

2507 Super Duplex stainless steels with PREN ≥ 40

Superduplex stainless steels have a very high resistance to localized corrosion in chloride media, combined with a high mechanical strength. The series consists of three grades: 2507 (EN 1.4410), 2507Cu (EN 1.4507) with addition of copper for enhanced resistance in sulfuric acid media, and 2507W (1.4501), with tungsten additions for enhanced localized corrosion resistance. The corrosion resistance of these grades is better than 904 and comparable to 6 Mo austenitics.

All these steels have a pitting resistance equivalent number, PREN, above 40, and a minimum guaranteed yield strength of 550 MPa, allowing for leaner design in load bearing applications. The alloy composition, including molybdenum and nitrogen additions, has been optimized to obtain a 50/50 austenoferritic microstructure with outstanding corrosion resistance even for heavy plates. The 2507 series of duplex grades provide cost - efficient alternatives for a wide range of applications, including offshore, phosphoric and sulfuric acid production as well as flue gas cleaning.

STANDARDS

Grade		EN	ASTM/UNS
2507	EN 1.4410	X2CrNiMoN 25 - 7 - 4	S32750

SPECIFICATIONS

UNS:S32750 EN:1.4410 ASTM:A-240,A-276,A-479,A-182(Gr. F53)

ASME: SA-240,SA-276,SA-479,SA-182 (Gr. F53), P-number 10H, GroupNumber1; ASME II - D2013

EuroPressure Vessels: EN10028-7:2007 NACE:ISO 1556/MR0175

CHEMICAL ANALYSIS - WEIGHT %

Typical values

Grades	C	Cr	Ni	Mo	N	PREN	Others
2507	< 0.030	25	6.5	3.6	0.26	41	-

$$\text{PREN} = [\text{Cr}\%] + 3.3 [\text{Mo}\%] + 16 [\text{N}\%] \geq 40$$

PHYSICAL PROPERTIES

Density: 7.85 kg/dm³ - 0.28 lb/in³ all grades

Interval temperature °C (°F)	Thermal expansion ($\alpha \times 10^{-6} \text{ K}^{-1}$)	T °C (°F)	($\mu\Omega \cdot \text{cm}$)	Thermal conductivity ($\text{W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$)	Specific heat ($\text{J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}$)	Young modulus E (GPa)	Shear modulus G (GPa)
20 - 200 (68 - 392)	13.5	20 (68)	85	17	450	200	75
20 - 300 (68 - 572)	14	100 (272)	95	18	500	190	73
20 - 500 (68 - 932)	14.5	200 (392)	100	19	530	180	70

MECHANICAL PROPERTIES

Tensile Properties (minimum values, all grades)

°C	Rp0.2 (MPa)	Rp1.0 (MPa)	Rm (MPa)	°F	YS 0.2% (ksi)	YS 1.0% (ksi)	UTS (ksi)	A/ Elongation (%)
20	550	570	770	68	78	83	111	25
100	485	500	700	212	70	72	102	25
250	400	420	640	500	57	61	92	25

Typical temperature range of use: - 50°C/+270°C (- 58°F/+518°F). For lower temperature applications, please contact us.

Impact toughness (KV typical values), all grades

	- 50°C (- 58°F)	- 20°C (~4°F)	0°C (+32°F)	20°C (+68°F)
KV plates (guaranteed)	> 70J	> 85J	> 90J	> 95J
KV weld metal (typical)	> 30J	> 40J	> 50J	> 55J

Impact values of welds are closely relates to the microstructure (α / β balance) and the control of chemical composition (oxygen, nitrogen, nickel) which depend on welding processes and parameters. The best results are obtained for high austenite contents (60 - 75%) and low oxygen levels. High nitrogen contents associated with high ferrite levels must be avoided. For more information, please contact us.

Hardness values (typical values)

HV5: 250 to 290

HRC < 28

STRUCTURE STABILITY

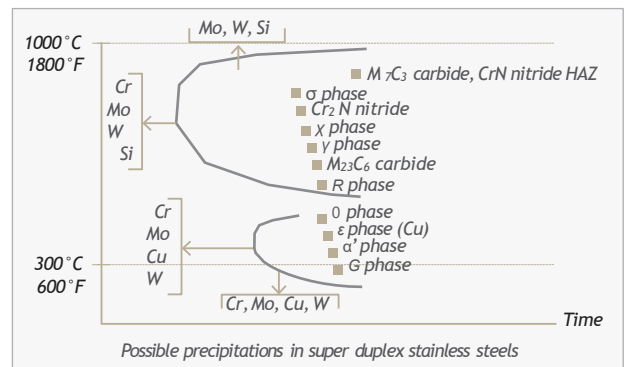
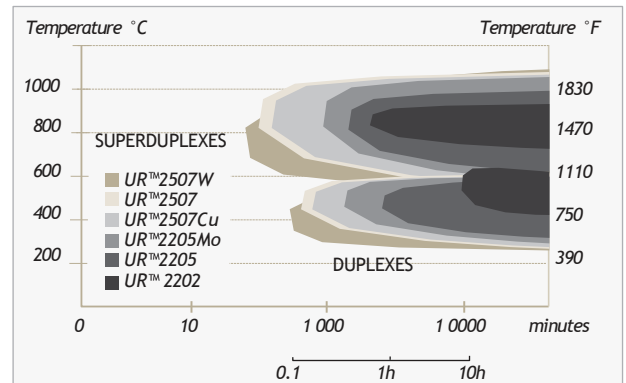
25 Cr super duplex grades are subject to intermetallic phase precipitations (σ , χ ...) particularly when improperly heat treated. Molybdenum and tungsten additions increase the sensitivity to sigma phase formation. Industeel equipment and heat treatments are optimised to control the composition, structure and properties of the products. We use a batch furnace to control time and temperature for each individual plate. This gives Industeel superduplex plate its unique quality. The microstructure, free of intermetallic phase, contributes to an increase in both toughness and corrosion resistance.

Molybdenum content is slightly reduced comparing to other superduplex grades. This makes it possible to add tungsten additions and still obtain a stable α / γ structure after water - quenching.

HEATTREATMENT

The 2507 grades are delivered in the solution annealed and water quenched conditions (1080/1120°C - 1976/2018°F). The chemical analysis and heat treatment are optimised to reach

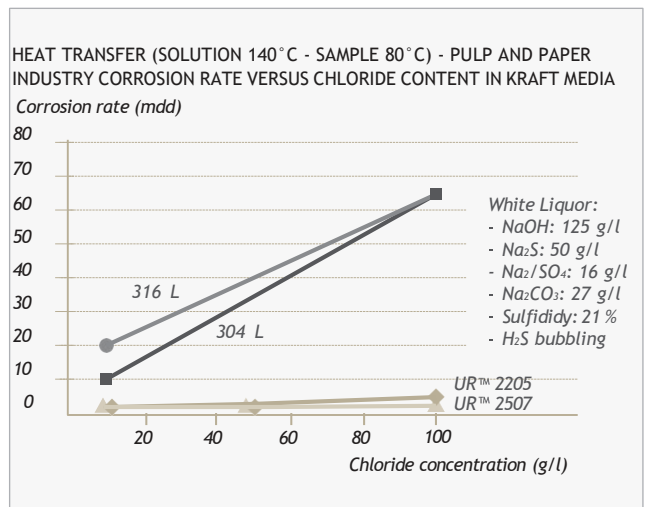
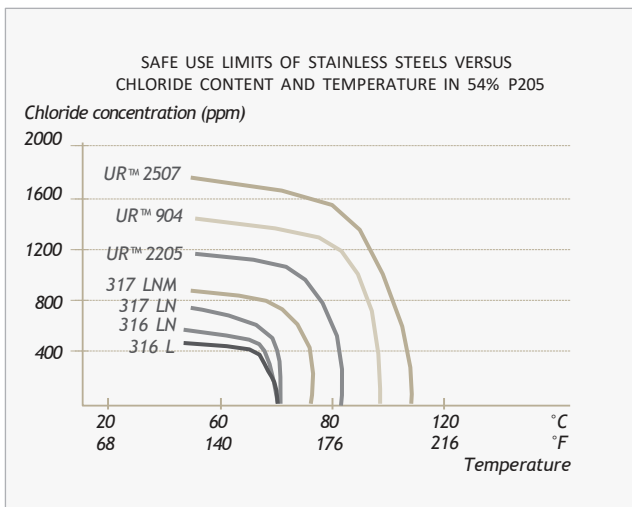
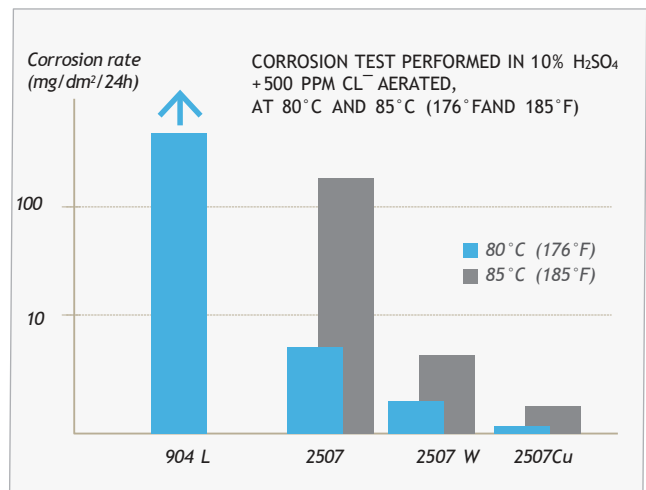
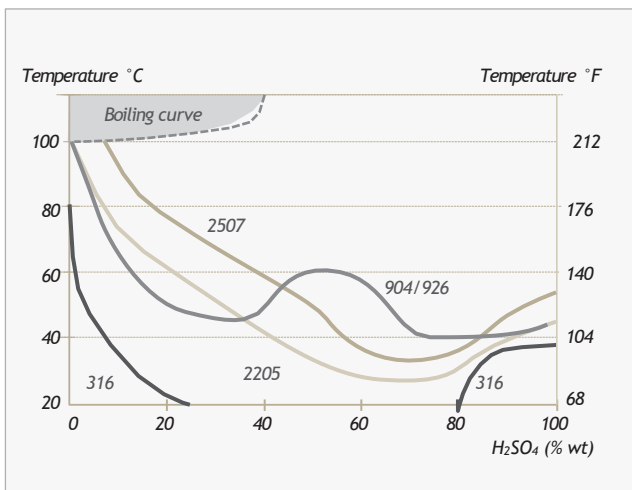
a 50% α / 50% γ microstructure. Welded structures with tungsten additions need solution annealing heat - treatments in the 1100 - 1125°C (2012 - 2057°F) temperature range.



CORROSION RESISTANCE

General corrosion resistance

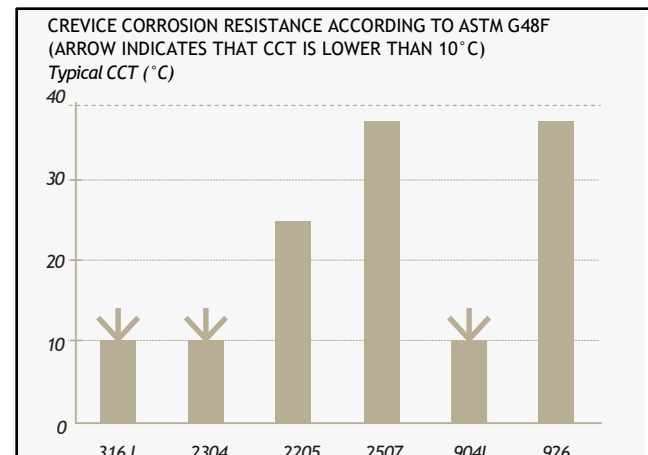
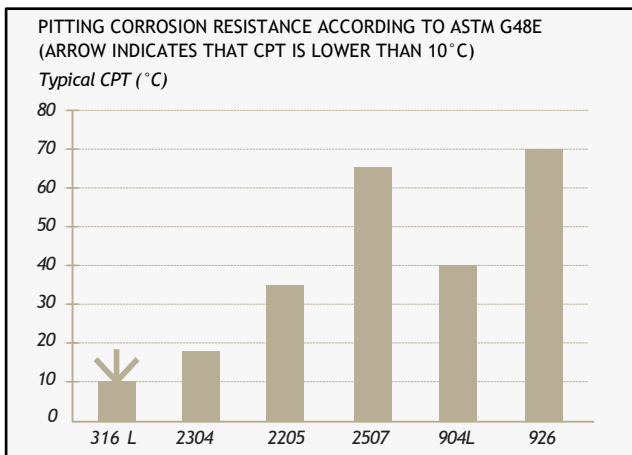
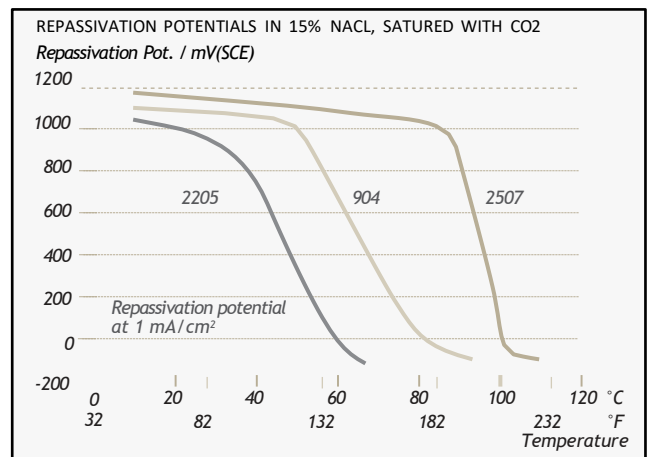
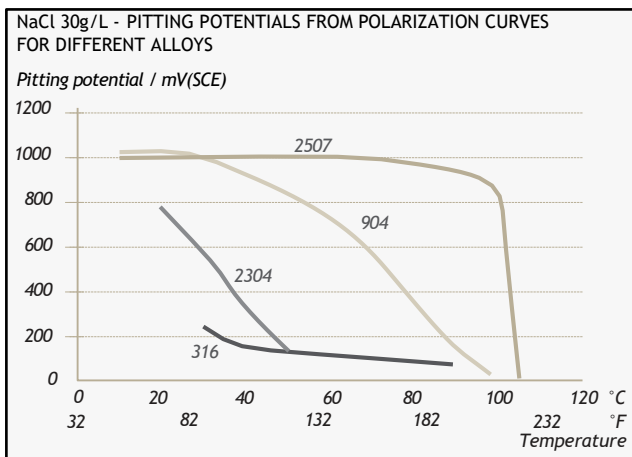
The 2507 grade perform particularly well in highly corrosive conditions, including sulphuric and phosphoric acid solutions, even in presence of chlorides. The duplex microstructure which provides high mechanical strength explains why the alloy behaves particularly well in abrasion - corrosion conditions (agitators, screws, rakes...). Superduplex grades are frequently used in mixed acids containing chlorides. Thanks to its copper content, 2507Cu performs very well in sulfate environments, for example flue gas cleaning.



IN SERVICE CONDITION

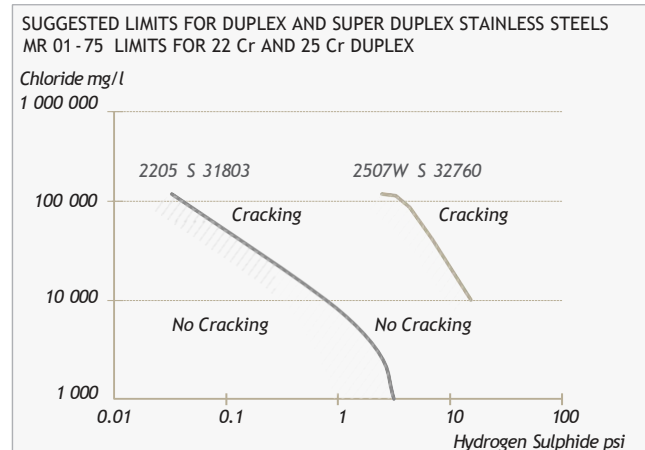
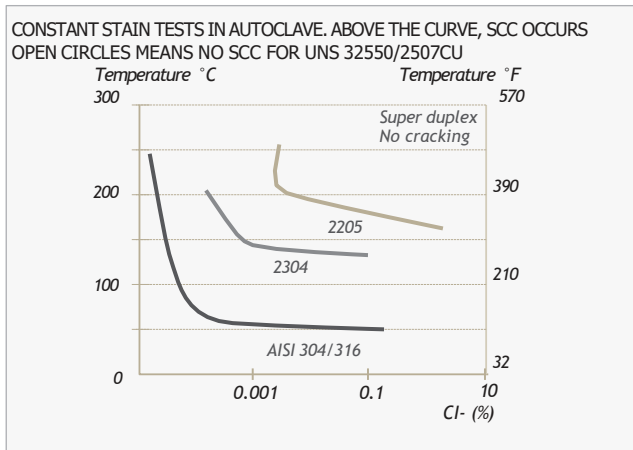
Pitting and crevice corrosion

The minimum PREN value of 40 also explains why the alloys are highly resistant to pitting corrosion and crevice corrosion. The 2507 alloy behaves much better than 904L and is, for pitting corrosion resistance, nearly equivalent to 6 Mo super austenitic grades. In some cases, the crevice corrosion resistance is slightly higher than 6 Mo alloys due to the 25% Cr additions. Tungsten additions are considered beneficial for crevice corrosion resistance.



Stress corrosion cracking resistance

The stress corrosion resistance properties of superduplex stainless steels are excellent in high temperature chloride containing solutions as well as in sour gas applications.



COLD FORMING

Due to their higher yield strength, forces required for the cold forming of the 2507 grades are higher than for austenitic steels. Edges will be ground and surfaces (absence of scratches...) will be checked before cold forming. For cold deformations higher than 20%, an intermediate treatment is required (solution annealing 1080/1120°C - (1976/2018°F) + water cooling). This heat treatment performed after cold forming is always required when the deformation exceeds 10%. Detailed recommendations for cold forming or bending of welded and unwelded duplex and superduplex plates are available upon request.

HOT FORMING

Hot forming is to be performed in between 1150°C and 1000°C (2102 and 1832°F). After hot forming, a new solution annealing heat treatment in the range 1080/1120°C (1976/2018°F) followed by water cooling is necessary.

PICKLING

Same conditions as for 316L, but the pickling time is at least twice that of 316L. An increase in the temperature of the pickling bath reduces the pickling time.

WELDING

The 2507 can be welded using the following processes: SMAW, GTAW (with filler), GMAW, PAW (with filler).

The welding procedures are similar to those of other duplex stainless steels:

- no pre-heating
- heat input between 0.5
- 2 kJ/mm is recommended (depending on the process and on the thickness of the plate).

Precise welding parameters for each type of process and thicknesses are available on request:

- interpass temperature less than 150°C (302°F) and preferably less than 120°C (248°F)

- no PWHT, except solution annealing at 1100/1125°C (2012/2057°F) + water cooling. As in welded conditions, the ferrite fraction in the heat affected zone should be lower than 70%, and between 20 to 60% for the weld metal; for SMAW, FCAW and SAW weld metal aim for the lower part of the range (20 to 40%).

Over alloyed filler materials are recommended (nickel and/or nitrogen additions) to control the structure and properties.

Excessive dilutions should be avoided. Filler materials and shielding gases guaranteeing PREN

- 40 have been developed (wire, metallic cored wire, electrodes).
- a list of tested filler materials is available on request.

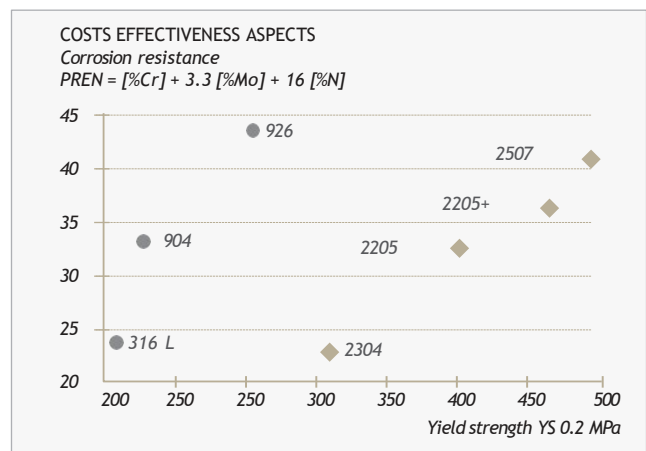
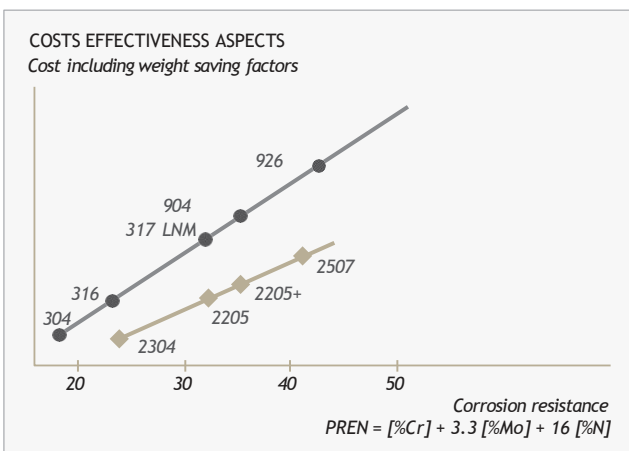
DESIGN

Cost factor considerations

Maximum allowable stresses given by different pressure vessel codes are shown below. The high mechanical strength of 2507 allows thickness and, consequently, cost reductions. We are happy to offer assistance in evaluating potential cost savings related to pressure vessel or structural design and the excellent corrosion resistance properties of 2507.

Design stress values (typical values)

Country	Code	Room temperature (MPa)				Saving factors 2507/904
		316	2205 S 31803	904 (904L)	2507CU S 32550/520	
USA	ASME VIII, DIV 1	108	155	123	190	35%
F	CODAP 90, F.1	166	275	176	287	38%
UK	BS 5500	128	289	173	294	42%
D	ADW 2	128	300	167	327	49%



COMMON APPLICATIONS

- Seawater systems and desalination
- Oil and gas Industry including sour gas applications
- Petrochemical industry including PVC strippers
- Pulp and paper industry (bleaching...)
- Chemical industry including organic acids
- Sulphuric acid plants
- Phosphoric acid plants
- Trucks multipurpose containers
- Pollution control equipment (scrubbers)
- Geothermal tubes
- Hydrometallurgy

