Sanicro® 42 for OCTG

Tube and pipe, seamless

Datasheet

Sanicro® 42 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 sour and chloride (H_2S/Cl^-) environments
- Good resistance to pitting and crevice corrosion

Standards

- UNS: N08825

Product standards

Seamless tubes used as casing, tubing and coupling stock:

- ISO 13680, PSL-1, PSL-2
- API 5CRA, PSL-1, PSL-2

Approvals

- NACE MR0175/ISO 15156-3 (Petroleum and natural gas industries – Materials for use in H_2S-containing environments in oil and gas production)
- Sanicro® 42, 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	Ni	Mo	Ti	Cu	Al	Fe
≤0.05	≤0.5	≤1.0	≤0.03	≤0.03	22	44	3.1	0.8	1.7	≤0.2	≥22

Applications

Sanicro® 42 is used for high strength downhole production tubing, casing, and liners in sour oil and gas wells. This includes environments with high temperatures, high partial pressures of CO_2 and H_2S, high chloride concentrations, low pH and also presence of elemental sulfur.

Corrosion resistance

Pitting Corrosion

Sanicro® 42 can withstand high temperatures in aggressive environments. 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:
PRE = %Cr + 3.3 × (%Mo + 0.5 × %W) + 16 × %N

A PRE number is the relative measure of a material's ability to resist pitting corrosion in chloride-containing environments. Sanicro® 42 has a minimum PRE number of 32, which confirms its good resistance to pitting corrosion when chlorides are present.

Critical pitting temperature (CPT) was determined on cold worked Sanicro® 42. Ground coupons were tested according to ASTM G150 with the test solution 1M NaCl, a starting temperature of 20°C and heating rate of 1 °C/min. The assessments were carried out at a potential of +734 mV vs. Ag/AgCl on triplicate specimens for the tube dimension 5½ in 20 ppf. The CPT was measured to 44 °C which proves its pitting corrosion resistance and its advantage in the tested environment compared to many other brand specifications of Alloy 825 (UNS N08825).

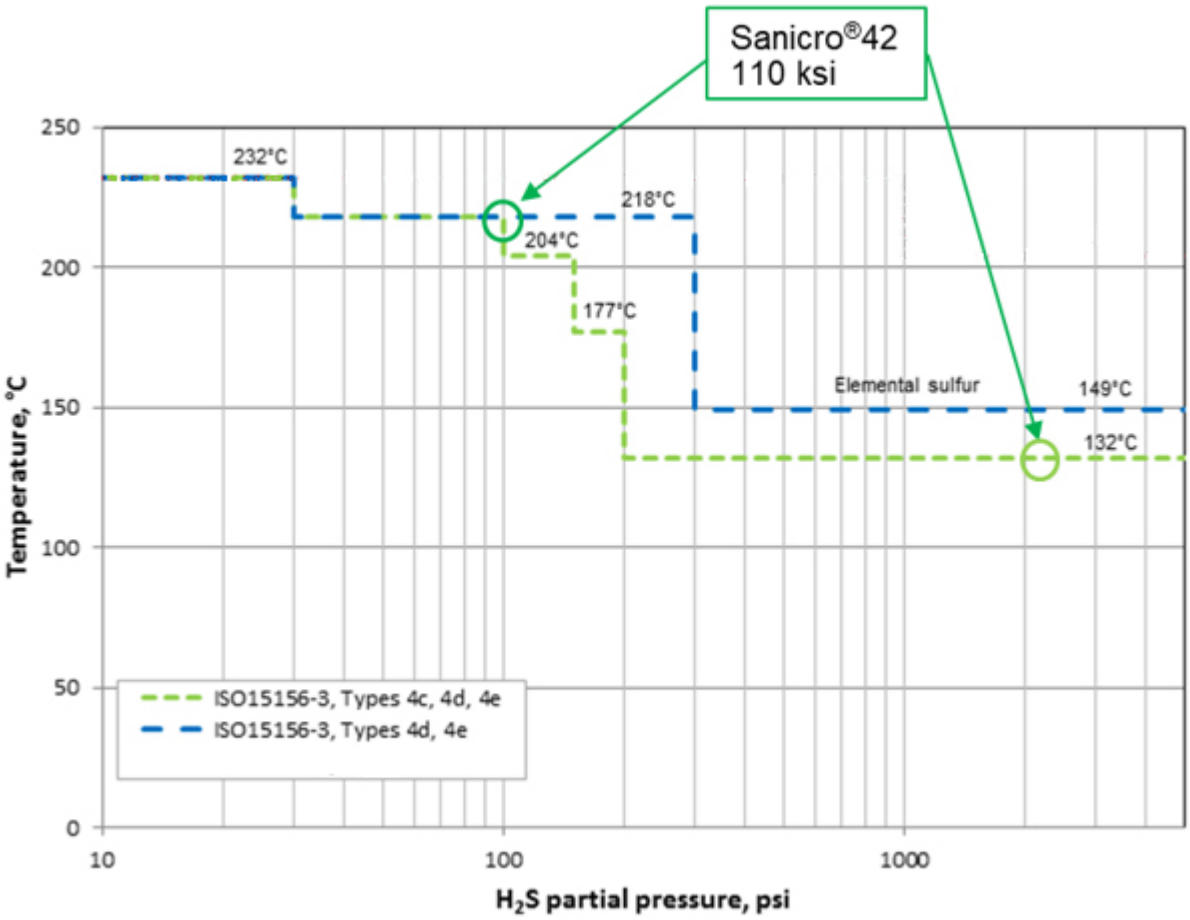
Stress Corrosion Cracking (SCC)

The resistance to stress corrosion cracking is vital for applications such as OCTG where the tubes frequently are exposed to sour environments with presence of hydrogen sulfide (H_2S). Sanicro® 42 is optimized within the specifications for Alloy 825 (UNS N08825) to a superior resistance to SCC.

According to ISO 15156-3 (2020), cold worked Sanicro® 42 belongs to type 4c material which can be safely used in the limited environmental combinations of temperature and H_2S in order to avoid the risk of SCC.

Laboratory test data shows that cold worked Sanicro® 42 tube materials are not susceptible to SCC in sour environmental limits covered by 4c materials.

Figure 1 illustrates SCC testing on Sanicro® 42 in Cl-H_2S-CO_2 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® 42 , minimum yield strength 110 ksi, using slow strain rate test (SSRT) per NACE TM0198 at strain rate of 4×10^{-6} 1/sec. Sanicro® 42 showed good ductility in the tested sour environments without secondary cracking.



	Temp (°C)	Temp (°F)	$R_{p0.2}$ (ksi)	ppH_2S (psi)	$ppCO_2$ (psi)	Chlorides (mg/l)	Elem.sulfur (g/l)	SCC SSRT
1	218	424	110	100	1000	180 000	0	Pass
2	132	270	110	2 200	1000	180 000	1	Pass

Fabrication

Sanicro® 42 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® 42 is supplied cold hardened with high strength properties. (Sanicro® 42 -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		Tensile strength		Elong.	Hardness
	$R_{p0.2}$ [a)]		R_m		$A_{2"}$	HRC
	MPa	ksi	MPa	ksi	%	
			min	min	min	max
PSL-1 Sanicro® 42-110	760 - 965	110 – 140	795	115	11	35
PSL-1 Sanicro® 42-125	860 - 1035	125 – 150	895	130	10	37
PSL-2 Sanicro® 42-110	760 - 965	110 - 140	795	115	11	35
PSL-2 Sanicro® 42-125	860 - 1000	125 - 145	895	130	10	35

1 MPa = 1 N/mm^2
a) $R_{p0.2}$ correspond to 0.2% offset yield strength.

At high temperatures

Cold-worked Sanicro® 42 also displays very good mechanical properties at higher temperatures. Further information is available on request. Email:stog.smt@alleima.com

Metric units Imperial units

Temperature, °C	De-rating factor*	Temperature, °F	De-rating factor*
20	1.00	68	1.00
100	0.97	200	0.97
120	0.97	250	0.97
150	0.96	300	0.96
180	0.96	350	0.96
220	0.95	400	0.95

*) Approximate yield strength at temperature is received by multiplying the corresponding de-rating factor and yield strength at 20°C (68°F).

Impact strength

Due to its austenitic microstructure, Sanicro® 42 has very good impact strength, both at room temperature and at lower temperatures. Tests have demonstrated that the nickel-base alloy readily fulfills the requirements in accordance with ISO 13680 and API Spec 5CRA.

Physical properties

Physical properties of cold-worked Sanicro® 42.

Density: 8.00 g/cm^3, 0.289 lb/in^3

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	5.8
50	11	100	6.0
100	12	200	6.7
150	13	300	7.3
200	14	400	8.0
250	15	500	8.5
300	15	550	8.8

Specific heat capacity

Metric units		Imperial units	
Temperature, °C	**J/kg °C**	**Temperature, °F**	**Btu/lb °F**
20	455	68	0.11
50	462	100	0.11
100	474	200	0.11
150	485	300	0.12
200	495	400	0.12
250	505	500	0.12
300	514	550	0.12

Thermal expansion [1)]

	Per °C	Temperature, °F	Per °F
30-50	14.1	86-100	7.6
30-75	14.3	86-150	7.9
30-100	14.5	86-200	8.0
30-125	14.7	86-250	8.1
30-150	14.7	86-300	8.2
30-175	14.8	86-350	8.2
30-200	14.9	86-400	8.3
30-225	15.0	86-450	8.4
30-250	15.1	86-500	8.4
30-275	15.2	86-550	8.5
30-300	15.3		

1) Mean values in temperature ranges ($\times 10^{-6}$), measured on annealed material

Modulus of elasticity [1)]

Metric units		Imperial units	
Temperature, °C	**MPa**	**Temperature, °F**	**ksi**
20	186	68	27
100	186	200	27
150	186	300	27
220	186	400	27

1) ($\times 10^{3}$)

Poisson's ratio

The Poisson's ratio is 0.31 for Sanicro® 42 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.

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