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Duplex stainless steel offer
grade DX2205/DX1803

Chemical composition

Elements (%)	C	Mn	Cr	Ni	Mo	N
DX2205	0.02	1.80	22.80	5.50	3.10	0.17
DX1803	0.02	1.80	22.10	5.00	3.60	0.17

Typical values - PREN = 35 for DX2205 and PREN = 33 for DX1803

European designation (1)	American designation (2)
X2CrNiMoN22-5-3/1.4462	UNS S32205/S31803

(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
- NFA 36 711 standard "Stainless Steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non packaging steel)"

General characteristics

The principal features of DX2205/DX1803 are:

- An excellent corrosion resistance, with a minimum PREN value of 35 for DX2205 and 33 for DX1803
- Twice as high yield strength as our grade 18-9E (1.4301, Type 304)
- Service temperature range: -40 °C to 300 °C

Applications

- Equipment and piping for the chemical industry, oil and gas industries and desalination plants
- Heat exchangers

Product range

Forms: sheet, blank, coil, strip

Thicknesses: 1.0 - 10 mm

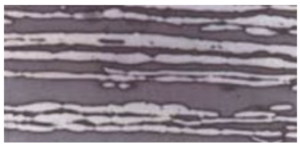
Width: up to 2000 mm (depends on thickness)

Finishes: hot rolled, cold rolled

Metallurgical properties

The grade DX2205/DX1803 is a stainless steel of the austeno-ferritic group, whose structure is composed of a mix of ferritic (α) and austenitic (γ) phases. The dual phase structure of the alloy makes it possible to obtain elevated yield strength values whilst still maintaining sufficient ductility. The hardening is indeed provided by the ferritic phase, whereas the austenitic lattice enables to preserve both ductility and toughness.

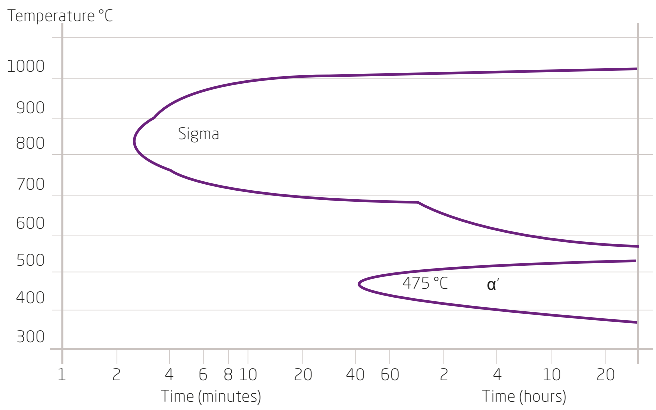
The mixed structure confers a good resistance to stress corrosion cracking to grade DX2205/DX1803 and also makes it insensitive to intergranular corrosion. Its high chromium and molybdenum content makes it resistant against both pitting and uniform corrosion.



Microstructure of DX2205/DX1803 (dark areas represent the ferritic phase)

Continuous use of DX2205/DX1803 at temperatures above 300 °C is not recommended for the following reasons:

- between 350 and 550 °C: loss of ductility by embrittlement of the ferritic phase due to the formation of a so-called α' phase, possibly accompanied by other embrittling phases; this is a classical phenomenon encountered with ferritic stainless steels, more commonly referred to as "475 °C embrittlement"
- between 600 and 950 °C: embrittling sigma phase precipitation, related to the high chromium and molybdenum content



Physical properties

Cold rolled and annealed sheet.

Density	d	kg/dm³	20 °C	7.8
Melting temperature	-	°C	-	1430
Specific heat	c	J/kg.K	20 °C	460
Thermal conductivity	k	W/m.K	20 °C	13.5
Mean thermal expansion coefficient*	α	10^{-6}/K	20-200 °C 20-400 °C	14.0 14.5
Electric resistivity	ρ	Ω mm²/m	20°C	0.8
Magnetic	-	-	-	yes
Young's Modulus	E	10^3 MPa	20 °C	200

*Thermal expansion 25% lower than that of 316, comparable with carbon steel

Mechanical properties

In annealed condition at 20°C

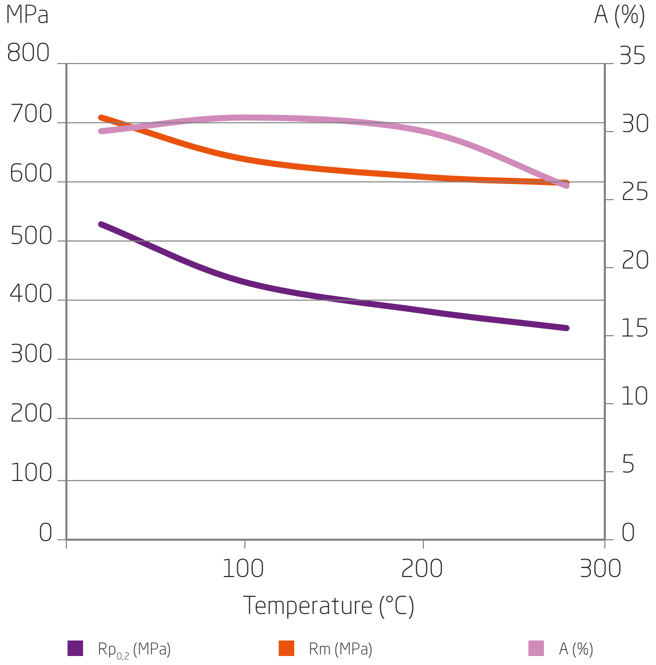
According to ISO 6892-1, transverse direction

Gauge length: 50 mm

Grade	European designation	UNS designation	Rm [1] (MPa)	$Rp_{0.2}$ [2] (MPa)	A [3] %
DX2205	1.4462	S32205	800	620	30
DX1803	1.4462	S31803	800	620	30
DX2202	1.4062	S32202	710	530	30
DX2304	1.4362	S32304	730	550	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

At high temperatures



Typical impact toughness

Temperature (°C)	Kv min.* (J/cm²)
20	250
-40	200

*Kv_2 transversal, HRAP 5mm

Corrosion resistance

General corrosion resistance

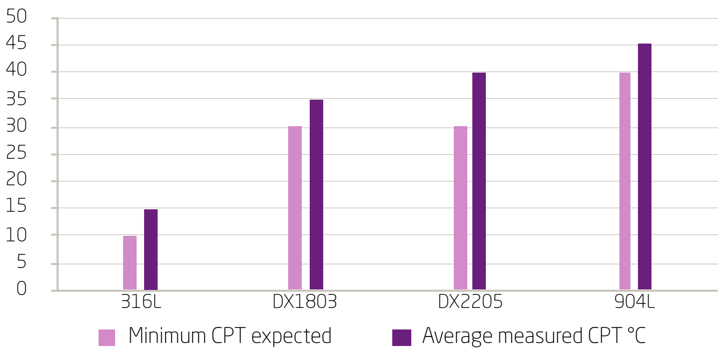
This grade is particularly recommended under severe corrosion conditions, where it can replace highly alloyed austenitic stainless steels.

Pitting corrosion

Given its higher chromium, molybdenum and nitrogen content, our DX2205/DX1803 exhibits very good resistance against pitting corrosion.

Its performance is in fact well superior to that of 316L. The pitting corrosion resistance ranking of stainless steels is generally established by means of the PREN (Pitting Resistance Equivalent Number = %Cr + 3.3*%Mo + 16*%N) formula. DX2205's value typically lies around 35.7 compared to 24.1 for the 1.4404, Type 316 grade and 26 for the DX2304 grade.

Critical Pitting Temperature (°C)



Intergranular corrosion

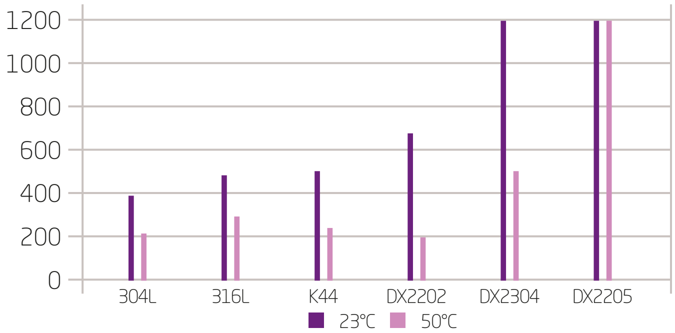
The DX2205/DX1803 is resistant to intergranular corrosion and is conform to the requirements of following standards:

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

Stress corrosion cracking

Due to its dual phase structure, DX2205/DX1803 is hardly sensitive to stress corrosion cracking. It shows adequate resistance in acid gas environments ($CO_2 + H_2S$).

Pitting potential (mV/SCE)

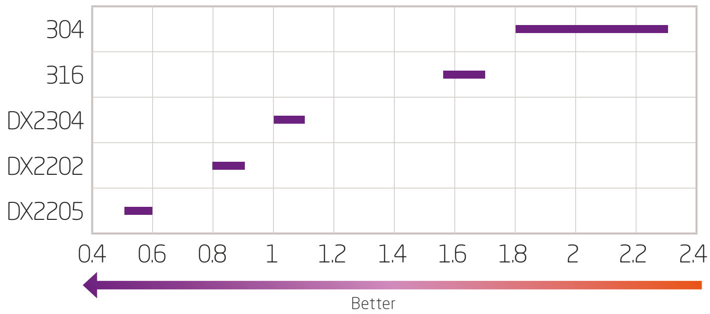


Crevice Corrosion

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 sufficiant 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



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 about double 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 ration (LDR).

Bending

For thicknesses below 0.8 mm, a minimum bending radius of 0.5 x thickness is recommended. For heavier gauges, the bending radius must be at least 1.5 x thickness.

Grade	Stretching: Erichsen height* (mm)	Limiting Drawing Ratio* (LDR)
DX2205	9.5	1.9 - 1.95
DX1803	9.5	1.9 - 1.95
DX2202	10.5	1.9 - 1.95
DX2304	9.5	1.95 - 2.0
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 DX2205/DX1803 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.

Welding (continued)

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 DX2205/DX1803 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 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 22 9 3 N L [1] ER2209 [2]	G 22 9 3 N L [1] ER2209 [2]	Ar + 2-3% N_2 Ar, Ar+ He
PLASMA	≤ 1.5 mm	> 0.5 mm		P 22 9 3 N L [1] ER2209 [2]	Ar + 2-3% N_2 Ar, Ar+ He
MIG		> 0.8 mm		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 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 cold forming, an annealing treatment of a couple of minutes at 1050 +/- 25°C, followed by air cooling restores the structure and eliminates internal stresses. After heat treatment, pickling followed by passivation must be carried out.

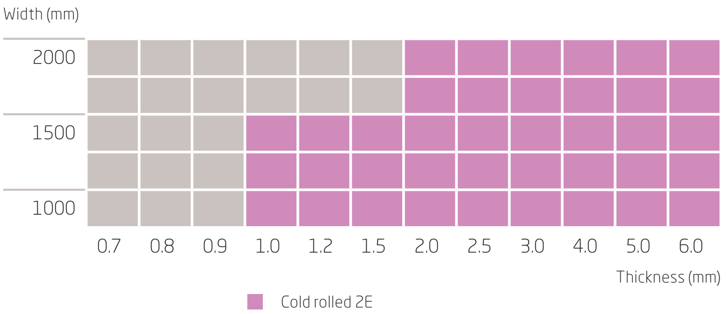
Pickling

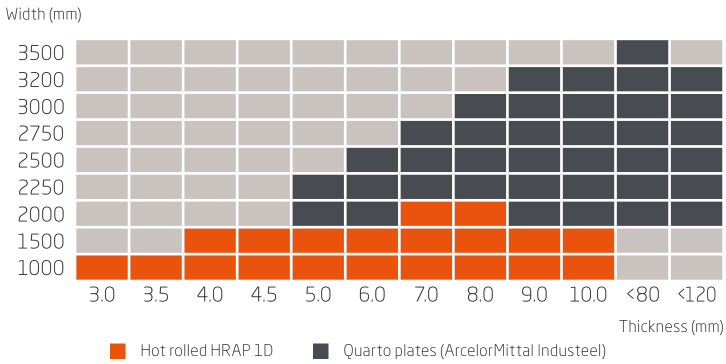
By acid mix (20% HNO_3 + 2% HF) at room temperature or at 60°C. By sulphuric-nitric bath (10% H_2SO_4 + 0.5% HNO_3) at room temperature or at 60 °C. Pickling pastes for welds.

Passivation

Nitric acid bath (10 – 25 %) at 20 °C. Passivating pastes for welds.

General size range for Duplex





Please consult us for sizes outside this range.

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