Alleima® 2C48
Tube and pipe, seamless
Datasheet

Alleima® 2C48 is a ferritic, heat resisting, stainless chromium steel, characterized by:

- Good resistance to reducing sulphurous gases
- Very good resistance to oxidation in air
- good resistance to oil-ash corrosion
- Resistance to molten copper, lead and tin

This steel can be used at temperatures up to 1075°C (1970°F). However, allowance should be made for the low creep strength at the highest temperatures in order to avoid distortion due to the mass of the steel.

Standards

- ASTM: 446-2
- UNS: S44600

Product standards

- ASTM A268

Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	N
0.09	0.5	0.8	≤0.030	≤0.015	23.5	0.2

Applications

Typical applications for Alleima® 2C48 are:

- Recuperators in the metallurgical and glass industries
- Thermocouple protection tubes
- Cable tubing
- Sootblower tubes
- Injection nozzles

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Corrosion resistance

Air

Alleima® 2C48 is highly resistant to oxidation, both at constant and at cyclically varying temperatures. The service temperature in air should not exceed about 1075°C (1970°F).

Hot corrosion / sulphidation

Owing to its high chromium content and the absence of nickel, Alleima® 2C48 has very good resistance in sulphidizing gases and salts. The steel has relatively good resistance to slags containing vanadium pentoxide and sodium sulphate, for example, which are extremely aggressive at temperatures above 600°C (1110°F).

Nitrogen pick-up

Nitrogen pick-up can occur in gas mixtures with low oxygen concentrations and high concentrations of nitrogen, cracked ammonia or mixtures of nitrogen and hydrogen. Nitrogen pick-up leads to embrittlement and reduced oxidation resistance. Alleima® 2C48 is more sensitive than austenitic steels in environments where nitrogen pick-up can occur.

Carburizing atmosphere
When a material comes into contact with hot gases containing hydrocarbons and carbon monoxide, carburization can occur. The extent of carburization depends on the composition of the material and of the gas.

The relatively high chromium content of Alleima® 2C48 promotes the formation of a protective oxide layer on the surface of the material, providing some protection against carburization.

However, because Alleima® 2C48 is ferritic, carburization occurs quickly, if the oxide layer cracks or if the oxygen content is too low to form a protective oxide layer. For this reason, the material does not possess the same resistance as the austenitic steels, for example, Alleima® 253 MA* or Sanicro 31HT.

Metal and salt baths

The ferritic structure of Alleima® 2C48 gives it good resistance in baths of molten copper. It also possesses good resistance in other molten metals, such as lead, tin, bearing metals, brass and magnesium. In these metals, it is a good idea to use replaceable sleeves of ceramic material or graphite, since corrosion is heaviest at the surface of the metal bath. In salt baths for heat treatment etc., such as cyanide baths and neutral salt baths, austenitic alloys with a high nickel content should be chosen instead (e.g. Sanicro 31HT).

* 253 MA is a trademark owned by Outokumpu OY.

Bending

Generally Alleima® 2C48 has improved bending properties, compared with ASTM TP446-1.

When Alleima® 2C48 tubes are to be bent cold, we recommend the use of cold-worked tubes. 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 radius is greater than 5 times the diameter.

Hot bending is carried out at 1000–800°C (1830–1470°F) and should be followed by annealing, if necessary for reasons of design.

Forms of supply

Seamless tube and pipe in Alleima® 2C48 is supplied in dimensions up to 120 mm outside diameter in the annealed condition, but is 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), 15–30 minutes, rapid cooling in air.

Annealing

800–900°C (1470–1650°F), 30–60 minutes, rapid cooling in air.

Mechanical properties

Metric units, at 20°C

Proof strength	Tensile strength	Elong.	Hardness
$R_{p0.2}$ [1)]	R_m	$A_{2"}$	
MPa	MPa	%	HRB
≥275	≥450	≥20	≤95

1 MPa = 1 N/mm^2

Imperial units, at 68°F

Proof strength	Tensile strength	Elong.	Hardness
$R_{p0.2}$ [1)]	R_m	$A^{2"}$	
ksi	ksi	%	HRB
≥40	≥65	≥20	≤95

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-sectional area.

The creep strength for Alleima® 2C48 is slightly inferior to that of Alleima® 4C54 (ASTM TP446-1).

Physical properties

Density: 7.6 g/cm^3, 0.27 lb/in^3

Thermal conductivity

Temperature, °C	W/(m °C)	Temperature, °F	Btu/(ft h °F)
20	20	68	11.5
100	21	200	12.5
200	22	400	12.5
300	23	600	13

400	23	800	13.5
500	24	1000	14.5
600	25	1200	14
700	24	1400	14.5
800	26	1600	15.5
900	28	1800	17
1000	30	2000	19
1100	34		

Specific heat capacity

Temperature, °C	J/(kg °C)	Temperature, °F	Btu/(lb °F)
20	475	68	0.11
100	520	200	0.12
200	555	400	0.13
300	595	600	0.14
400	625	800	0.16
500	710	1000	0.18
600	795	1200	0.18
700	720	1400	0.17
800	695	1600	0.16
900	680	1800	0.17
1000	715	2000	0.18
1100	760		

Thermal expansion[1)]

Temperature, °C	Per °C	Temperature, °F	Per °F
30-100	10	86-200	5.5
30-200	10	86-400	5.5
30-300	10.5	86-600	6
30-400	11	86-800	6
30-500	11	86-1000	6
30-600	11.5	86-1200	6.5

30-700	11.5	86-1400	6.5
30-800	12	86-1600	7
30-900	13	86-1800	7.5
30-1000	13.5		

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	125	1400	18.5
1000	120	1800	17.5

1) x 10^{3}

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). The sigma phase can be redissolved after a heat treatment above 900°C (1650°F).

Welding

The weldability of Alleima® 2C48 is good. Welding must be carried out with preheating at 200-300°C (390-570°F), subsequent heat treatment is not required where Alleima® 2C48 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® 2C48, 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 steel welded joint in a reducing sulphurous atmosphere.

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