Alleima

SAF 2205™+

Bar

Datasheet

SAF™ 2205+ is a duplex (austenitic-ferritic) stainless steel with excellent material cleanliness, for highly demanding applications. The grade is characterized by:

- Alignment to IOGP S-563 and ISO 17781 standards
- Decreased phosphorous and sulfur content to match higher demanding applications
- High resistance to stress corrosion cracking (SCC) in chloride-bearing environments
- High resistance to stress corrosion cracking (SCC) in environments containing hydrogen sulphide
- High resistance to general corrosion, pitting and crevice corrosion
- High mechanical strength – roughly twice the proof strength of austenitic stainless steels
- Good hot-working properties
- High resistance to erosion corrosion and corrosion fatigue
- Physical properties that offer design advantages
- Good weldability

Standards

- UNS: S31803, S32205
- EN Number: 1.4462
- W.Nr.: 1.4462

Product standards

- IOGP S-563:2018
- ISO 17781:2017
- EN 10088-3, EN 10088-5 (dimensions up to 160 mm), EN 10272, EN 10222-5,

Datasheet last updated 2023-11-09 14:38:55 (supersedes all previous editions)

– ASTM A479, ASTM A276,
– NORSOK MDS D47 Rev 3, Rev 4, Rev 5
– Chemical composition and mechanical properties acc. to ASTM A182

Approvals

– Pressure Equipment Directive (PED 2014/68/EU)
– NORSOK M650 Ed. 4, NORSOK M630 Ed. 6, dimensions up to 260 mm.
– DNV, dimensions up to 300 mm
– Pre-approval for PMA

Certificate

– Status according to EN 10204/3.1

Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.030	≤1.0	≤2.0	≤0.020	≤0.010	22.5	5.5	3.2	0.18

Applications

Due to its excellent corrosion properties, SAF™ 2205+ is a highly suitable material for service in environments containing chlorides and hydrogen sulfide. The material is suitable for use in flowlines for the extraction of oil and gas from sour wells, in refineries and in-process solutions contaminated with chlorides. SAF™ 2205+ is particularly suitable for chloride-bearing water or brackish water is used as a cooling medium. The steel is also suitable for use in dilute sulphuric acid solutions and for the handling of organic acids, e.g. acetic acid and mixtures.

– The high strength of SAF™ 2205+ makes the material an attractive alternative to austenitic steels in structures subject to heavy loads.
– The good mechanical and corrosion properties make SAF™ 2205+ an economical choice in many applications by reducing the life cycle cost of the equipment.

Corrosion resistance

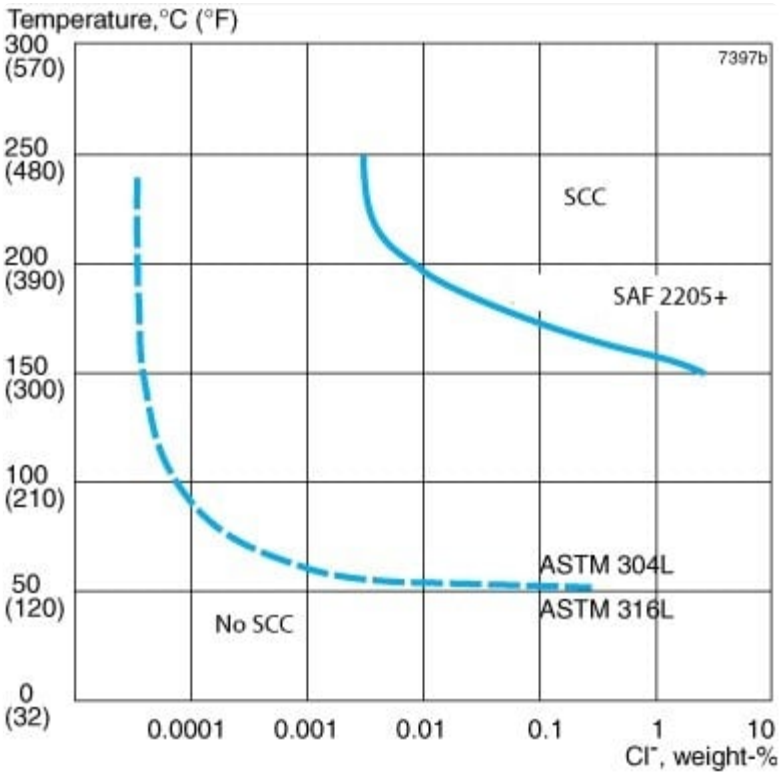
Datasheet last updated 2023-11-09 14:38:55 (supersedes all previous editions)

General corrosion

In most media, SAF™ 2205+ possesses better resistance to general corrosion than steel of type ASTM 316L and ASTM 317L. Impurities that increase corrosivity are often present in process solutions of acids. If there is a risk of active corrosion, higher-alloyed austenitic stainless steels should be chosen, e.g. Alleima® 2RK65 or Sanicro® 28.

Stress corrosion cracking

The standard austenitic steels of the ASTM 304L and ASTM 316L types are prone to stress corrosion cracking (SCC) in chloride-bearing solutions at temperatures above 60°C (140°F). Duplex stainless steels are far less prone to this type of corrosion. Laboratory tests have shown good resistance to stress corrosion cracking of SAF™ 2205+. Results from these tests are presented in fig. 3. The diagram indicates the temperature-chloride range within which SAF™ 2205+, the standard steels ASTM 304L and ASTM 316L can be used without risk of stress corrosion cracking.



Forms of supply

- Bar
- Finishes and dimensions:
  Bar steel in grade SAF™ 2205+ is stocked in a number of sizes. The standard size range for stock comprises 75-260mm (selected dimensions). Round bar is supplied in the solution annealed and quenched and peel-turned condition.
- Lengths
  Bars are delivered in random lengths of 3-7 m, depending on diameter.

Straightness

75 – 260mm	1 mm/m

Tolerances

Diameter, mm	Tolerances, mm
75-260	-0/+1.50

Surface condition

	Ra, µm, typical values	Diameter, mm
Peeled and burnished	1	75-200
Peel turned	2	>205 - 260

Heat treatment

SAF™ 2205+ stock program bars are delivered in the solution annealed and quenched condition.

Solution annealing

Solution annealing at 1020 – 1100°C (1870 – 2010°F) followed by quenching.

Mechanical properties

The following values apply to material in the solution annealed and quenched condition up to bar stock size 260mm.

At 20°C (68°F)

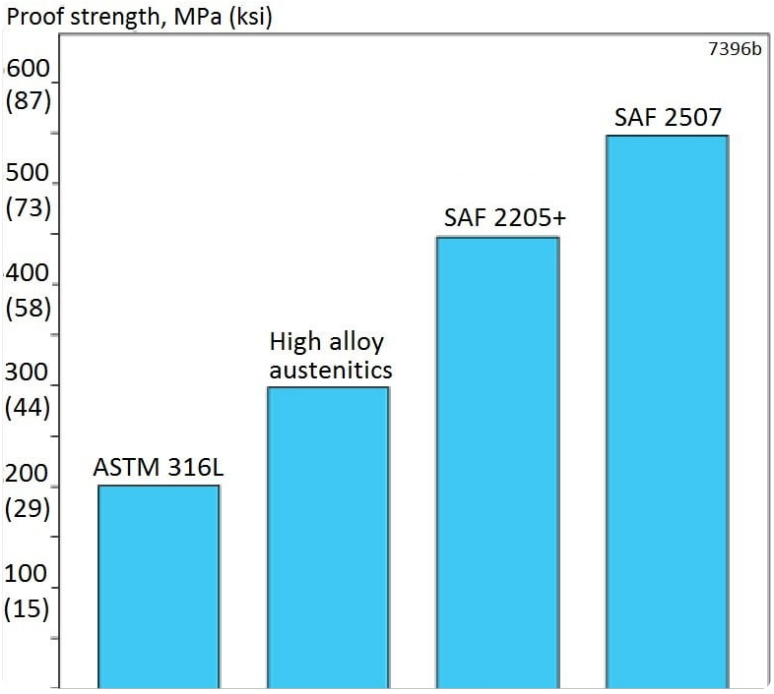
Metric units

Proof strength		Tensile strength	Elong.	Hardness
$R_{p0.2}$[a)]	$R_{p1.0}$[a)]		A[b)]	Brinell
MPa	MPa	MPa	%	
≥450	≥500	660-860	≥25	≤270

Imperial units

Proof strength		Tensile strength	Elong.	Hardness
$R_{p0.2}$[a)]	$R_{p1.0}$[a)]		A[b)]	Brinell
ksi	ksi	ksi	%	
≥65	≥73	96-125	≥25	≤270

1 MPa = 1 N/mm ^{2}
a) $R_{p0.2}$ and $R_{p1.0}$ correspond to 0.2% offset and 1.0% offset yield strength respectively.
b) Based on $L_0 = 5.65\sqrt{S}$, where L_0 is the original gauge length and S_0 the original cross-sectional area.



Impact strength

SAF™ 2205+ possesses good impact strength both at room temperature and at low temperatures. Fig. 2 shows typical impact energy values for SAF™ 2205+ bars in different sizes at -50°C (-58°F). The values apply for

standard Charpy-V specimens (10 x 10 mm, 0.39 x 0.39 in.) taken in the longitudinal direction of the bar. For dimensions larger than 260 mm (10.2 in.) the impact strength is somewhat lower.

SAF™ 2205+ bar stock program guarantees an impact strength of 70 J (52 ft-lb) at -50°C (-58°F) for dimensions up to 260 mm (10.2 in.). Over 260 mm (10.2 in.), values for information only.

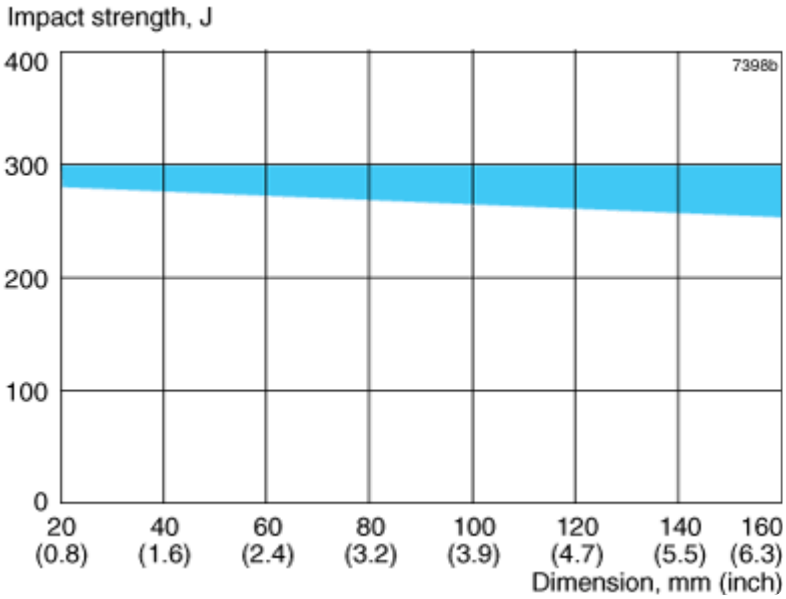


Figure 2. Typical impact strength values for Sandvik SAF 2205™+ bar at -50°C (-58°F).

At high temperatures

If SAF™ 2205+ is exposed for prolonged periods to temperatures exceeding 280 °C (540 °F), the microstructure changes which results in a reduction in impact strength. This effect does not necessarily affect the behavior of the material at the operating temperature. Contact Alleima for advice. For pressure vessel applications, 280°C (540°F) is required as a maximum.

Temp.	Proof Strength	Temp.	Proof Strength
	$R_{p0.2}$		$R_{p0.2}$
°C	MPa	°F	ksi
	min.		min.
100	360	200	52
150	335	300	49
200	315	400	46
250	300	500	44

Physical properties

Density: 7.8 g/cm^3, 0.28 lb/in^3

Specific heat capacity

Temperature, °C	J/(kg °C)	Temperature, °F	Btu/(lb °F)
20	480	68	0.11
100	500	200	0.12
200	530	400	0.13
300	550	600	0.13
400	590	800	0.14

Thermal conductivity

Metric units

Temperature,°C	20	100	200	300	400
	W/(m °C)				
SAF™ 2205+	14	16	17	19	20
ASTM 316L	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 316L	8	9	10	10	12

Thermal expansion, mean values in temperature ranges (x10^{-6})

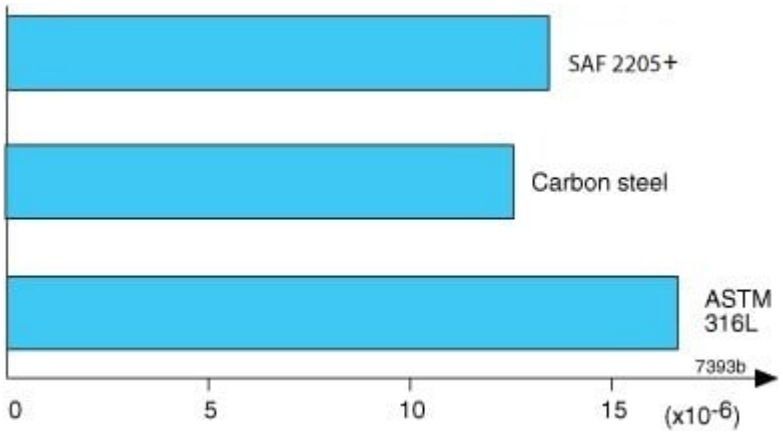
Metric units

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 316L	16.5	17.0	17.5	18.0

Imperial units

Temperature, °F	**86-200**	**86-400**	**86-600**	**86-800**
	Per °F			
SAF™ 2205+	7.0	7.5	7.8	8.0
Carbon steel	6.8	7.0	7.5	7.8
ASTM 316L	9.0	9.5	9.8	10.0



Resistivity

Temperature, °C	**µΩm**	**Temperature, °F**	**µΩin.**
20	0.74	68	29.1
100	0.85	200	33.1
200	0.96	400	39.8
300	1.00	600	43.3
400	1.10	800	43.3

Modulus of elasticity (x10^3)

Temperature, °C	**MPa**	**Temperature, °F**	**ksi**
20	200	68	29.0
100	194	200	28.2
200	186	400	27.0
300	180	600	26.2

Welding

The weldability of SAF™ 2205+ is good. Welding must be carried out without preheating. Subsequent heat

treatment is normally not required. 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.

For SAF™ 2205+ heat-input of <2.5 kJ/mm and interpass temperature of <150°C (300°F) are recommended.

Recommended filler metals:

TIG/GTAW or MIG/GMAW welding

ISO 14343-A W/G 22 9 3 N L / AWS A5.9 ER2209 (e.g. Exaton 22.8.3.L)

MMA/SMAW welding

ISO 3581-A E 22 9 3 N L R / AWS A5.4 E2209-17 (e.g. Exaton 22.9.3.LR)

For welds exposed to particularly severe environments more resistant welding consumables are recommended:

TIG/GTAW or MIG/GMAW welding

ISO 14343-A W/G 25 9 4 N L / AWS A5.9 ER2594 (e.g. Exaton 25.10.4.L)

MMA/SMAW welding

ISO 3581-A E 25 9 4 N L R / AWS A5.4 E2594-16 (e.g. Exaton 25.10.4.LR)

Machining

The machining of SAF™ 2205+, as with other stainless steels, requires an adjustment of tooling data and machining method in order to achieve satisfactory results. Compared to Sanmac® 2205, the cutting speed must be reduced when turning SAF™ 2205+ with coated cemented carbide tools. The same applies to most other cutting operations. Feed should only be modified slightly and with caution.

The table below shows the ranges within which you can choose cutting data to obtain a tool life of 7 minutes in the duplex material SAF™ 2205+. The diagram is applicable for short cutting times. For long, continuous cuts, the cutting speeds should be slightly reduced.

Recommended insert and cutting data for turning SAF™ 2205+

Insert			Cutting data				Application
Geometry	Grade	Insert	Feed		Cutting speed		
			mm/rev.	in./rev.	m/min	ft/min	
MF	GC2015	SNMG 120404-MF	0.15	0.006	180	590	Finishing
MM	GC2025	SNMG 120408-MM	0.25	0.010	100	330	Medium machining

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.

Datasheet last updated 2023-11-09 14:38:55 (supersedes all previous editions)