishing temperature: 950°C

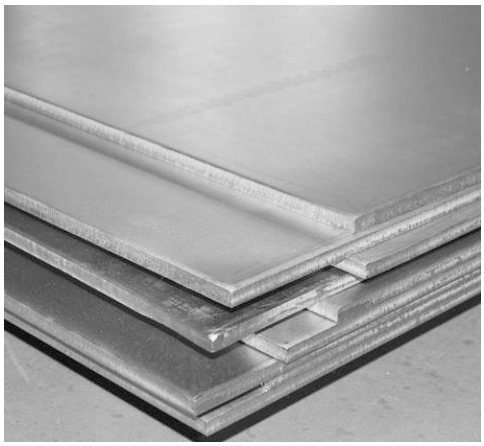
321/321H Stainless Steel Applications

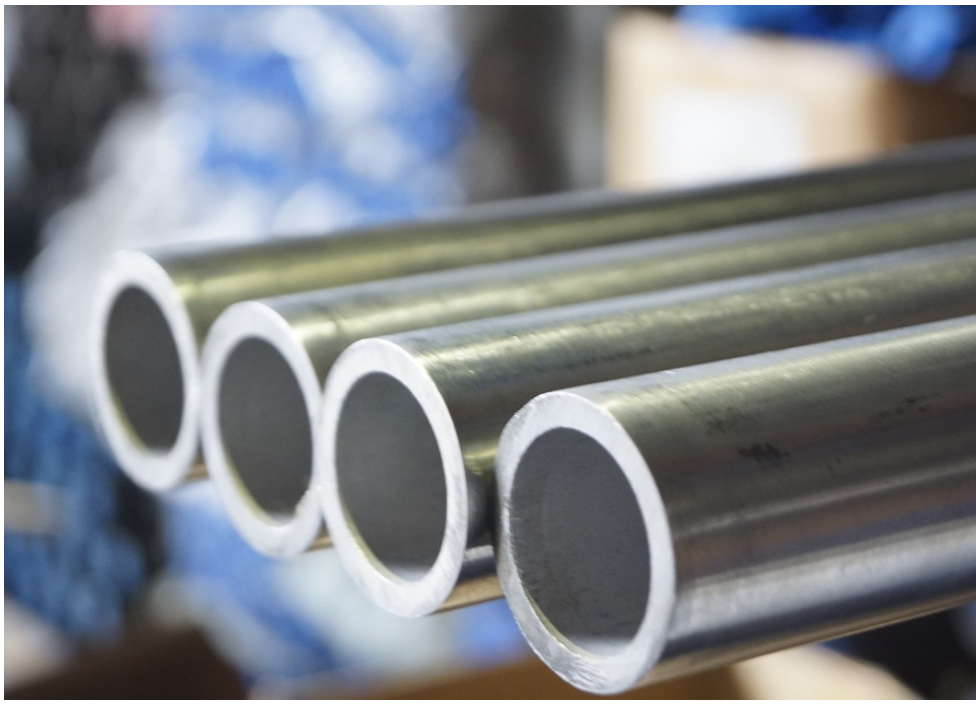
- Aircraft exhaust manifolds
- Expansion joints
- Bellows
- Furnace parts
- Heating element tubing
- Heat Exchanger
- Woven or welded screens for high temperature mineral processing
- Spiral Welded tube for burner pipes and flues

321/321H Stainless Steel Welding

It has excellent weldability by all standard fusion methods, both with and without filler metals.







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