Sanicro® 25
Tube and pipe, seamless
Datasheet

Sanicro® 25 is an austenitic 22Cr25NiWCoCu stainless steel material with excellent high temperature properties, designed for use in advanced pulverized coal fired steam boilers. The grade is characterized by:

- Very high creep strength
- High oxidation resistance
- High structural stability
- Good fabricability

Standards

- UNS: S31035
- EN Number: 1.4990
- EN Name: X7NiCrWCuCoNb25-23-3-3-2

Product standards
Seamless tube and pipe: ASTM A213, ASTM A312

Approvals

- European Particular Material Appraisal (PMA)
- VdTÜV material data sheet 555, 23.10.2018
- The American Society of Mechanical Engineers (ASME) Boiler and Pressure
- ASME Code Case 2753-1, Section I and 2752-1, Section VIII Division 1
- China Pressure Vessel Approval CSCBPV BV-ME-210

Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	W	Co	Cu	Nb	N
≤0.1	0.2	0.5	≤0.025	≤0.015	22.5	25	3.6	1.5	3.0	0.5	0.23

Applications

The high creep strength of Sanicro® 25 combined with its good corrosion resistance makes it an extremely suitable option for use in superheaters and reheaters in advanced coal fired power boilers. Use in high temperature applications in other types of steam boilers employing different fuel types is also possible. The

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material has been specifically developed for use at material temperatures up to around 700°C (1300°F).

Corrosion resistance

Hot corrosion

Sanicro® 25 has very good resistance to hot corrosion in a coal ash environment.

Oxidation tests in air, performed as both isothermal tests at 650°C (1202°F) and 750°C (1382°F) for 1000, 2000 and 3000 hours and discontinuous tests with cooling to room temperature after 24, 50, 100, 200, 500, 1000, 1500, 2000 and 3000 hours, show a very low mass rate change.

Oxidation tests in aqueous steam at 600°C (1112°F) and 700°C (1292°F) for 500 and 1000 hours respectively, showed that Sanicro® 25 has very good oxidation resistance.

Bending

The material can be bent at high as well as at low temperatures.

Recommended temperature range for hot bending is 850-1250°C (1560-2280°F) . Following hot bending, solution annealing is needed, unless the bending has been performed at controlled temperatures between 1180°C and 1250°C (2155°F and 2280°F).

Cold-bending should be followed by solution annealing if the cold deformation is >20% or the R/D ratio is ≤2.5, if the service temperature is in the creep range. For best corrosion properties at high temperatures it is recommended that solution annealing should be performed, even at lower degrees of cold forming.

See also the Heat treatment section.

Forms of supply

Sanicro® 25 is supplied as cold pilgered solution annealed and white-pickled seamless tubes, in common reheater and superheater boiler tube dimensions.

The VdTÜV-material datasheet 555, 23.10.2018, applies for outside diameter 25 mm to 114.3 mm and wall thickness 4.5 mm -12.5 mm.

Heat treatment

Tubes are delivered in the heat treated condition. If additional heat treatment is needed due to further processing, the following is recommended.

Solution annealing

1180-1250°C (2155-2280°F) and quenched.

Contact Alleima for advice regarding further heat treatment issues.

Mechanical properties

At 20°C (68°F), annealed condition

Metric units

Proof strength		Tensile strength	Elong.		Hardness Vickers
$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m	A[b]	$A_{2"}$	

MPa	MPa	MPa	%	%	
					approx.
≥310	≥355	≥680	≥40	≥40	185

1 MPa = 1 N/mm^2

Imperial units

Proof strength		Tensile strength	Elong.		Hardness Vickers
$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m	A[b]	$A_{2"}$	
ksi	ksi	ksi	%	%	
					approx.
≥45.0	≥50.0	≥99.0	≥40	≥40	185

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 is the original cross-section area.

At high temperatures, annealed condition

Metric units

Temperature	Proof strength		Tensile strength
	$R_{p0.2}$	$R_{p1.0}$	R_m
°C	MPa	MPa	MPa
	min	min	min
100	250	315	625
200	225	255	575
300	210	240	560
400	200	225	550
500	195	215	535
600	180	205	500
700	180	195	455
800	180	195	355

Imperial units

Temperature	Proof strength		Tensile strength
	$R_{p0.2}$	$R_{p1.0}$	R_m

°F	ksi	ksi	ksi
	min	min	min
200	38.6	45.0	91.1
400	33.0	38.0	84.1
600	29.7	33.9	80.9
800	28.1	31.8	79.2
1000	27.5	30.8	76.4
1200	27.0	29.9	70.1
1400	26.0	28.4	57.9

Impact strength

Due to its austenitic microstructure, Sanicro® 25 has very good impact strength, both at room temperature and at cryogenic temperatures.

Creep rupture strength according to VdTÜV Wb555, 09.2018

Temperature					
°C	°F	10 000 h		100 000 h	
		MPa	ksi	MPa	ksi
500	932	500	72.5	405	58.7
550	1022	380	55.1	325	47.1
600	1112	310	45.0	230	33.4
650	1202	230	33.4	155	22.5
700	1292	145	21.0	95	13.8
750	1382	85	12.3	50	7.3
800	1472	50	7.3	25	3.6

Max allowable stress values according to ASME Code Case 2753-1, Section I and 2752-1, Section VIII Division 1.

Imperial units			Metric units		
Metal temperature, °F	Allowable stress, ksi	Allowable stress, ksi [1)]	Metal temperature, °C	Allowable stress, MPa	Allowable stress, MPa [1)]
75	27.1	27.1	40	184	184
100	27.1	27.1	65	184	184
150	26.9	27.1	100	174	184

200	25.5	27.1	125	167	184
250	24.3	26.9	150	161	181
300	23.4	26.3	175	156	179
350	22.6	25.9	200	152	176
400	22.0	25.5	225	149	174
450	21.4	25.2	250	146	173
500	21.0	25.0	275	143	172
550	20.6	24.8	300	141	171
600	20.3	24.7	325	139	170
650	20.0	24.6	350	138	170
700	19.7	24.5	375	136	169
750	19.5	24.4	400	134	168
800	19.2	24.3	425	133	168
850	18.9	24.2	450	131	167
900	18.7	24.0	475	129	166
950	18.4	23.7	500	128	164
1000	18.2	23.4	525	126	163
1050	17.9	23.0	550	125	160
1100	17.7	22.5	575	123	158
1150	17.5	21.1	600	122	154
1200	16.2	16.2	625	120	140
1250	12.1	12.1	650	111	111
1300	8.9	8.9	675	85.1	85.1
1350	6.5	6.5	700	64.4	64.4
1400	4.9	4.9	725	48.5	48.5
			750	37.1	37.1

[1)] Due to the relatively low yield strength of these materials, in some cases slightly higher stress values in this column were established at temperatures where slightly greater deformation was acceptable. These stress values are not recommended in applications where small amounts of distortion can cause leakage or malfunction.

Stress values shown in italics are obtained from time-dependent data.
The maximum use temperature is 1382°F (750°C).

Physical properties

Density: 8.32 kg/dm^3; 0.29 lb/in^3

Thermal conductivity

Temperature, °C	W/(m °C)	Temperature, °F	Btu/(ft h °F)
20	12	68	7
100	13	100	7
200	15	200	7.5
300	16	400	9
400	18	600	10
500	20	800	11
600	22	1000	12
700	23	1200	13
800	25	1400	14.5
900	27	1600	15.5
1000	28	1800	16.5
1100	30	2000	17.5

Specific heat capacity [1)]

Temperature, °C	J/(kg °C)	Temperature, °F	Btu/(lb °F)
20	470	68	0.11
100	485	100	0.11
200	500	200	0.12
300	520	400	0.12
400	535	600	0.12
500	555	800	0.13
600	570	1000	0.13
700	585	1200	0.14
800	605	1400	0.14
900	620	1600	0.15
1000	640	1800	0.15
1100	665	2000	0.16

1) Mean values

Resistivity

Temperature, °C	µΩm	Temperature, °F	µΩin.
20	0.98	68	38.6

Thermal expansion [1)]

Temperature, °C	Per °C	Temperature, °F	Per °F
30-100	14.5	86-200	8
30-200	1.5.	86-400	8.5
30-300	16	86-600	8.5
30-400	16	86-800	9
30-500	16.5	86-1000	9
30-600	16.5	86-1200	9.5
30-700	17	86-1400	9.5
30-800	17	86-1600	9.5
30-900	17.5	86-1800	10
30-1000	18	86-2000	10
30-1100	18.5		

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

Thermal expansion [1)]

Temperature, °C	Per °C	Temperature, °F	Per °F
100-200	16	200-400	8.5
200-300	16.5	400-600	9
300-400	16.5	600-800	9.5
400-500	17	800-1000	10
500-600	18	1000-1200	10.5
600-700	19	1200-1400	11
700-800	19.5	1400-1600	11
800-900	20	1600-1800	11.5
900-1000	21	1800-2000	12
1000-1100	23.5		

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

Modulus of elasticity [1)]

Temperature, °C	MPa	Temperature, °F	ksi
20	197	68	28.6
100	191	200	27.8
200	183	400	26.5
300	175	600	25.2
400	168	800	24.0
500	160	1000	22.8
600	153	1200	21.6
700	145	1400	20.3
800	137		

1) (x10³)

Welding

The weldability of Sanicro® 25 is good. 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.

In common with all fully austenitic stainless steels, Sanicro® 25 has low thermal conductivity and high thermal expansion. Welding plans should therefore be carefully selected in advance, so that distortions of the welded joint are minimized. If residual stresses are a concern, solution annealing can be performed after welding.

For Sanicro® 25, heat-input of <1.0 kJ/mm and interpass temperature of <100°C (210°F) are recommended. A string bead welding technique should be used.

Recommended filler metals

TIG/GTAW or MIG/GMAW welding

ISO 18274 S Ni 6617/AWS A5.14 ERNiCrCoMo-1 (e.g. Exaton Ni53, Alloy 617 mod)

MMA/SMAW welding

ISO 14172 E Ni 6117/AWS A5.11 ENiCrCoMo-1

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