SAF™ 2507 is a high alloy super duplex (austenitic-ferritic) stainless steel for service in highly corrosive conditions. The grade is characterized by:

- Excellent resistance to stress corrosion cracking in chloride-bearing environments
- Excellent resistance to pitting and crevice corrosion
- High resistance to general corrosion
- Very high mechanical strength
- Physical properties that offer design advantages
- High resistance to erosion corrosion and corrosion fatigue
- Good weldability

Standards

- UNS: S32750
- EN Number: 1.4410
- EN Name: X 2 CrNiMoN 25-7-4

Product standards

- EN 10216-5
- EN 10297-2
- ASTM A511, A790
- NORSOK MDS D51

Approvals

- Pressure Equipment Directive (2014/68/EU)
- Approved by the American Society of Mechanical Engineers (ASME) for use in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, div. 1
- ASME B31.3 Chemical Plant and Petroleum Refinery piping
- VdTÜV-Werkstoffblatt 508
- ISO 15156-3/NACE MR 0175 (Sulphide stress cracking resistant material for oil field equipment). Applies to liquid quenched tubes

Certificate

Status according to EN 10 204/3.1

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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

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.

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 hour 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.

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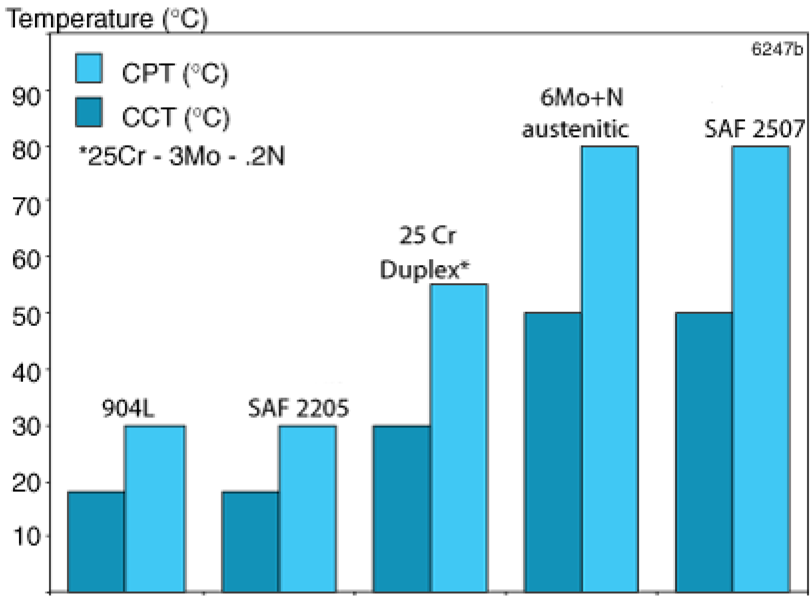

Figure 4. Critical pitting and crevice temperatures in 6% $FeCl_3$. 24h (similar to ASTM G48).

Stress corrosion cracking

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

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.

Forms of supply

Finishes and dimensions

SAF™ 2507 hollow bar is produced to order in hot-finished condition in the size range OD 32 – 275 mm, ID as required. Dimensions are given as outside and inside diameter with guaranteed component sizes after machining.

Tolerances

Outside diameter +2 / -0 %, but minimum +1 / -0 mm
Inside diameter +0 / -2 %, but minimum +0 / -1 mm
Straightness +/-1.5mm/m

Closer tolerances can be supplied.

Other forms of supply

SAF™ 2507 is also available as solid bar and seamless tube and pipe.

Heat treatment

Hollow bar is normally delivered in the solution annealed and quenched condition. If additional heat treatment is needed after further processing the following is recommended.

Solution annealing

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

Stress relief heat treatment at 350°C (660°F) for 5h followed by air cooling.

Mechanical properties

Hollow bar is tested in the delivery condition.

The following figures apply to material in the solution annealed and quenched condition. Hollow bar with wall thickness above 20 mm (0.787 in.) may have slightly lower values. More detailed information can be supplied on request.

At 20°C (68°F)

Metric units

Proof strength, MPa		Tensile strength, MPa	Elongation, %		Hardness, HRC
$R_{p0.2}$ [a)]	$R_{p1.0}$ [a)]	R_m	A [b)]	$A_{2"}$	
≥550	≥640	800-1000	≥25	≥15	≤32

Imperial units

Proof strength, ksi		Tensile strength, ksi	Elongation, %		Hardness, HRC
$R_{p0.2}$ [a)]	$R_{p1.0}$ [a)]	R_m	A [b)]	$A_{2"}$	HRC
≥80	≥93	116-145	≥25	≥15	≤32

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 $L_0 = 5.65 \sqrt{S_0}$ where L_0 is the original gauge length and S_0 the original cross-sectional area.

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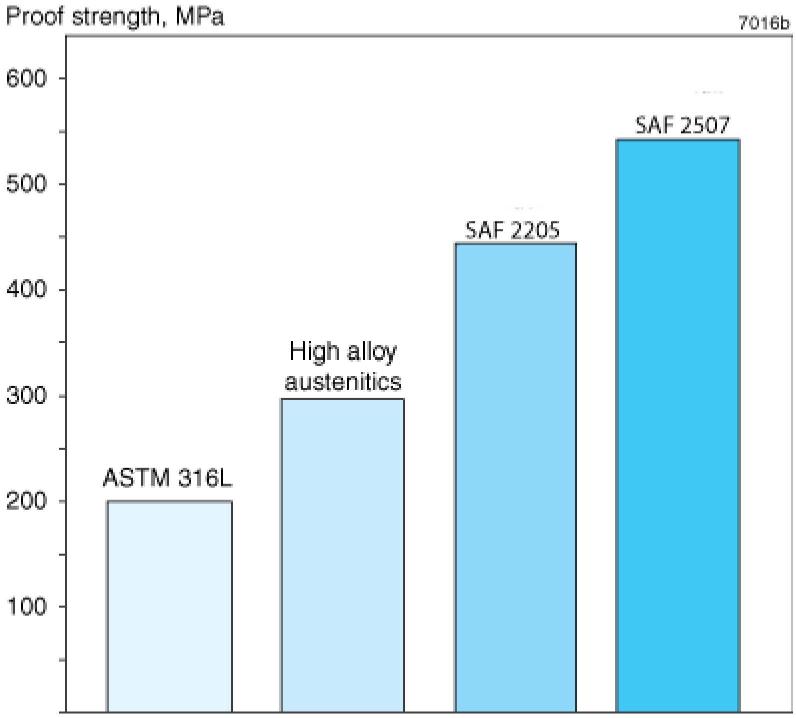

At higher temperatures

If SAF™ 2507 hollow bar is exposed for prolonged periods to temperatures exceeding 250°C (480°F), the microstructure will change which will result in a reduction in impact strength. This effect will not necessarily affect the behavior of the material at the operating temperature.

More detailed information can be supplied on request.

Impact strength

SAF™ 2507 hollow bar possesses good impact strength. Figure 2 shows typical impact strength values for SAF™ 2507 in various diameters at -46°C (-51°F), using standard Charpy V specimens. Samples taken in the longitudinal direction.

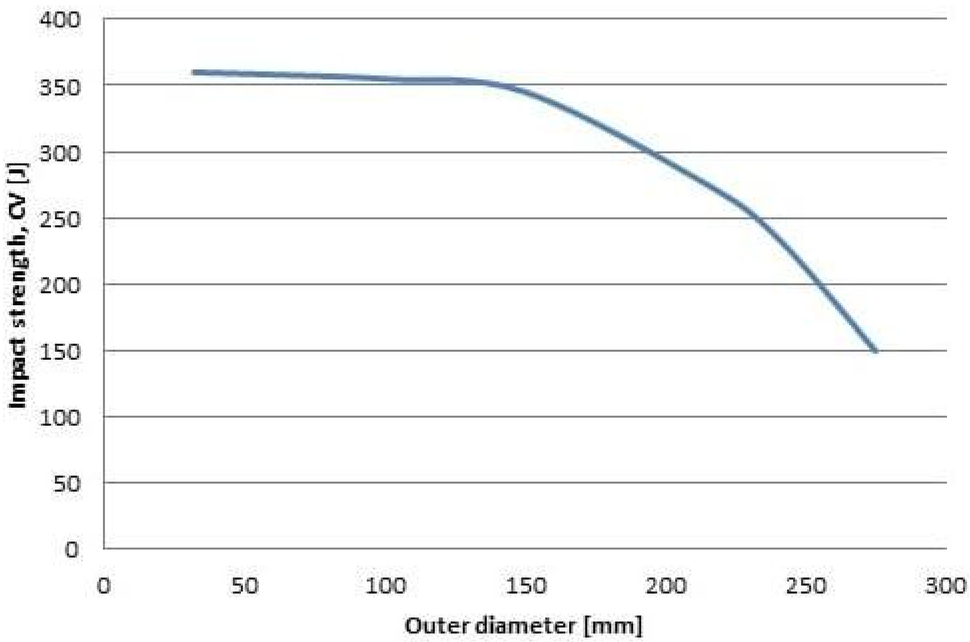

Figure 2. Impact strength (Charpy V) for SAF™ 2507 hollow bar at -46°C (-51°F).

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

Thermal conductivity

Metric units, W/(m °C)

Temperature, °C	20	100	200	300	400
SAF™ 2507	14	15	17	18	20
ASTM 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
ASTM 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 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

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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

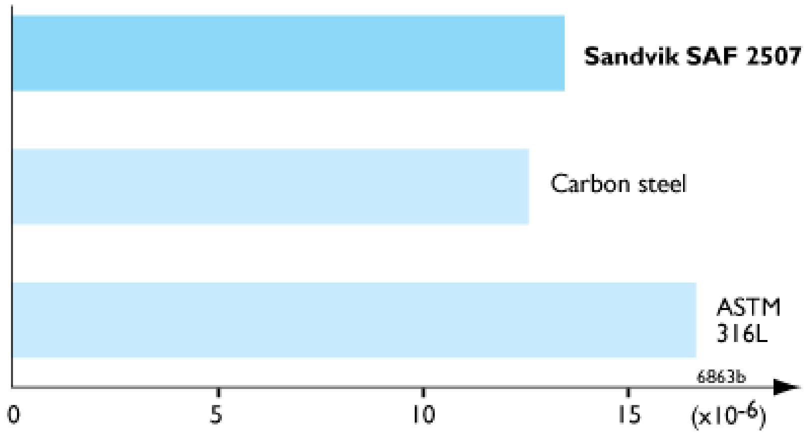

Figure 3. Thermal expansion, per °C (30-100°C, 86-210°F).

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

Machining

Being a two-phase material (austenitic-ferritic) SAF™ 2507 will present a different wear picture from that of single-phase austenitic steels of type ASTM 304L. The cutting speed must therefore be lower than that recommended for ASTM 304L. It is recommended that a tougher insert grade is used than when machining austenitic stainless steels, e.g. ASTM 304L. Also in comparison with Sanmac® 2205 lower speed and tougher insert grade is recommended. Machining recommendations available on request. More cutting data information for Sanmac® 2205 is available in the product handbook S-02909-ENG, these recommendations could act as guidelines in choice of appropriate cutting data.

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 is 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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