

Sanicro® 48 for OCTG

Tube and pipe, seamless

Datasheet

Sanicro® 48 is an austenitic nickel-base alloy for highly corrosive OCTG downhole applications. The grade is characterized by:

- Excellent resistance to sulfide stress cracking and stress corrosion cracking (SCC) in chloride and sour (H₂S/Cl) environments
- Very high resistance to pitting and crevice corrosion

Standards

- UNS: N06985

Product standards

Seamless tubes used as casing, tubing and coupling stock: ISO 13680, PSL-1 and PSL-2

API spec 5CRA

Approvals

- NACE MR0175/ISO 15156-3 (Petroleum and natural gas industries - Materials for use in H₂S-containing environments in oil and gas production)
- Sanicro® 48, grade 110 ksi and grade 125 ksi, can be delivered with API-5CRA Monogram (License Number 5CRA-0016)

Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Fe	Mo	Co	Cu	Nb + Ta	W
≤0.015	≤0.5	≤1.00	≤0.02	≤0.01	21.0 - 23.0	18.0 - 21.0	6.5 - 7.5	≤1.0	1.5 - 2.3	≤0.5	≤1.5

Balance Ni

Applications

Sanicro® 48 is used for high strength downhole production tubing, casing, and liners in sour gas wells. This

includes environments with high temperatures, high partial pressures of CO₂ and H₂S, high chloride concentrations, low pH, and the presence of elemental sulfur.

Corrosion resistance

Pitting Corrosion

Sanicro® 48 can withstand high temperatures in aggressive environments without pitting. A recognized method of ranking a material's susceptibility to localized corrosion is by means of the PRE number (Pitting Resistance Equivalent). This PRE number is based on the contents of chromium, molybdenum, tungsten, and nitrogen in the alloy according to the following formula:

$$\text{PRE} = \% \text{Cr} + 3.3 \times (\% \text{Mo} + 0.5 \times \% \text{W}) + 16 \times \% \text{N}$$

A PRE number is the relative measure of a material's ability to resist pitting corrosion in chloride-containing environments. Sanicro® 48 has a minimum PRE number of 45, which confirms its very high resistance to pitting corrosion when chlorides are present.

Critical pitting (CPT) was determined on cold worked Sanicro® 48 in two different test solutions. Specimens representing the tube surface were tested using modified ASTM G150. The temperature of the test solution was started at 20°C, and heated at a rate of 1°C/min. The tests were carried out in a 3M MgCl₂ solution. The assessments were carried out at a potential of +734 mV vs. Ag/AgCl on duplicate specimens for three different tube dimensions.

Ground coupons were tested according to ASTM G150 with the test solution 1M NaCl, a starting temperature of 20°C, and a heating rate of 1°C/min. The potential was +734 mV vs. Ag/AgCl.

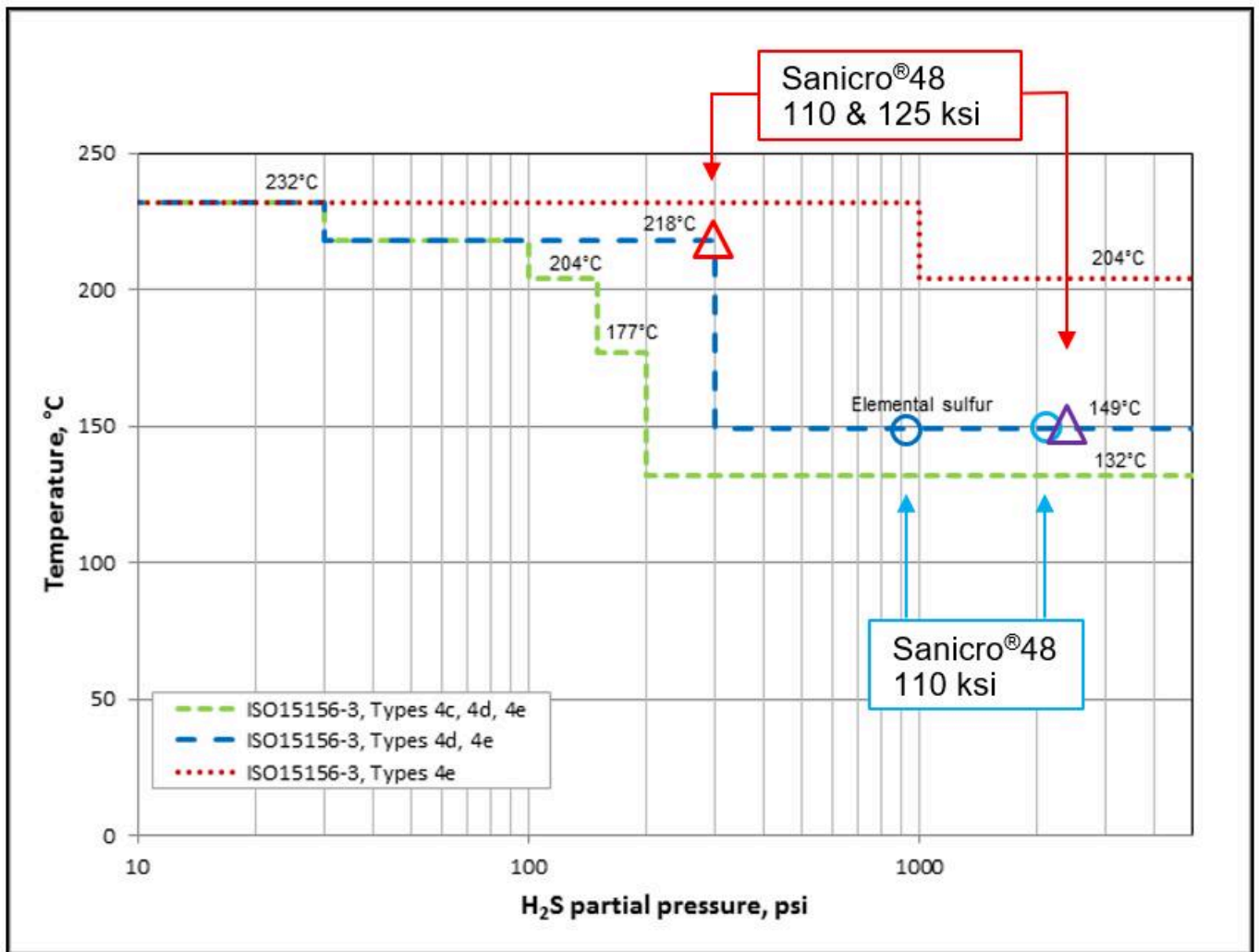
The high CPT measured to 55°C in the more severe test solution of 3M MgCl₂ and 71°C in 1M NaCl solution suggest a very high pitting corrosion resistance of the material in the environments tested.

Stress Corrosion Cracking (SCC)

Environmental assisted cracking, especially in the presence of hydrogen sulfide (H₂S), is one of the more serious forms of corrosion in sour environments. Failure of tubing by environmentally assisted cracking can occur rapidly without any warning. For that reason, the prevention of this form of corrosion must be considered when selecting tubing materials for sour wells.

According to ISO 15156-3 (2020), cold worked Sanicro® 48 belongs to type 4d material which can be safely used in the limited environmental combinations of temperature and H₂S in order to avoid the risk of SCC. Laboratory test data shows that cold worked Sanicro® 48 tube materials are not susceptible to SCC in sour environmental limits covered by 4d materials.

Figure 1 illustrates SCC testing on Sanicro® 48 in Cl-H₂S-CO₂ environments with and without elemental sulfur in comparison with ISO 15156-3 limits for type 4c materials (under the green dashed line), type 4d materials (under the blue dashed line), and type 4e materials (under the red dashed line). The SCC testing has been performed on cold worked Sanicro® 48, minimum yield strength 110 ksi & 125 ksi, using slow strain rate test (SSRT) per NACE TM0198 at a strain rate of 4×10⁻⁶ 1/sec and C-ring per NACE TM0177 method C stressed at 90% of actual yield strength (AYS). Crevice corrosion resistance and corrosion rate by mass loss were also included in the autoclave test for the C-rings. Sanicro® 48 showed good ductility in the tested sour environments without cracking, pitting, or crevice corrosion.



	Temp	R _{p0.2}	ppH ₂ S	ppCO ₂	Chlorides	HCO ₃	Elem. sulfur	SCC SSRT	SCC C-ring (90 d)	Crevice, Corr rate (90 d)
	°C	ksi	psi	psi	mg/l	mg/l	g/l			mm/yr
 A	218	110	300	1 000	180 000	0	0	Pass	÷	÷
 B	218	125	300	1 000	180 000	0	0	Pass	÷	÷
 C	149	110	2 200	1 000	180 000	0	1	Pass	÷	÷

	149	125	2 200	1 000	180 000	0	1	Pass	÷	÷
D										
	143	110	918	357	170 000	140	0	Pass	Pass	<0.001
E										
	149	110	2 061	613	52 000	395	100	Pass	Pass	<0.001
F										

Fabrication

Sanicro® 48 tubes are supplied in cold-worked condition and are primarily intended for use with threaded connections.

Forms of supply

Materials for oil and gas production

Cold hardened (cold worked) seamless tube and pipe

For production tubing, casing, liner, and coupling stock for downhole oil and gas applications, Sanicro® 48 is supplied cold hardened with high strength properties (Sanicro® 48 -110ksi, -125ksi).

Full details on sizes, finishes, and mechanical properties are available on request.

Email: stog.smt@alleima.com

Heat treatment

Tubes for downhole oil and gas applications are delivered in the high strength, cold hardened condition. They are not annealed after cold working.

Mechanical properties

At 20°C (68°F), metric and imperial units

Grade	Proof strength, $R_{p0.2}^{a)}$		Tensile strength, R_m		Elong.	Hardness
	MPa	ksi	MPa	ksi	A_2 , %	HRC
PSL-1 Sanicro® 48-110	760-965	110-140	≥795	≥115	≥11	≤35
PSL-1 Sanicro® 48-125	860-1035	125-150	≥895	≥130	≥10	≤37
PSL-2 Sanicro®	760-965	110-140	≥795	≥115	≥11	≤35

48-110

PSL-2 Sanicro® 48-125	860-1035	125-150	≥895	≥130	≥10	≤37
-----------------------------	----------	---------	------	------	-----	-----

1 MPa = 1 N/mm²
a) R_{p0.2} corresponds to 0.2% offset yield strength.

At high temperatures

Cold-worked Sanicro® 48 also displays very good mechanical properties at higher temperatures. Further information is available on request. Email:stog.smt@alleima.com

Temperature, °C	De-rating factor*	Temperature, °F	De-rating factor*
20	1.00	68	1.00
100	0.95	200	0.95
120	0.93	250	0.93
150	0.92	300	0.92
180	0.91	350	0.91
220	0.90	400	0.90

(*) Approximate yield strength at temperature is received by multiplying the corresponding de-rating factor and yield strength at 20°C (68°F). The de-rating factors represent typical values and should not be used as the sole basis for design verification. For more detailed material property data at specific operating temperatures, please contact Alleima.”

Impact strength

Due to its austenitic microstructure, Sanicro® 48 has very good impact strength, both at room temperature and at lower temperatures. Tests have demonstrated that the alloy readily fulfills the requirements in accordance with ISO 13680 and API Spec 5CRA.

Physical properties

Physical properties of cold-worked Sanicro® 48.

Density: 8.21 g/cm³, 0.297 lb/in³

Relative magnetic permeability

1.003 (approximate value)

Thermal conductivity

Metric units		Imperial units	
Temperature, °C	W/(m °C)	Temperature, °F	Btu/(ft h °F)

20	10	68	5.6
50	10	100	5.8
100	11	200	6.4
150	12	300	7.0
200	13	400	7.5
250	14	500	8.1
300	15	600	8.7

Specific heat capacity

Metric units		Imperial units	
Temperature, °C	J/(kg °C)	Temperature, °F	Btu/(lb °F)
20	435	68	0.10
50	443	100	0.11
100	457	200	0.11
150	468	300	0.11
200	478	400	0.11
250	488	500	0.12
300	497	600	0.12

Modulus of elasticity ¹⁾

Metric units		Imperial units	
Temperature, °C	MPa	Temperature, °F	ksi
20	195	68	28
100	195	200	28
150	195	300	28
220	195	400	28

¹⁾ (×10³)

Poisson's ratio

The Poisson's ratio is 0.31 for Sanicro® 48 at room temperature.

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.