Alleima® 6R35
Tube and pipe, seamless
Datasheet

Alleima® 6R35 is an austenitic, titanium-stabilized stainless chromium-nickel steel. It is suitable for wet-corrosive service but also 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

Seamless tube and pipe

- ASTM A213, A312, A269, A376, (A511)
- EN 10216-5
- BS 3059, 3605, 3606
- DIN 17456, 17458
- SS 14 23 37
- NFA 49-117, 49-217

Approvals

PED (Pressure Equipment Directive) 2014/68/EU and AD2000

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

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Ti=>5xC

Applications

Good resistance to hydrogen sulfide gas and intergranular corrosion coupled with good high temperature strength make Alleima® 6R35 a suitable material for applications as tubes in heating furnaces and heat exchangers in sulfurization and hydro-treating plants. In the petrochemical industry the steel is used in cracking furnaces for the production of ethylene and vinyl chloride. It is also frequently used for heat exchangers and piping in the chemical and petrochemical industries.

Corrosion resistance

General corrosion

Alleima® 6R35 has with some limitations (nitric acid) the same resistance as the unstabilized steel ASTM 304. Consequently, the grades have good resistance to

- Organic acids at moderate temperatures
- Salt solutions, e.g. sulfates, sulfides and sulfites
- Caustic environments at moderate temperatures

Intergranular corrosion

The stabilization with titanium gives Alleima 6R35 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 stabilization with titanium results in a somewhat better resistance than that of ASTM 304.

Stress corrosion cracking

Austenitic steels, like Alleima® 6R35 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. Conditions when plants are shut down must also be considered as the condensates which are then formed can develop a chloride content that leads to both stress corrosion cracking and pitting.

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

Gas corrosion

Alleima® 6R35 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 sulfur, 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 oxidizing 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

Seamless tube and pipe-Finishes and dimensions

Seamless tube and pipe in Alleima® 6R35 is supplied in dimensions up to 260 mm outside diameter in the solution-annealed and white-pickled condition or solution-annealed in a bright-annealing process.

Hollow bar

Hollow bars are supplied solution-annealed and white-pickled.

Sizes in stock

Seamless tube and pipe
Seamless tube and pipe are stocked in a wide range of sizes according to ISO and ANSI both in hot extruded as well as in the cold finished and annealed condition. Details of our manufacturing and stock programme are given in catalogue S-110-ENG.

Hollow bar
Hollow bar is stocked in large number of sizes. Our standard size range for stock comprises 32-250 mm (1.3-9.8 in.) O.D. See catalogue S-110-ENG.

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

Stabilization 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 stabilization treatment.

Stress relieving

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

Mechanical properties

At 20°C (68°F)

Proof strength	Tensile strength	Elong.	Hardness

$R_{p0.2}$ [a]		$R_{p1.0}$ [a]		R_m		A [b]	HRB
MPa	**ksi**	**MPa**	**ksi**	**MPa**	**ksi**	**%**	
≥210	≥30	≥240	≥35	515-690	75-100	≥35 [c]	≤90

1 MPa = 1 N/mm^2
a) $R_{p0.2}$ and $R_{p1.0}$ correspond to 0.2% offset and 1.0% offset yield strength, respectively.
b) Based on $L_0 = 5.65 \sqrt{S_0}$ where L_0 is the original gauge length and S_0 the original cross-section area.
c) NFA 49-117 and NFA 49–217 with min 45% can be fulfilled.

Impact strength

Due to its austenitic microstructure, Alleima® 6R35 has very good impact strength both at room temperature and at cryogenic temperatures.

Tests have demonstrated that the steel fulfils the requirements (60 J (44 ft-lb) at -196 °C (-320 °F)) according to the European standards EN 13445-2 (UFPV-2) and EN 10216-5.

At high temperatures

Metric units

Temperature	Proof strength [c]	
	$R_{p0.2}$	$R_{p1.0}$
°C	**MPa**	**MPa**
	min	**min**
50	195	230
100	180	210
150	170	195
200	160	185
250	150	180
300	140	175
350	135	170
400	130	165
450	130	165
500	125	160
550	125	160
600	120	155

Imperial units

Temperature	Proof strength [c]

	$R_{p0.2}$	$R_{p1.0}$
°F	ksi	ksi
	min	min
200	26.0	30.5
400	22.5	26.5
600	19.5	25.0
800	18.5	23.5
1000	17.5	23.0
1100	17.0	22.0

c) For extruded tube and pipe with wall thickness greater than 10 mm (0.4 in.) the proof strength may fall short of the stated value by 20 MPa (2.9 ksi) at 100°C (200°F) and by 10 MPa (1.4 ksi) in the temperature range 200-600°C (400-1100°F).

Creep rupture strength

Temperature		10 000 h		100 000 h	
°C	°F	MPa	ksi	MPa	ksi
		approx.	approx.	approx.	approx.
550	1020	234	34.0	184	26.7
575	1065	175	25.4	126	18.3
600	1110	143	20.7	94	13.6
625	1155	110	16.0	75	10.9
650	1200	90	13.1	58	8.4
675	1245	76	11.0	48	7.0
700	1290	59	8.6	39	5.7
750	1380	29	4.2	16	2.3

Physical properties

Density: 7.9 g/cm^3, 0.29 lb/in^3

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
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) ($x10^{3}$)

Welding

Welding

The weldability of Alleima® 6R35 is good. Welding must be carried out without preheating and subsequent heat treatment is normally not required. Suitable methods of fusion welding are manual metal-arc welding (MMA/SMAW) and gas-shielded arc welding, with the TIG/GTAW method as first choice.

For Alleima® 6R35, heat input of <1.5 kJ/mm and interpass temperature of <150°C (300°F) are recommended.

Recommended filler metals

TIG/GTAW or MIG/GMAW welding

ISO 14343 S 19 9 Nb / AWS A5.9 ER347 (e.g. Exaton 19.9.Nb)

MMA/SMAW welding

ISO 3581 E 19 9 Nb R / AWS A5.4 E347-17(e.g. Exaton 19.9.NbR)

ISO 14343 S 19 9 Nb / AWS A5.9 ER347 (e.g. Exaton 19.9.LNb) wire or strip electrodes are recommended for overlay welding of tube sheets and high-pressure vessels in cases where corrosion resistance, equal to that of Alleima 6R35, is required.

Machining

Alleima® 6R35 has good machining properties. Please contact Alleima for detailed recommendations on the choice of tools and cutting data.