SANDVIK

SANDVIK 2C48
TUBE AND PIPE, SEAMLESS

DATASHEET

Sandvik 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

FORMS OF SUPPLY

Seamless tube and pipe in Sandvik 2C48 is supplied in dimensions up to 120 mm outside diameter in the annealed condition, but is also available white-pickled after annealing.

MECHANICAL PROPERTIES

Metric units, at 20°C

Proof strength	Tensile strength	Elong.	Hardness
$R_{p0.2}$ [1)]	R_m	A2"	
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 Sandvik 2C48 is slightly inferior to that of Sandvik 4C54 (ASTM TP446-1).

PHYSICAL PROPERTIES

Density: 7.6 g/cm³, 0.27lb/in³

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

CORROSION RESISTANCE

Air

Sandvik 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, Sandvik 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. Sandvik 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 Sandvik 2C48 promotes the formation of a protective oxide layer on the surface of the material, providing some protection against carburization.

However, because Sandvik 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, Sandvik 253 MA* or Sanicro 31HT.

Metal and salt baths

The ferritic structure of Sandvik 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.

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).

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.

WELDING

Suitable fusion-welding methods are manual metal-arc (MMA) welding with covered electrodes or gas-shielded arc welding, preferably using the TIG and MIG methods.

The welding zone should be preheated to 200–300°C (390–570°F). No post-weld heat treatment is necessary where Sandvik 2C48 is used in structures that operate for prolonged periods at high temperature. For other structures and where heat treatment is considered appropriate, due to design considerations, annealing as described above is recommended.

In cases where there is risk of cracking due to inherent welding stresses, the wire electrodes Sandvik 29.9, Sandvik 25.20.C and Sanicro 72HP can be used.

For manual metal-arc welding, the covered electrodes Sandvik 29.9.R, Sandvik 25.20.B* and Sanicro 71 are recommended.

When using nickel alloy wire electrode Sanicro 72HP and covered electrode Sanicro 71, however, allowance must be made for lower corrosion resistance in a reducing, sulphurous atmosphere.

Also, when using the austenitic wire electrode Sandvik 25.20.C and the covered electrode Sandvik 25.20.B*, the higher thermal expansion for these austenitic electrodes must be considered.

* Contact us for information about this covered electrode.

BENDING

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

When Sandvik 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.

APPLICATIONS

Typical applications for Sandvik 2C48 are:

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

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