

# SAF™ 2205 for OCTG

## Tube and pipe, seamless

### Datasheet

SAFTM 2205 is a duplex (austenitic-ferritic) stainless steel for OCTG downhole applications.

The grade is characterized by:

- High resistance to stress corrosion cracking (SCC) in chloride-bearing environments
- Moderate resistance to SCC in sour (H<sub>2</sub>S/Cl-) environments
- High resistance to general corrosion, pitting, and crevice corrosion
- High mechanical strength – roughly twice the proof strength of austenitic stainless steel
- UNS: S31803, S32205
- EN Number: 1.4462
- ISO: 4462-318-03-I

#### Product standards

Seamless tubes used as casing, tubing and coupling stock:

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

#### Approvals

- NACE MR0175/ISO 15156 (Petroleum and natural gas industries - Materials for use in H<sub>2</sub>S-containing Environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion resistant alloys and other alloys) (Published:2015)
- SAF 2205 grade 65 ksi, 110 ksi, and 125 ksi, (PSL-1 or PSL-2) and grade 140 ksi (PSL-1) 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	N
≤0.03	≤1.0	≤2.0	≤0.03	≤0.015	22	0.18	3.2	0.18

### Applications

SAF™ 2205 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 CO<sub>2</sub> and H<sub>2</sub>S, and high chloride concentrations. The material is suitable for use in production tubing and flowlines for the extraction of oil and gas from sour wells, in refineries and in process solutions contaminated with chlorides.

The high strength of SAF™ 2205 makes the material an attractive alternative to the austenitic steels in structures subjected to heavy loads.

## Corrosion resistance

### Pitting Corrosion

SAF™2205 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 and nitrogen in the alloy according to the following formula:

$$PRE = \%Cr + 3.3 \times \%Mo + 16 \times \%N$$

A PRE number is the relative measure of a material's ability to resist pitting corrosion in chloride containing environments. The PRE number for SAF™ 2205 is compared with other materials in the following table:

Grade	% Cr	% Mo	% N	PRE
SAF 2205	22	3.2	0.18	>35
UNS S31803	21.0 - 23.0	2.50 - 3.50	0.08 - 0.20	>30
Alloy 825	20	2.6	-	29
ASTM TP317L	18	3.5	-	30
ASTM TP316L	17	2.2	-	24

SAF™ 2205 has a minimum PRE number of 35, which confirms its high resistance to pitting corrosion when chlorides are present.

### Stress Corrosion Cracking (SCC)

The standard austenitic steels ASTM TP304L and ASTM TP316L are prone to stress corrosion cracking (SCC) in chloride-bearing solutions at temperatures above 60°C (140°F).

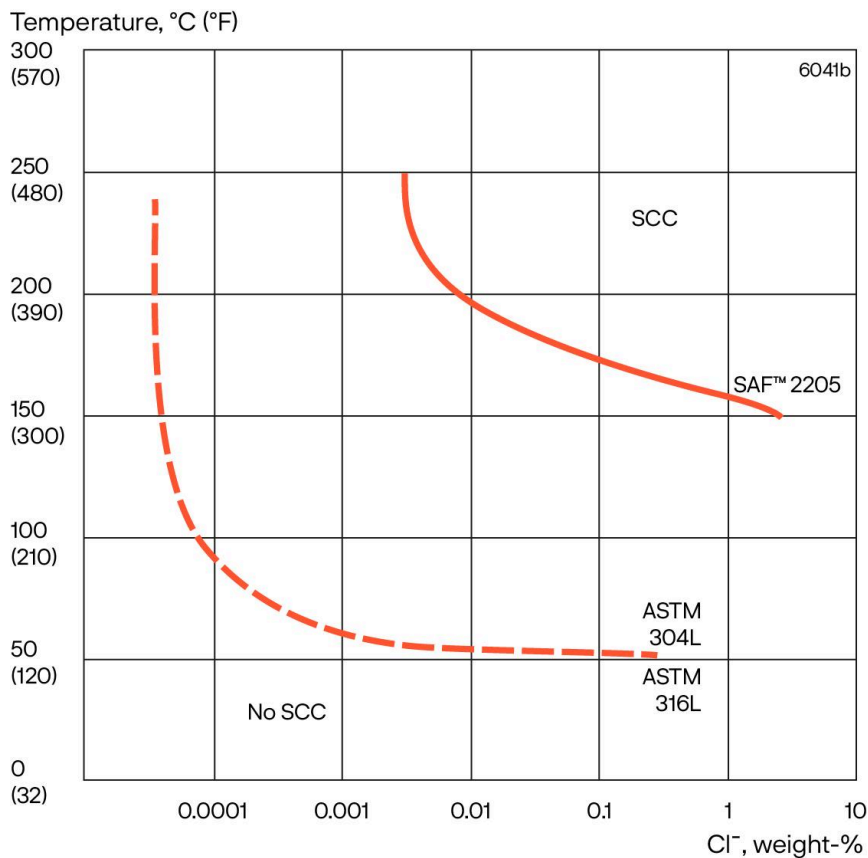


Figure 7. Resistance to stress corrosion cracking (SCC) in neutral chloride solutions with an oxygen content of about 8 ppm. Laboratory results for SAF™ 2205 of constant load specimens loaded to the proof strength at the test temperature.

Duplex stainless steels are far less prone to this type of corrosion. Laboratory tests reveal good resistance to stress corrosion cracking of SAF™ 2205. Results from the tests are presented in Figure 7. The diagram indicates the temperature-chloride range within which SAF™ 2205 and the standard steels ASTM TP304L and ASTM TP316L have low susceptibility to stress corrosion cracking.

## Fabrication

SAF™ 2205 tubes are supplied in the cold worked condition and are 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, SAF™ 2205 is supplied solution annealed (65 ksi) or cold hardened with high strength properties. (110 ksi, 125 ksi, 140 ksi).

Full details on sizes, finishes and mechanical properties are available on request. Email: [stog.smt@alleima.com](mailto:stog.smt@alleima.com)

## Mechanical properties

At 20°C (68°F)

### Metric and imperial units

Grade	Proof strength		Tensile Strength		Elongation	Hardness
	$R_{p0.2}^{a)}$		$R_m$		$A_{2''}$	HRC
	MPa	ksi	MPa min	ksi min	% min	% max
PSL-1 SAF2205-65	448 - 621	65 - 90	621	90	25	26
PSL-1 SAF2205-110	758 - 965	110 - 140	862	125	11	36
PSL-1 SAF2205-125	862 - 1034	125 - 150	896	130	10	37
PSL-1 SAF2205-140	965 - 1103	140 - 160	1000	145	9	38
PSL-2 SAF2205-65	448 - 621	65 - 90	621	90	25	26
PSL-2 SAF2205-110	758 - 965	110 - 140	862	125	11	36
PSL-2 SAF2205-125	862 - 1000	125 - 145	896	130	10	36

1 MPa = 1 N/mm<sup>2</sup>

a)  $R_{p0.2}$  corresponds to 0.2% offset yield strength.

### At high temperatures

SAF™ 2205 shows very good mechanical properties at higher temperatures. Further information is available on request. Email: [stmo.smt@alleima.com](mailto:stmo.smt@alleima.com)

### Metric units / Imperial units

Temperature °C	De-rating factor*	Temperature °F	De-rating factor*
20	1.00	68	1.00
50	0.85	122	0.85
100	0.74	212	0.74
150	0.69	302	0.69
200	0.63	392	0.63

## Physical properties

Density, at 7.8 g/cm<sup>3</sup>, 0.28 lb/in<sup>3</sup>

Thermal conductivity

Metric units

Temperature,°C	20	100	200	300	400
	W/(m °C)				
SAF™ 2205	14	16	17	19	20
ASTM TP316L	14	15	17	18	20

Imperial Units

Temperature,°F	68	200	400	600	800
	Btu/(ft h °F)				
SAF™ 2205	8	9	10	11	12
ASTM TP316L	8	9	10	10	12

Specific Heat Capacity

Metric units

Temperature,°C	20	100	200	300	400
	J/(kg °C)				
SAF™ 2205	480	500	530	550	590

Imperial Units

Temperature,°F	68	200	400	600	800
	Btu/(lb °F)				
SAF™ 2205	0.11	0.12	0.13	0.13	0.14

Thermal Expansion

Metric units, x10<sup>-6</sup>/°C

Temperature, °C	30-100	30-200	30-300	30-400
	Per °C			
SAF™ 2205	13.0	13.5	14.0	14.5
Carbon steel	12.5	13.0	13.5	14.0
ASTM TP316L	16.5	17.0	17.5	18.0

Imperial units, x10<sup>-6</sup>/°F

Temperature, °F	86-200	86-400	86-600	86-800
	Per °F			
SAF™ 2205	7.0	7.5	8.0	8.0
Carbon steel	6.8	7.0	7.5	7.8
ASTM TP316L	9.0	9.5	9.8	10.0

Resistivity

Metric units

Temperature, °C	20	100	200	300
	μΩm			
SAF™ 2205	0.74	0.85	0.96	1.00

Imperial units

Temperature, °F	68	200	400	600
	μΩin			
SAF™ 2205	29.1	33.1	39.8	43.3

Modulus of elasticity

Metric units, x10<sup>3</sup>

Temperature, °C	20	100	200	300
	MPa			
SAF™ 2205	200	194	186	180

Imperial units, x10<sup>3</sup>

Temperature, °F	68	200	400	600
	ksi			
SAF™ 2205	29.0	28.2	27.0	26.2

Impact Strength

SAF™ 2205 possesses good impact strength both at room temperature and at low temperatures, as is evident from Figure 1. The values apply for standard Charpy-V specimens (10 x 10 mm, 0.39 x 0.39 in.).

# CVN Impact strength

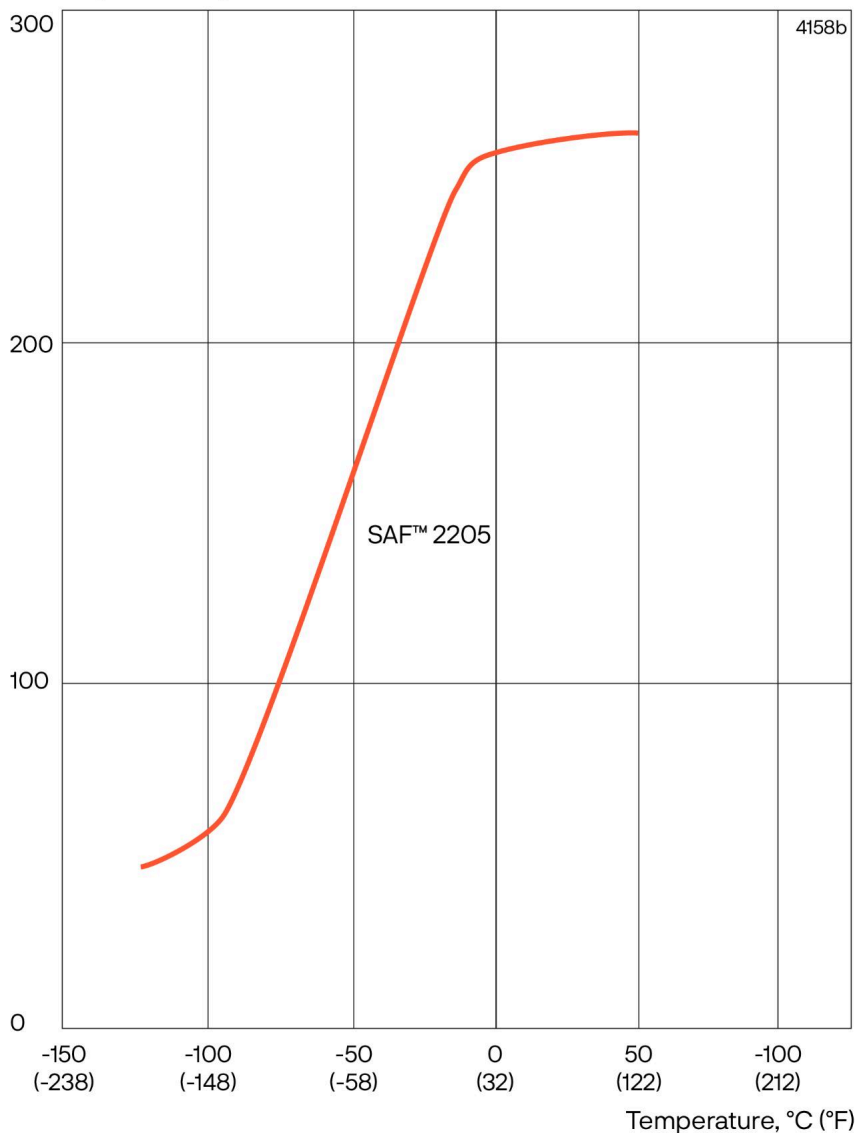


Figure 1. Curve showing typical impact strength values (Charpy-V) for SAF 2205. Specimen size 10x10mm (0.39 x 0.39 in.).

## 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.