

Alleima® 321 Aerospace

Tube and pipe, seamless

Datasheet

Alleima® 321 is an austenitic, titanium-stabilized stainless chromium-nickel steel used in the aircraft industry. It has good mechanical strength at high temperatures.

Standards

- ASTM: TP321, TP321H
- UNS: S32100, S32109
- EN Number: 1.4541, 1.4940
- EN Name: X6CrNiTi18-10, X7CrNiTi18-10
- W.Nr.: 1.4541, 1.4878
- DIN: X6CrNiTi 18 10, X12CrNiTi 18 9
- SS: 2337
- AFNOR: Z6CNT18-10
- BS: 321S31, 321S51

Product standards

- AMS 5561

Customer specifications on request.

Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni
0.05	0.5	1.3	≤0.030	≤0.015	17.5	10.5

Applications

Alleima® 321 stainless steel seamless tubes are used in the aircraft industry for airframe and engine components.

Corrosion resistance

General corrosion

Alleima® 321 has with some limitations (nitric acid) the same resistance as the unstabilised steel ASTM 304. Consequently, the grades have good resistance to:

- Organic acids at moderate temperatures
- Salt solutions, e.g. sulphates, sulphides and sulphites
- Caustic environments at moderate temperatures

Intergranular corrosion

The stabilisation with titanium gives Alleima® 321 improved resistance to intergranular corrosion.

Pitting and crevice corrosion

Pitting and crevice corrosion may occur even in solutions of relatively low chloride content. However, the stabilisation with titanium results in a somewhat better resistance than that of ASTM 304.

Stress corrosion cracking

Austenitic steels, like Alleima® 321 are susceptible to stress corrosion cracking. This may occur at temperatures above about 60 °C (140 °F), if the material is subjected to tensile stresses and at the same time comes into contact with certain solutions, particularly those containing chlorides. Such service conditions should therefore be avoided.

In applications demanding high resistance to stress corrosion cracking we recommend the austenitic-ferritic steel SAF™ 2304.

Gas corrosion

Alleima® 321 can be used in

- Air up to 850°C (1560°F)
- Steam up to 750°C (1380°F)
- Synthesis gas (ammonia synthesis) up to about 550 °C (1020 °F)

Creep should also be taken into account when using the steel in the creep range.

In flue gases containing sulphur, the corrosion resistance is reduced. In such environments this steel can be used at temperatures up to 600-750 °C (1110-1380 °F) depending on service conditions. Factors to consider are whether the atmosphere is oxidising or reducing, i.e. the oxygen content, and whether impurities such as sodium and vanadium are present.

Bending

Annealing after cold bending is not normally necessary, but this point must be decided with regard to the degree of bending and the operating conditions. Heat treatment, if any, should take the form of stress-relieving or solution annealing.

Hot bending is carried out at 1100-850°C (2010-1560°F) and should be followed by solution annealing.

Forms of supply

Alleima® 321 seamless stainless steel tubes are supplied in the bright annealed condition or cold-worked.

Dimensions

Outside diameter, mm (in.)	Wall thickness, mm (in.)
4.76 - 50.80 (0.187 - 2.0)	0.42 - 1.63 (0.0165 - 0.064)

Tolerances

Outside diameter, mm (in.)	Wall thickness, %
h12	+/- 10
For special tolerance requirements, please contact Sandvik.	

Heat treatment

The tubes are normally delivered as described above. If additional heat treatment is needed after further processing the following is recommended.

Solution annealing

Tp 321

1040-1100°C (1905-2010°F), 2-5 min, rapid cooling in air or water.

Tp321H

Stabilisation treatment: 1040-1100°C (1920-2010°F), 2-5 min rapid cooling in air or water. However, annealing above 1100°C (2010°F) may be required in order to meet grain size requirements. This treatment should be followed by a stabilisation treatment.

Stress relieving

850-950°C (1560-1740°F), 10-15 minutes, cooling in air.

Mechanical properties

At 20°C (68°F), annealed condition

Proof strength, $R_{p0.2}$	Tensile strength, R_m	Elongation, $A_{2''}$
MPa (ksi)	MPa (ksi)	%
≥210 (30)	≥550 - 700 (80 - 101)	≥40

At 20°C (68°F), hard condition

Proof strength, $R_{p0.2}$	Tensile strength, R_m	Elongation, $A_{2''}$
MPa (ksi)	MPa (ksi)	%
≥700 (101)	≥800 (116)	≥10

For special mechanical properties, please contact Sandvik.

Physical properties

Density: 7.9 g/cm³, 0.29 lb/in³

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	14	68	8
100	15	200	8.5
200	17	400	10
300	19	600	11
400	21	800	12
500	22	1000	13
600	24	1200	14
700	25	1400	15
800	26	1600	16
900	28	1800	16.5
1000	29	2000	17.5
1100	30		

Specific heat capacity

Temperature, °C	J/kg °C	Temperature, °F	Btu/lb °F
20	465	68	0.11
100	490	200	0.12
200	515	400	0.12
300	540	600	0.13
400	560	800	0.14
500	580	1000	0.14
600	595	1200	0.14
700	610	1400	0.15
800	625	1600	0.15
900	640	1800	0.16
1000	650	2000	0.16
1100	665		

Thermal expansion ¹⁾

Temperature, °C	Per °C	Temperature, °F	Per °F
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30-100	17.5	86-200	9.5
30-200	17.5	86-400	10
30-300	18	86-600	10
30-400	18	86-800	10
30-500	18.5	86-1000	10.5
30-600	18.5	86-1200	10.5
30-700	19	86-1300	10.5

1) Mean values in temperature ranges (x10⁻⁶)

Modulus of elasticity ¹⁾

Temperature, °C	MPa	Temperature, °F	ksi
20	200	68	29.0
100	194	200	28.2
200	186	400	26.9
300	179	600	25.8
400	172	800	24.7
500	165	1000	23.5

1) (x10³)

Welding

The weldability of Alleima® 321 is good. Suitable welding methods are manual metal-arc welding with covered electrodes and gas-shielded arc welding with the TIG and MIG methods as first choice. Preheating and post-weld heat treatment are not normally necessary.

Since the material has low thermal conductivity and high thermal expansion, welding must be carried out with a low heat input and with welding plans well thought out in advance so that the deformation of the welded joint can be kept under control. If, despite these precautions, it is foreseen that the residual stresses might impair the function of the weldment, we recommend that the entire structure be stress relieved.

As filler metal for gas-shielded arc welding we recommend wire electrodes and rods Exaton Ni72HP. In manual metal-arc welding covered electrodes Exaton Ni72HP are recommended. For application at temperatures up to 400°C (750°F) also welding wire/rod Exaton 19.9.NbSi, 19.9.Nb, 19.9.LSi or 19.9.L and covered electrodes Exaton 19.9.NbR or 19.9.LR are recommended.

Machining

Alleima® 321 has good machining properties. Please contact Alleima for detailed recommendations on the choice of tools and cutting data.

Disclaimer:

Recommendations are for guidance only, and the suitability of a material for a specific application can be

confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Alleima materials.