SAF®2507
Bar
Datasheet

SAF®2507 is a high alloy duplex (austenitic-ferritic) stainless steel for service in highly corrosive conditions.

Grade characteristics

Excellent

- Resistance to stress corrosion cracking in chloride-bearing environments
- Resistance to pitting and crevice corrosion

Very high

- Mechanical strength

High

- Resistance to general corrosion
- Resistance to erosion corrosion and corrosion fatigue

Good

- Weldability

Material designations

- UNS: S32750
- EN Number: 1.4410
- EN Name: X2CrNiMoN25-7-4

Standards

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Datasheet last updated 8/30/2024 8:49:55 AM (supersedes all previous editions)

Product standards

- ASTM A-479 / ASME SA-479
- ASTM A-276 / ASME SA-276
- EN 10088-3
- NORSOK M-630 Rev.6, MDS D57 Rev.5
  D >200-250 mm (D >7.87"-9.84").
- NACE MR0175 / ISO 15156-3
- NACE MR0103 / ISO 17945-1

Chemical composition and mechanical properties only

- EN 10222-5
- EN 10272
- ASTM A-182 / ASME SA-182

Approvals

- Pressure Equipment Directive / PED (2014/68/EU)
- Pre-approval for PMA
- ISO17782:2018, NORSOK M650 Ed. 4
- DNV approved manufacturer

Climate change impact

Carbon footprint / CO2e data (kg/ton) and Life Cycle Assessment report is available for these products in the range of D >200-250 mm (D >7.87"-9.84").

Material Test Certificate

- According to EN 10204/3.1

Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu
≤0.030	≤0.8	≤1.2	≤0.035	≤0.015	25	7	4	0.3	≤0.5

Chemical composition (nominal) %

	C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu
SAF 2507	≤0.030	≤0.8	≤1.2	≤0.035	≤0.015	25	7	4	0.3	≤0.5

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Applications

SAF®2507 is a duplex stainless steel specially designed for service in aggressive chloride-containing environments. Typical applications are:

- Oil and gas industry
- Seawater cooling
- Salt evaporation industry
- Desalination plants
- Geothermal wells
- Refineries and petrochemical plants
- Mechanical components requiring high strength
- Pulp and paper industry

Corrosion resistance

General corrosion

SAF®2507 is highly resistant to corrosion by organic acids, e.g. formic and acetic acid. It is suitable for use at high concentrations and temperatures, where austenitic stainless steels corrode at a high rate.

Resistance to inorganic acids is comparable to that of high alloy austenitic stainless steels in certain concentration ranges.

Stress corrosion cracking

SAF®2507 has excellent resistance to chloride-induced stress corrosion cracking.

Pitting and crevice corrosion

The pitting and crevice corrosion resistance of a stainless steel is primarily determined by the content of chromium, molybdenum and nitrogen. An index for comparing the resistance to pitting and crevice corrosion is the PRE number (Pitting Resistance Equivalent).

The PRE is defined as, in weight-% PRE = %Cr + 3.3 x %Mo + 16 x %N

For duplex stainless steels the pitting corrosion resistance is dependent on the PRE-value in both the ferrite phase and the austenite phase, so that the phase with the lowest PRE-value will be limiting for the actual pitting corrosion resistance. In SAF®2507 the PRE-value is equal in both phases, which has been achieved by a careful balancing of the elements.

The minimum PRE-value for SAF®2507 is 41. This is significantly higher than e.g. the PRE-values for other duplex stainless steels of the 25Cr type which are not "super-duplex". As an example UNS S31260 (25Cr3Mo0.2N) has a PRE-value of typically 38.

One of the most severe pitting and crevice corrosion tests applied to stainless steel is ASTM G48, i.e., exposure to 6% $FeCl_3$ with and without crevices (method A and B respectively). When pits are detected following a 24 hours exposure, together with a substantial weight loss (>5 mg), the test is interrupted. Otherwise, the temperature is increased 5°C (9°F) and the test is continued with the same sample. Figure 4 shows critical pitting and crevice temperatures (CPT and CCT) from this test.

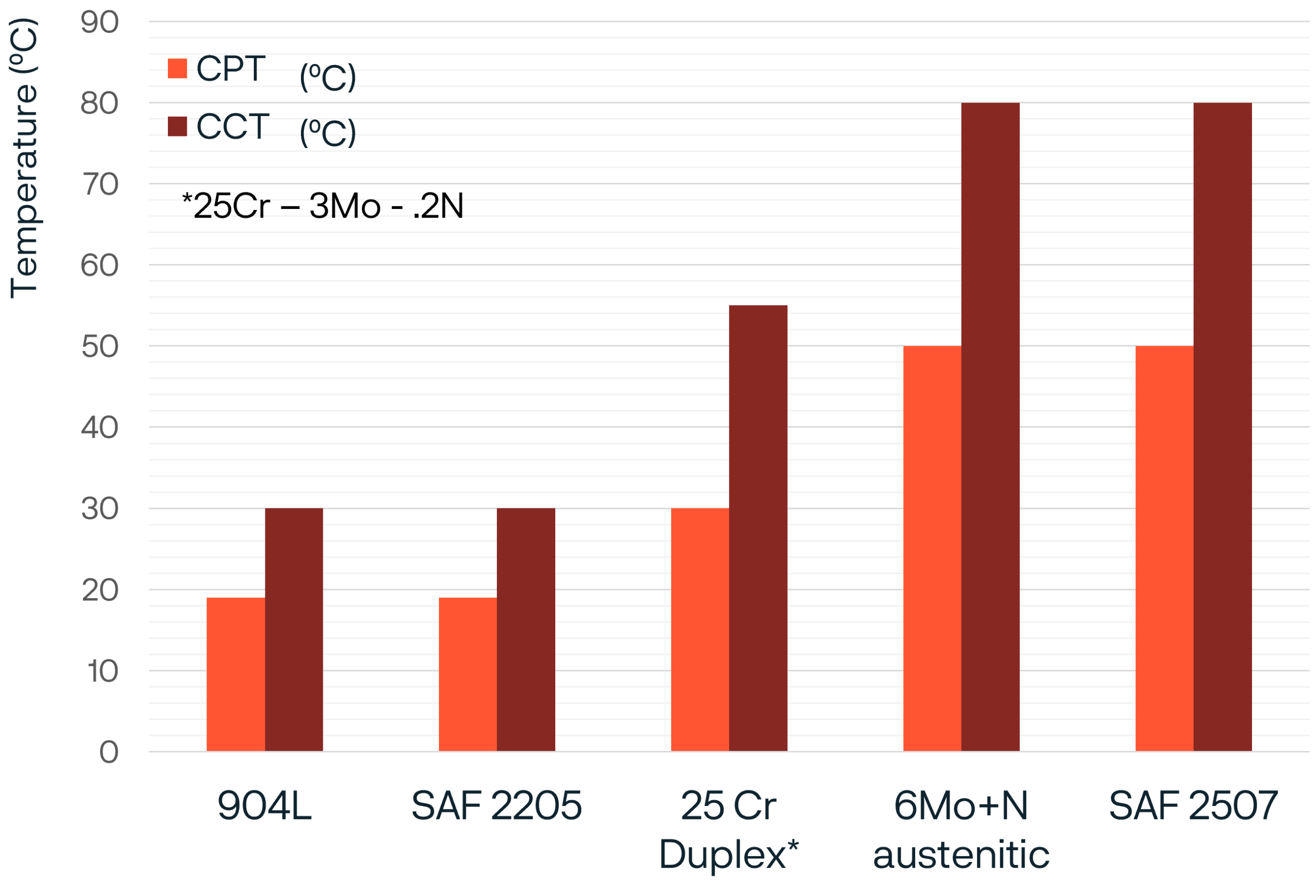

Figure 4. Critical pitting and crevice temperatures in 6% $FeCl_3$. 24h (similar to ASTM G48).

Erosion corrosion and corrosion fatigue

The superior mechanical properties combined with the improved corrosion resistance of SAF®2507 result in excellent resistance to both erosion corrosion and corrosion fatigue compared to standard austenitic stainless steels.

Units

Metric units apply. Imperial for reference.

Forms of supply

Dimensions and finishes

SAF®2507 bar steel is stocked in a number of sizes. The standard size range for stock comprises 205-250 mm (8.07”-9.84”). Solid round bar is supplied in solution annealed, quenched and peel-turned condition.

Lengths

Bars are delivered in random lengths of 3-7 m (9.84-22.96 ft.), depending on diameter.

Datasheet last updated 8/30/2024 8:49:55 AM (supersedes all previous editions)

Tolerances

Metric (mm)		Imperial (in.)	
Diameter	Tolerance	Diameter	Tolerance
>200-250	0/+1.50	>7.87-9.84	0/+0.059

Straightness

Height of arch, typical values			
Diameter, mm	mm/m	Diameter, in.	in./ft
>75	2	>2.95	0.12" / 5 ft.

Surface conditions

Diameter			
Metric (mm)	Imperial (in.)	Condition	Typical finish (Ra)
>200-250	>7.87-9.84	Peel turned	2 µm

Manufacturing

All products are made at the Alleima Tube AB integrated production facility in Sandviken, Sweden. From raw materials, melting, hot working, heat treatment to finishing and testing.

Heat Treatment

Solution annealing

Slow heating up to 1000°C (1830°F). Annealing at 1050-1125°C (1920-2060°F), followed by quenching.

Microstructure

In the solution annealed and quenched condition SAF®2507 has an austenitic-ferritic microstructure, which is free from grain-boundary carbides and intermetallic phases. The ferrite content is 35 – 55%.

Datasheet last updated 8/30/2024 8:49:55 AM (supersedes all previous editions)

Mechanical properties

Tensile strength at 20°C (68°F)

The following values apply to material in the solution annealed and quenched condition. For small sections the proof strength values are higher than those listed below. More detailed information can be supplied on request.

Proof strength	Ultimate tensile strength
Rp0.2 min.	**Rm**
550 MPa	760-930 MPa
80 Ksi	110-135 Ksi

Elongation: ≥25%

1 MPa = 1 N/mm2

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

Based on L0 = 5.65√S0 , where L0 is the original gauge length and S0 the original cross-section area.

For sizes below 50 mm/2" R_m min. 800 MPa (116ksi).

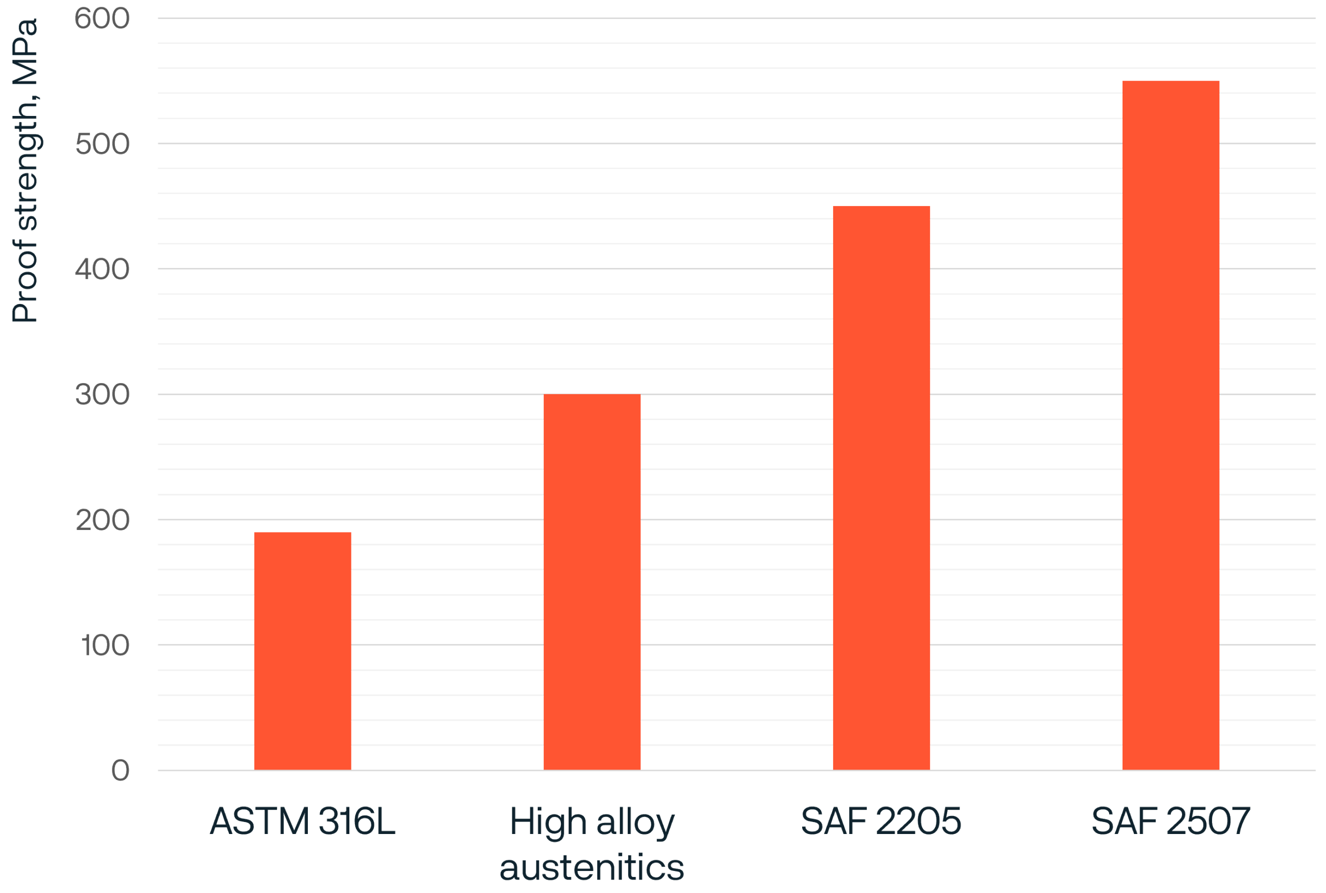

Figure 2. Typical proof strength ($R_{p0.2}$) values, comparison.

Datasheet last updated 8/30/2024 8:49:55 AM (supersedes all previous editions)

Impact strength

SAF®2507 possesses good impact strength, both at room temperature and at low temperatures.

The Alleima bar stock program guarantees the following impact strength (Charpy-V longitudinal) at -50°C / -58°F.
D>200-250 mm 45J average / 35J single
(D>7.87"-9.84") (33 ft.lb average / 25 ft.lb single)

The impact strength at "RT" / 20°C (68°F) is min 100J average / 70J single (73 ft.lb average / 51 ft.lb single).

At higher temperatures

If SAF®2507 is exposed for prolonged periods to temperatures exceeding 250°C (480°F), the microstructure changes which results in a reduction in impact strength. This does not necessarily affect the behavior of the material at the operating temperature. More detailed information can be supplied on request.

Impact strength

SAF™ 2507 possesses good impact strength. Figure 2 shows typical impact energy values for SAF™ 2507 in different sizes at -20°C (-4°F), using standard Charpy V specimens. Samples taken in the longitudinal direction.

Hardness

Max. 28HRC

Physical properties

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

Specific heat capacity

Metric units, Imperial units

Temperature, °C	J/(kg °C)	Temperature, °F	Btu/(lb °F)
20	490	68	0.12
100	505	200	0.12
200	520	400	0.12
300	550	600	0.13
400	585	800	0.14

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Thermal conductivity

Metric units, W/(m °C)

Temperature, °C	20	100	200	300	400
SAF®2507	14	15	17	18	20
AISI 316L	14	15	17	18	20

Imperial units, Btu/(ft h °F)

Temperature, °F	68	200	400	600	800
SAF®2507	8	9	10	11	12
AISI 316L	8	9	10	10	12

Thermal expansion

SAF®2507 has a coefficient of thermal expansion close to that of carbon steel. This gives SAF®2507 definite design advantages over austenitic stainless steels in equipment comprising of both carbon steel and stainless steel. The values given below are average values in the temperature ranges.

Metric units, $x10^{-6}$/°C

Temperature, °C	30-100	30-200	30-300	30-400
SAF®2507	13.5	14.0	14.0	14.5
Carbon Steel	12.5	13.0	13.5	14.0
ASTM 316L	16.5	17.0	17.5	18

Imperial units, $x10^{-6}$/°F

Temperature, °F	86-200	86-400	86-600	86-800
SAF®2507	7.5	7.5	8.0	8.0
Carbon Steel	6.8	7.0	7.5	7.8
ASTM 316L	9.0	9.5	10.0	10.0

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Resistivity

Temperature, °C	µΩm	Temperature, °F	µΩin.
20	0.83	68	32.7
100	0.89	200	34.9
200	0.96	400	37.9
300	1.03	600	40.7
400	1.08	800	43.2

Modulus of elasticity, (x10^3)

Metric units Imperial units

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®2507 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.

For SAF®2507, heat input of 0.2-1.5 kJ/mm and interpass temperature of <150°C (300°F) are recommended. Preheating and post-weld heat treatment are normally not necessary.

Recommended filler metals

- GTAW/TIG welding
- ISO 14343 S 25 9 4 N L / AWS A5.9 ER2594 (e.g. Exaton 25.10.4.L)
- MMA/SMAW welding
- ISO 3581 E 25 9 4 N L R / AWS A5.4 E2594-16 (e.g. Exaton 25.10.4.LR)
- ISO 3581 E 25 9 4 N L B / AWS A5.4 E2594-15 (e.g. Exaton 25.10.4.LB)

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Machining

General

Machining is an expression used for a number of subtractive manufacturing methods.

Mainly turning, milling, drilling. But also other operations like cutting, boring, grinding, reaming and tapping.

For solid bars the initial operations primarily are cutting and external turning to prepare a blank for component manufacturing.

Stainless steels

Materials within the ISO-M material area can be challenging to machine.

The materials vary a lot within the ISO-M group, but in general presents difficult chip control, high cutting forces and tool wear.

In order to get as efficient function and tool life as possible,
dedicated cutting tools and strategies to be used.

Getting started

To get it right, the first thing is to know the material to be machined. As the material properties are input to the selection of start values.

- ISO material group
- Condition/heat treatment
- Actual hardness of the material lot

Consult your cutting tool supplier for start recommendations, since the choice of cutting tools and machine tool set the direction for which start values to use.