Round Bar SAF 2507 (Sandvik) UNS S32750 / F53 Super Duplex

Technical Spec.

Stock range: Dia 20.0mm to 250.0mm

Current as at April 2008.

General description

SAF 2507 / UNS S32750 is a high alloy duplex (austenitic-ferritic) stainless steel for service in highly corrosive conditions. It is characterised 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

Chemical composition (nominal) %

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

Standards

UNS: S32750
EN: 1.4410
EN: X2CrNiMoN25-7-4
AISI – F53 (A182 / A479)
Sandvik Grade (Brand): SAF 2507

Product standard
EN 10088-3
EN 10272, EN 10222-5
ASTM A-479, Statoil MDS D35 Rev F
Analysis and mech. properties acc. ASTM A-182

Approval
Pressure Equipment Directive (97/23/EC)
NORSOK M650 Rev 3, M630 Rev 4, dimensions up to 250 mm.

Certificate
Status according to EN 10 204/3.1

Form of supply – Round bar

Finishes and dimensions
SAF 2507 / UNS S32750 bar is stocked in a large number of sizes. The standard size range for stock comprises 20-250 mm. Round bar is supplied in solution annealed and water quenched condition. The surface is peeled turned and polished.

Lengths
Bars are delivered in random lengths of 3-7 m, depending on diameter.

Straightness

Diameter mm	Height of arch, mm / m Typical value
20 - 70	1
> 70	2

Tolerances, mm-sizes

Diameter, mm	Tolerances, mm
20-35	-0/+0.15
40-45	-0/+0.16
50-70	-0/+0.19
75-95	-0/+1.00
100-250	-0/+1.50

Surface conditions

Surface conditions	Ra, µm Typical value	Size, mm dia
Peeled and polished	1	20-250

Mechanical properties

Bars are tested in delivery condition.

The following figures apply to material in the solution annealed and quenched condition.

For small sections the proof strength values are higher than those listed below at 20 °C (68 °F).

At 20°C (68°F)
Metric units

	Proof strength $R_{p0.2}$ [a] MPa min.	Tensile strength R_m MPa	Elong. A (b) % min.	HB approx.
Bar	550	760-930 (c)	25	260

Imperial units

	Proof strength $R_{p0.2}$ [a] ksi min.	Tensile strength R_m ksi .	Elong. A (b) % min.	Hardness Rockwell C max.
Bar	80	110-135	25	28

1 MPa = 1 N/mm2
a) Rp0.2 corresponds to 0.2% offset yield strength.
b) Based on Lo = $5.65\sqrt{So}$, where Lo is the original gauge length and So the original cross-section area.
c) For sizes below 50 mm/2" Rm min. 800 MPa.

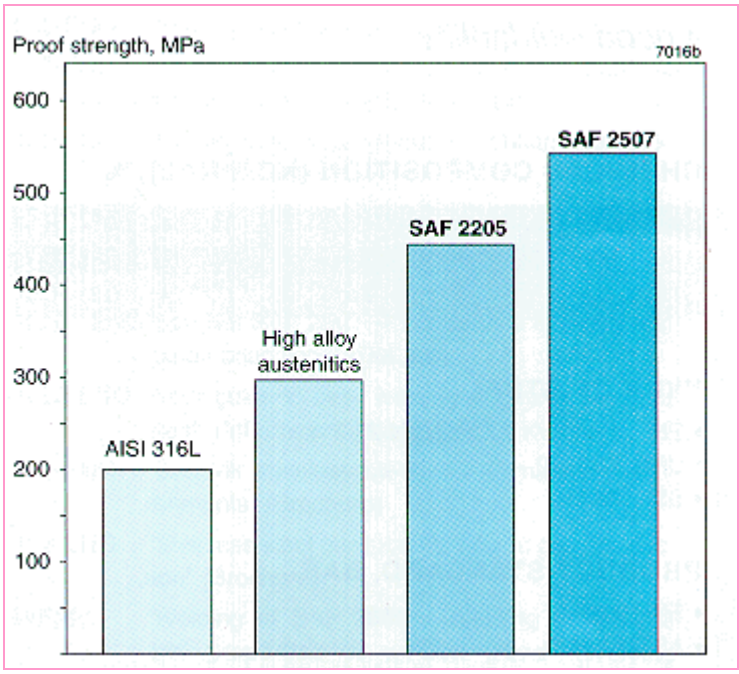

Figure 1.
Comparison of proof strength, 0.2% offset of SAF 2507 / UNS S32750 and other grades, for material in solution annealed and quenched condition.

At higher temperatures

If SAF 2507 / UNS S32750 is exposed for prolonged periods to temperatures exceeding 250°C (480°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.

Impact strength

SAF 2507 / UNS S32750 possesses good impact strength. Figure 2 shows typical impact energy values for SAF 2507 / UNS S32750 in different sizes at -20°C (-4°F), using standard Charpy V specimens. Samples taken in the longitudinal direction.

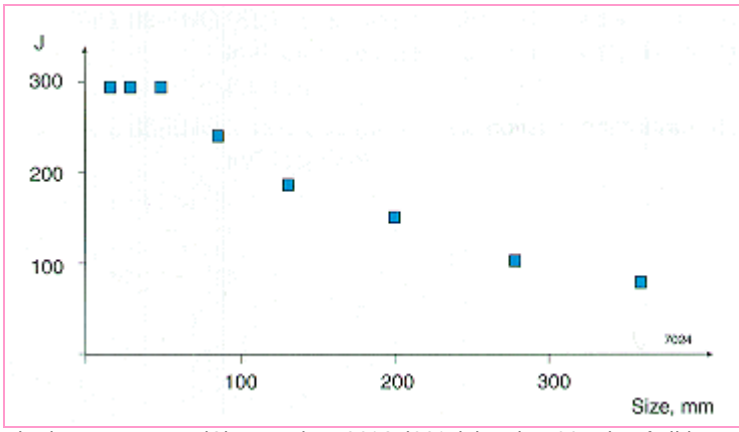

Figure 2. Typical impact energy values at -20° C (-4°F).

The impact energy (Charpy V) at 20°C (68°F) is min 100 J (74 ft-lb).

Microstructure

In the solution annealed and quenched condition SAF 2507 / UNS S32750 has an austenitic-ferritic microstructure which is free from grain boundary carbides and intermetalic phases. The ferrite content is 35-55% (ASTM E562).

Physical properties

At 20 °C (68 °F), typical values	
Density	7.8 g/cm^3 , 0.28 lb/in^3
Modulus of elasticity	200x10^3 MPa, 29x10^3 ksi
Specific heat capacity	480 J/kg °C, 0.12 Btu/lb°F
Thermal conductivity	14 W/m °C, 8 Btu/ft h°F
Thermal expansion	13 x10^{-6}/°C, 7 x10^{-6}/°F

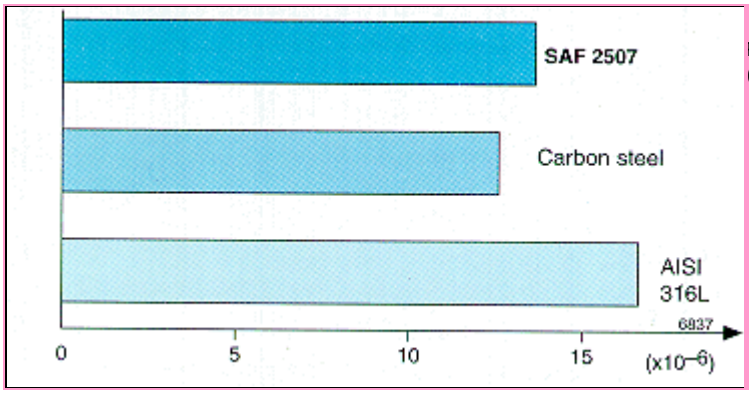

Figure 3. Thermal expansion, per °C (30-100°C, 86-210°F).

Corrosion resistance

General corrosion

SAF 2507 / UNS S32750 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 PREN (Pitting Resistance Equivalent Number).

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

For duplex stainless steels the pitting corrosion resistance is dependent on the PREN-value in both the ferrite phase and the austenite phase, so that the phase with the lowest PREN-value will be limiting for the actual pitting corrosion resistance. In SAF 2507 / UNS S32750 the PREN-value is equal in both phases, which has been achieved by a careful balancing of the elements.

The minimum PREN-value for SAF 2507 / UNS S32750 is 41. This is significantly higher than e.g. the PREN-values for other duplex stainless steels of the 25Cr type which are not "super-duplex". As an example UNS S31260 (25Cr3Mo0.2N) has a PREN-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% FeCl3 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.

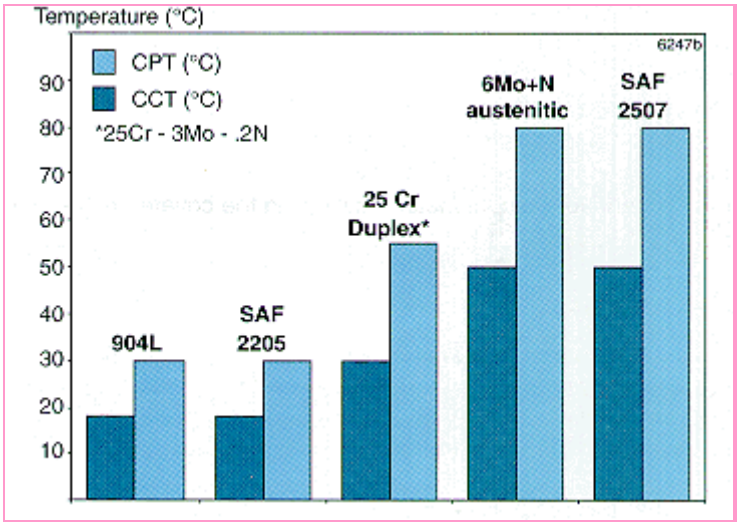

Figure 4. Critical pitting and crevice temperatures in 6% FeCl3. 24h (similar to ASTM G48).

Stress corrosion cracking

SAF 2507 / UNS S32750 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 / UNS S32750 result in excellent resistance to both erosion corrosion and corrosion fatigue compared to standard austenitic stainless steels.

Hot working

SAF 2507 / UNS S32750 is ductile at high temperatures. The deformation resistance increases with decreasing temperature and hot working should therefore be carried out at material temperature of 1250-1100°C (2280-2010°F), slow heating up to 1000°C (1830°F).

If the temperature falls below 1000°C (1830°F) during hot working there is risk for sigma phase formation, and the material must therefore be reheated.

Hot working of finished products in SAF 2507 / UNS S32750 should be followed by solution annealing and quenching in accordance with the recommendations given for heat treatment.

Heat Treatment

Bars are normally delivered in 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.

Welding

The weldability of SAF 2507 / UNS S32750 is good. Suitable welding methods are manual metal-arc welding with covered electrodes or gas-shielded arc welding. Welding should be undertaken within the heat input range of 0.2-1.5 kJ/mm and with an interpass temperature of maximum 150°C (300°F). Preheating or post-weld heat treatment is not necessary.

Matching filler metals are recommended in order to obtain a weld metal with optimum corrosion resistance and mechanical properties. For gas-shielded arc welding use Sandvik 25.10.4.L, and for manual metal-arc welding the covered electrode Sandvik 25.10.4.LR.

Intoco can offer the above electrodes if required.

Machining

Being a two-phase material (austenitic-ferritic) SAF 2507 / UNS S32750 will present a different wear picture from that of single-phase steels of type AISI 304L. The cutting speed must therefore be lower than that recommended for AISI 304L. It is recommended that a tougher insert grade is used than when machining austenitic stainless steels, e.g. AISI 304L. Also in comparison with UNS S31803 / SAF 2205 lower speed and tougher insert grade is recommended.

Applications

SAF 2507 / UNS S32750 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

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 data sheet is only valid for SAF 2507 / UNS S32750 material. Other material, covering the same international specifications, does not necessarily comply with the mechanical and corrosion properties presented in this datasheet.

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