Alleima® 1C356
Tube and pipe, seamless
Datasheet

Alleima® 1C356 is a ferritic, heat resisting, chromium steel, characterized by:

- Very good resistance to reducing sulphurous gases
- Good resistance to oxidation in air
- Good resistance to oxidizing salts

The grade can be used at temperatures up to 1000°C (1830°F). However, allowance should be made for the low creep strength at the highest temperatures in order to avoid distortion due to the inherent mass of the steel.

Standards

- EN Number: 1.4742**
- W.Nr.: 1.4742*
- DIN: X10CrAl18*

Product standards

- SEW 470
- EN 10095**

* Obsolete. Replaced by EN.
** Heat resisting steels and nickel alloys. Technical delivery conditions for sheet/plate, strip, bars, rods and sections.

Chemical composition (nominal)

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C	Si	Mn	P	S	Cr	Ti	Al
≤0.04	1.0	0.7	≤0.035	≤0.015	17.5	0.4	1.0

Applications

Alleima® 1C356 should be chosen mainly for service in slightly sulphidizing gases where austenitic stainless steel with low contents of alloying elements may suffer corrosion. Typical applications for Alleima® 1C356 are:

- Recuperators in the metallurgical and allied industries

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- Thermocouple protection tubes
- Injection nozzles

Corrosion resistance

Air

Alleima® 1C356 is highly resistant to oxidation, both at constant and at cyclically varying temperatures. The service temperature in air should not exceed about 1000°C (1830°F).

Isothermal oxidation at 1000°C (1830°F) results in a metal loss of about 10µm/1000h.

Hot corrosion / sulphidation

Owing to its combined aluminium, silicon and chromium content and the absence of nickel, Alleima® 1C356 has very good resistance in sulphidising gases and salts.

Bending

Alleima® 1C356 tubes can be bent hot or cold. Annealing is not normally necessary after cold bending.

Hot-worked tubes should preferably be bent hot, but they can be bent cold, if the bending radii is greater than 5 times the diameter.

Hot bending is carried out at 900–800°C (1650–1470°F), followed by subsequent cooling in air.

Forms of supply

Seamless tube and pipe in Alleima® 1C356 is supplied in dimensions up to 120 mm (4.72 in.) outside diameter in the annealed condition, but are also available white-pickled after annealing.

Heat treatment

Tubes are delivered in the heat treated condition. If another heat treatment is needed after further processing, the following is recommended:

Stress relieving

800–850°C (1470–1560°F) 10-30 minutes, rapid cooling in air.

Annealing

800–860°C (1470–1580°F), 5-60 minutes, rapid cooling in air.

Hot working

1100–800°C (2010–1470°F).

Mechanical properties

Metric units, at 20°C

Proof strength	Tensile strength	Elong.	Hardness
$R_{p0.2}$ [1)]	R_m	A [2)]	Vickers

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MPa	MPa	%	
			approx.
≥270	440[3)]–700	≥15	215

1 MPa = 1 N/mm^2

Imperial units, at 68°F

Proof strength	Tensile strength	Elong.	Hardness
$R_{p0.2}$[1)]	R_m	A[2)]	Vickers
ksi	ksi	%	
			approx.
≥39	64[3)]–101	≥15	215

1) $R_{p0.2}$ and $R_{p1.0}$ correspond to 0.2% offset and 1.0% offset yield strength, respectively.
2) 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.
3) Hot finished products do not generally fulfill the min Rm requirement (500 MPa, 73 ksi) according to SEW 470.

Creep strength (approx. values)

Metric units

Temperature	Creep rupture strength, MPa	
°C	10 000 h	100 000 h
500	100	55
600	35	20
700	9.5	5.0
800	4.3	2.3
900	1.9	1.0

Imperial units

Temperature,	Creep rupture strength, ksi	
°F	10 000 h	100 000 h
930	14.5	8.0
1110	5.1	2.9
1290	1.38	0.72
1470	0.63	0.33
1650	0.28	0.15

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Since Alleima 1C356 has very large creep-rupture elongation, often more than 100%, and little resistance to creep, it is necessary to allow for considerable creep deformation long before rupture occurs. At normal service temperatures, i.e. over 700°C (1290°F), even the mass of the tubes can cause stresses leading to extensive deformations.

Careful attention must, therefore, be given to the way in which the tubes are supported. Alleima 1C356, in common with other ferritic chromium steels, is less tough than austenitic stainless steels in the as-delivered condition.

Physical properties

Density: 7.7 g/cm^3, 0.28 lb/in^3

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	19	68	11
500	25	200	14.5

Specific heat capacity

Temperature, °C	J/kg °C	Temperature, °F	Btu/lb °F
20	500	68	0.12

Thermal expansion [1)]

Temperature, °C	Per °C	Temperature, °F	Per °F
20–200	10.5	68–400	6
20–400	11.5	68–800	6.5
20–600	12	68–1200	7
20–800	12.5	68–1600	7

1) Mean values in temperature ranges x10^{-6}

Modulus of elasticity[1)]

Temperature, °C	MPa	Temperature, °F	ksi
20	195	68	28.5
200	190	400	27.5
400	180	800	25.5
600	145	1200	20.5
800	1250	1400	18.5
1000	120	1800	17.5

1) x 10^3

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Resistivity

Temperature, °C	µΩm	Temperature, °F	µΩin.
20	0.93	68	36.6

Structural stability

Temperatures of about 400–550°C (750–1020°F) should be avoided for even short periods of time, whether the steel is in service or merely being held at that temperature, since severe embrittlement, known as 475 deg. embrittlement, can take place. This is noticeable after the tubes have cooled to room temperature. However, the steel can be restored to its original condition by short term heating at a temperature above 600°C (1110°F).

Embrittlement can also occur as a result of sigma phase formation after prolonged service at 550-750°C (1020-1380°F), but it is less pronounced compared with 24–27 % chromium steels such as ASTM TP 446-1 (EN no. 1.4749), and high chromium-aluminium steels, such as EN no. 1.4762. The sigma phase can be redissolved after heat treatment above 900°C (1650°F).

Welding

The weldability of Alleima® 1C356 is good. Welding must be carried out with preheating at 200-300°C (390-570°F), subsequent heat treatment is not required where Alleima® 1C356 is used in structures that operate for prolonged periods at high temperature. 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® 1C356, heat-input of <1.5 kJ/mm and interpass temperature of <150°C (300°F) are recommended.

Recommended filler metals

TIG/GTAW welding

- ISO 14343 S 29 9/AWS A5.9 ER312 (e.g. Exaton 29.9) or
- ISO 14343 S 25 20/AWS A5.9 ER310 (e.g. Exaton 25.20.C) or
- ISO 18274 S Ni 6082/AWS A5.14 ERNiCr-3 (e.g. Exaton Ni72HP)

MMA/SMAW welding

- ISO 3581 E 29 9 R/AWS A5.4 E312-16 (e.g. Exaton 29.9.R) or
- ISO 3581 E 25 20 B/AWS A5.4 E310-16 (e.g. Exaton 25.20.B) or
- ISO 14172 E Ni 6182/AWS A5.11 ENiCrFe-3 (e.g. Exaton Ni71)

When using the austenitic stainless-steel wire electrode S 25 20/ER310 and the covered electrode E 25 20 B/E310-16, the higher thermal expansion of the austenitic weld metal must be considered.

When using nickel alloy wire electrode S Ni 6082/ERNiCr-3 and covered electrode E Ni 6182/ENiCrFe-3, however, allowance must be made for lower corrosion resistance of the Alleima® 1C356 welded joint in a reducing sulphurous atmosphere.

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.