Duplex stainless steel offer

grade

DX2304

Chemical composition

Elements	C	Mn	Cr	Ni	Mo	N
%	0.02	1.80	22.80	3.80	0.40	0.13

Typical values - PREN = 26

European designation [1]	American designation [2]
X2CrNiN23-4 / 1.4362	UNS 32304 / Type 2304

[1] According to NF EN 10088 [2] According to ASTM A240

This grade complies with:

- Stainless Europe Material Safety Data Sheet n°1 (European Directive 2001/58/EC)
- European Directive 2000/53/EC on end-of-life vehicles and later modifications
- Standard NFA36 711 "Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non packaging steel)"
- Requirements of NSF/ANSI 51 – 2014 edition International Standard for "Food Equipment Materials" and of the F.D.A. (United States Food and Drug Administration) regarding materials used for food contact
- French Decree No.92-631 dated 8 July 1992 and Regulation No. 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food (and repealing Directives 80/590/EEC and 89/109/EEC)
- French regulatory paper dated 13 January 1976 relating to materials and articles made of stainless steel in contact with foodstuffs
- PED (Pressure Equipment Directive) according to EN 10028-7 and AD2000 Merkblatt W2 (TÜV W496)

General characteristics

The principal features of DX2304 are:

- Excellent resistance to general corrosion (similar to 316L)
- Improved mechanical strength (yield strength twice as those of 304/316 grades) and therefore possible to save weight in properly designed applications
- Service temperature range: -50°C to 300°C
- Improved stress corrosion resistance compared to 304/316 grades

Applications

- Desalination
- Construction: façade & foot bridges
- Flexible tubes
- Oil & Gas industry
- Mining
- Pulp & paper industry
- Pressure vessels
- Caustic solutions
- Organic acids
- Safety panels

Product range

Forms: sheets, blanks, strips

Thicknesses: from 1.0 up to 10 mm

Width: up to 2000 mm according to thickness

Finishes: hot rolled, cold rolled

Metallurgical properties

The grade DX2304 is a stainless steel of the austeno-ferritic group, whose structure is composed of a mix of ferrite (α) and austenite (γ) phases. The two-phase microstructure of the alloy makes it possible to obtain elevated yield strength values while maintaining sufficient ductility. The hardening is provided by the ferritic phase, whereas the austenitic lattice enables to preserve both ductility and toughness.

The chemical analysis of our DX2304 is optimized to obtain a typical 50% α -50% γ microstructure after an annealing at 950-1050°C. This ratio combined with its low molybdenum content gives the DX2304 a better microstructural stability. Continuous use of our DX2304 at temperatures above 300°C is not recommended since precipitation hardening occurs.

Physical Properties

Cold rolled and annealed sheet.

Density	d	kg/dm³	20 °C	7.8
Melting temperature	-	°C	-	1465
Specific heat	c	J/kg.K	20 °C	450
Thermal conductivity	k	W/m.K	20 °C	14
Mean thermal expansion coefficient	α	10^{-6}/K	20-200 °C 20-400 °C	13.5 14
Electric resistivity	ρ	Ω mm²/m	20°C	0.7
Magnetic	-	-	-	yes
Young's Modulus	E	10^3.MPa	20 °C	200

Mechanical properties

In annealed condition at 20°C

According to ISO 6892-1, transverse direction

Gauge length: 50 mm

Grade	European designation	UNS designation	Rm (1) (MPa)	$Rp_{0.2}$ (2) (MPa)	A (3) %
DX2304	1.4362	S32304	730	550	30
DX2202	1.4062	S32202	710	530	30
DX2205	1.4462	S32205	800	620	30
316L	1.4401/4404	316/316L	620	300	52
K45	1.4509	445 (a)	510	360	29
304	1.4301	304	650	300	54

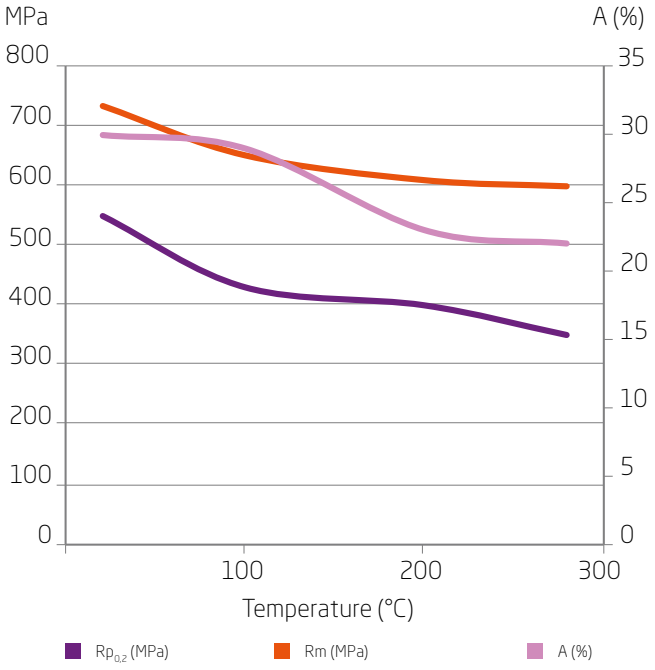
1 MPa= 1 N/mm² / *Typical values / (1) Ultimate Tensile Strength (UTS) / (2) Yield Strength (YS)
(3) Elongation (A) (a) Common designation

Typical impact toughness

Temperature (°C)	Kv min.* (J/cm²)
20	150
-40	100

*Kv_2 transversal, HRAP 5mm

At high temperatures



Corrosion resistance

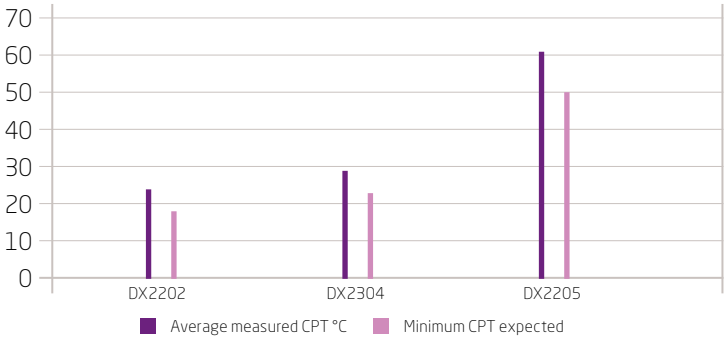
General corrosion resistance

Due to its optimized chemical composition, our DX2304 shows a general corrosion resistance almost similar to the 316/316L (1.4401/1.4404).

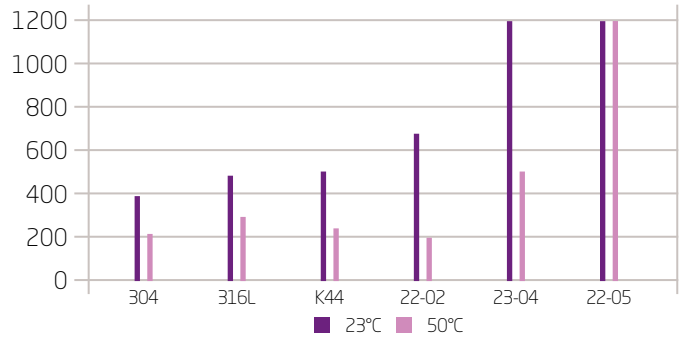
Pitting corrosion resistance

Due to the 23% chromium and 0.1% nitrogen addition, the DX2304 shows much better results compared to the 316L (18-11ML).

Critical Pitting Temperature (°C)



Pitting potential (mV/SCE)

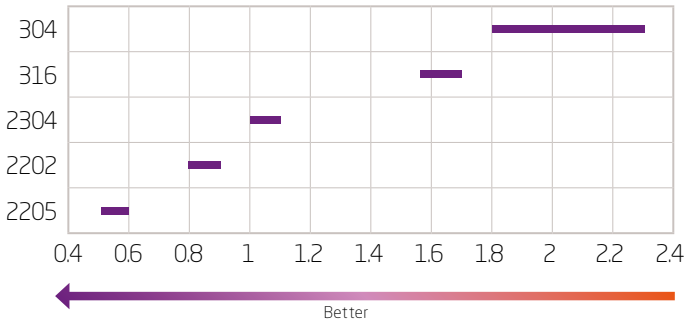


Crevice Corrosion

Crevice corrosion is a type of corrosion that can be divided in two processes. During the first stage (the initiation), an incubation period is needed before sufficient chloride accumulation and acidification lead to depassivation within the crevice region. A depassivation pH can be defined as the critical condition for passivity breakdown.

The propagation is the second stage and is involved in the dissolution of metal. To slow down this stage, molybdenum and nickel containing grades are to be preferred since both these elements have a positive effect on decreasing the speed of propagation.

Depassivation pH, 2M NaCl, 23°C



Stress corrosion resistance

Stress corrosion resistance test results in chloride containing aqueous solutions show that DX2304 outperforms 304L and 316L grades, due to its high chromium additions and low nickel contents. This is a typical feature of duplex stainless steels. For further improvement, the DX2205 (1.4462) can be selected when DX2304 is not sufficient.

Intergranular corrosion resistance

The DX2304 is resistant to inter-granular corrosion and is conform to the requirements of following standards:

- Strauss test according to ASTM A262E
- HUEY test according to ASTM A262C

More information about corrosion test results is available from our technical customer support department.

Forming

This grade can generally be used for forming applications. Since its yield strength is significantly higher than that of 1.4301 (Type 304) the use of presses or section rolling equipment with suitable power is required. The aptitude for stretch forming is determined by the dome height of the Erichsen test, whereas the deep drawing ability is defined by the limiting drawing ratio (LDR).

Grade	Stretching: Erichsen height* (mm)	Limiting Drawing Ratio* (LDR)
DX2304	9.5	1.95 - 2.0
DX2202	10.5	1.9 - 1.95
DX2205	9.5	1.9 - 1.95
K41	9.4	2.29
304L	11.4	1.9

* Typical values - LDR: cylindrical punch (diam. 33 mm), Erichsen test: hemispherical punch (diam. 20 mm)

Welding

The chemical composition of DX2304 has been balanced to limit microstructural changes in the heat affected zone. In the case of welding without filler material, solidification is fully ferritic followed by austenite formation during further cooling. Too rapid cooling can lead to excess of ferrite. It is important, though, to select welding parameters, i.e. energy, filler metal, shielding gas, to obtain a controlled ferrite fraction both in the fusion zone and in the heat affected zone. The welding conditions depend on the thickness and on the welding equipment, please don't hesitate to consult our specialists.

Recommendations

The use of a top/bottom shielding gas is recommended. Nitrogen must be added in the case of welding without filler metal or adapted to the filler metal in the other case. The austeno-ferritic structure of DX2304 eliminates the risk of hot cracking. If welded under with improper conditions, this grade can become sensitive to cold-cracking.

To avoid any risks, non hydrogenated gas must be used for the purpose of welding and all filler materials must be correctly dried (temperature above 250°C in most cases). Pre or post-welding heat treatment is not recommended, as improper conditions can lead to intermetallic phase precipitation. In case of multipass welding, maximal interpass temperature of 150°C is advised to prevent precipitation of deleterious phases. Better corrosion resistance is achieved with weld pickling and passivation.

Welding (continued)

Welding process	No filler material	With filler metal			Shielding gas
	Typical thicknesses	Typical thicknesses	Filler material		
			Rod	Wire	
Resistance: spot, seam	≤ 2 mm				
TIG	≤ 1.5 mm	> 0.5 mm	W 23 7 N L or W 22 9 3 N L [1] ER2209 [2]	G 23 7 N L or G 22 9 3 N L [1] ER2209 [2]	Ar + 2-3% N_2 Ar, Ar+ He
PLASMA	≤ 1.5 mm	> 0.5 mm			Ar + 2-3% N_2 Ar, Ar+ He
MIG		> 0.8 mm		G 23 7 N L or G 22 9 3 N L [1] ER2209 [2]	Ar + 2-3 % N_2 + 2% CO_2 or O_2
S.A.W.		> 5 mm		S 23 7 N L or S 22 9 3 N L [1] ER2209 [2]	
S.M.A.W		Repairs	E 22 9 3 N L R [1] ER2209 [2]		
Laser	≤ 5 mm				N_2 (Ar or He possible)

[1] EN ISO 14343 [2] AWS 5.9

Heat treatment and finishing

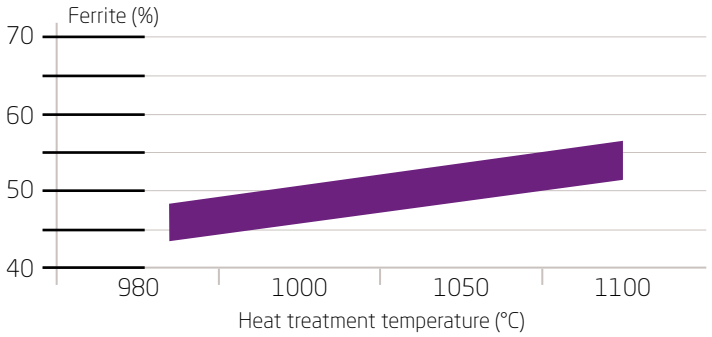
Heat treatment

After hot forming or cold forming, an annealing treatment of a couple of minutes at temperatures between 950 and 1050°C, followed by water quenching or rapid air cooling restores the structure and eliminates internal stresses. Corrosion resistance and mechanical properties will be restored as well. During heating, parts must be supported carefully to avoid creep deformation.

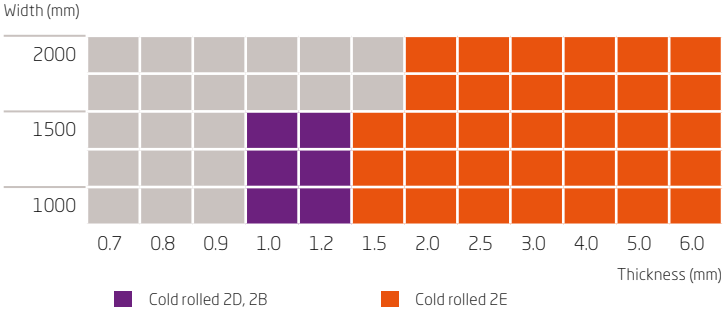
Pickling

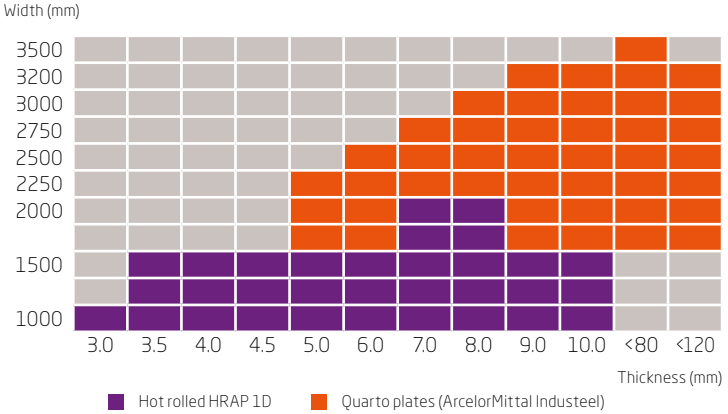
The same solutions and pastes as for 304/316 grades can be used. The pickling time will be higher than for these austenitic grades due to the corrosion resistance properties of the DX2304.

- Nitric-Hydrofl uoric acid mixture (10%HNO_3 + 2% HF) at ambient temperature or up to 60°C
- Sulfuric-nitric acid mixture (10% H_2SO_4 + 0.5% HNO_3) at 60°C
- Descaling pastes for weld areas



Size range





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