Industeel

ArcelorMittal

SIRIUS™ 314

SIRIUS™ 314: A 25% Cr - 1.8% Si Heat Resistant Stainless Steel

SIRIUS™ 314 grade is a fully austenitic stainless steel containing 25% Cr, 20% Ni and 1.8% Si. The alloy is designed for high temperature corrosion resistance applications even in severe conditions. Carbon additions are optimized in order to increase creep properties and mechanical properties. The alloy is well designed for applications up to 1150°C (2102°F) in oxidizing atmospheres, or up to 1050°C (2012°F) in reducing atmospheres. Sulphur, carbon or nitrogen pick up reduce the behaviour of the steel. The alloy performs better than SIRIUS™ 310S or SIRIUS™ 253 grades in most of the applications.

PROPERTIES

STANDARDS

> EURONORM: EN 1.4841 X15 Cr Ni Si 25 - 21

> ASTM: Type 314 UNS S31400

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Si	N	Others
< .15	25	20	1.8	-	-

PHYSICAL PROPERTIES

Density: 7.9 kg/dm^3

Interval temperature (°C)	Thermal expansion (α x10^{-6} K^{-1})	T °C (°F)	Resistivity (µΩ.cm)	Thermal conductivity (W.m^{-1}.K^{-1})	Specific heat (J.kg^{-1}.K^{-1})	Young modulus E (GPa)	Shear modulus G (GPa)
20 - 100	16	20 (68)	95	14	500	200	75
20 - 200	17	200 (392)	105	16	580	185	70
20 - 400	18	400 (752)	115	18	710	170	64
20 - 600	18.5	600 (1112)	125	20	820	155	58
20 - 800	19	800 (1472)	130	22	900	135	53
20 - 1000	19.5	1000 (1832)	135	25	960	120	45

MECHANICAL PROPERTIES

Temperature		Y.S. 0.2%		Y.S. 1%		UTS		Elongation
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	285	41	305	44	600	87	45
100	212	230	33	250	36	570	83	45
200	392	190	27	205	30	550	84	45
400	572	170	25	180	26	500	72	45
600	752	150	22	160	23	410	59	45
800	1472	120	17	125	18	200	29	45
1000	1832	(30)	(4)	(35)	(5)	(40)	(6)	45

Typical tensile properties after solution annealing heat treatment. Results obtained on 10 mm (.39") hot rolled plates

CREEP PROPERTIES

Typical creep values

Temperature		Creep strain MPa			Creep rupture MPa		
°C	°F	1000h	10000h	100000h	1000h	10000h	100000h
600	1112	130	105	45	210	1 50	90
700	1292	53	37	21	85	50	20
800	1472	23	12	9	40	20	10
900	1652	10	7	3	20	10	5
1000	1832	5	3	1.5	7	4	2

STRUCTURE

SIRIUS™ 314 heat resistant steel has a fully austenitic structure. The high carbon content is used to improve the creep properties of the alloy and explains why some carbide precipitations may be observed on grain boundaries. After high temperature uses - mostly between 650°C and 900°C (1202°F and 1652°F), due to high chromium and silicon contents, the alloy is susceptible to phase transformations and embrittlement effects may occur. A new solution annealing treatment at 1100 - 1150°C (2012 - 2102°F) is recommended to restore part of the ductility.

IN SERVICE CONDITIONS

CORROSION RESISTANCE

Wet corrosion resistance

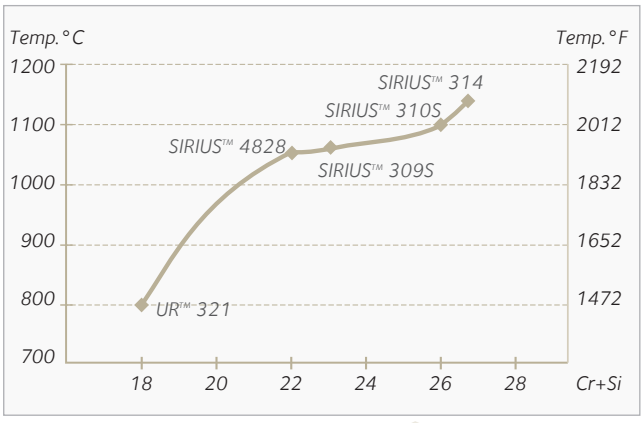
Due to carbon additions, the alloy is sensitive to intergranular corrosion phenomenon after sensibilisation.
The alloy is not designed for wet corrosion resistance even if it contains 25% Cr, which improves its corrosion resistance behaviour.

High temperature corrosion resistance

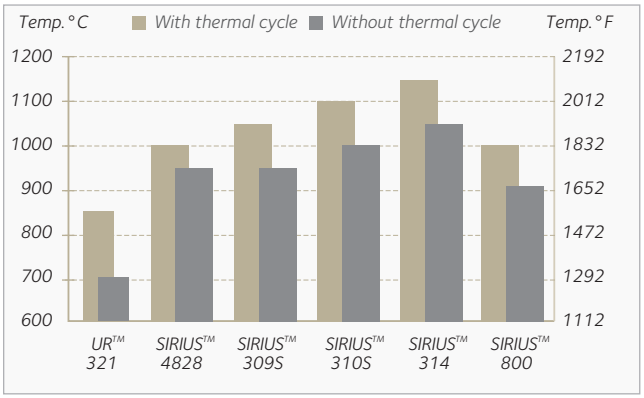
The fully austenitic microstructure combined with the high additions of chromium (25%) and silicon (1.8%) explain the particular high resistance to oxidation for high temperatures applications, even in atmospheres containing sulphur, carbon or nitrogen species.
Typical working temperatures are as follow:

- **> Oxidating atmospheres with no or low sulphur (S ≤ 2 g/m³): 1100°C (2012°F) continuous service; 1150°C (2102°F) peak temperature.**
- **> Oxidating atmospheres with sulphur species: 950°C (1742°F) continuous service.**
- **> Low oxydating atmosphere with no or low sulphur (S ≤ 2 g/m³): 1050° C (1922°F) continuous services; 1100°C (2012°F) peak temperature.**
- **> Low oxydating atmosphere with sulphur species < 750°C (1382°F) maximum, continuous service.**
- **> Nitriding or carburizing atmospheres: 950°C (1742°F) continuous services.**

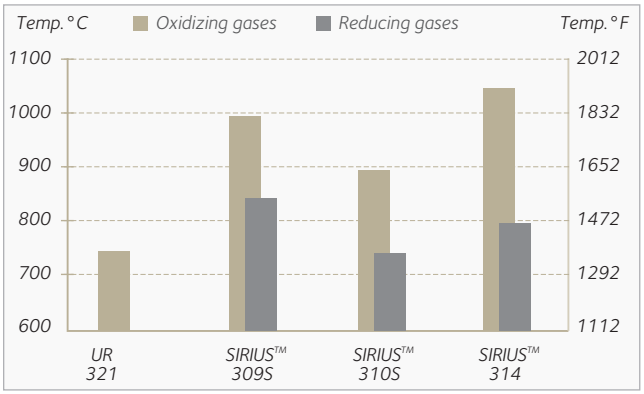
The alloy is not designed for reducing and nitriding or carburizing atmospheres. Higher nickel contents alloys are here considered.



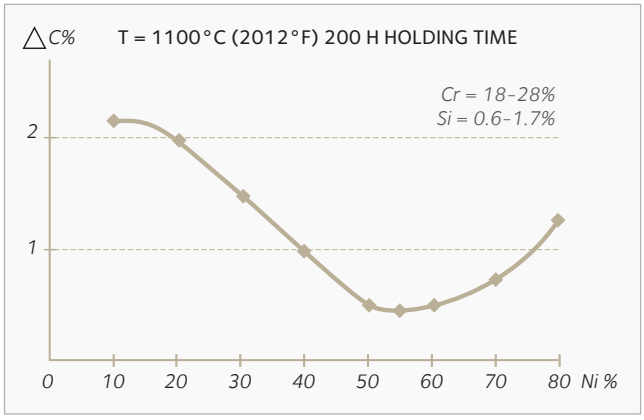
Effect of chromium and silicium additions on the peak temperature when considering the resistance to high temperature oxydation.



Limits of uses for high temperature corrosion resistance grades in air without and with thermal cycles



Limits of use for high temperature corrosion resistant grades in sulphur containing gases (3 g/m³)



Effects of silicon, chromium and nickel additions on the pick up of carbon during cementery treatments performed for 200h at 1100°C (2012°F). High nickel content grades (alloy 800) are to be considered as well as steels with increased chromium and silicon contents.

DELIVERY CONDITIONS

SIZE RANGE

	Quarto plates	Clad plates
Thickness	5 to 150 mm 3/16" to 6"	6 to 150 mm 1/4" to 6"
Width	Up to 3300 mm Up to 130"	Up to 3300 mm Up to 130"
Length	Up to 12000 mm Up to 39 ft	Up to 14000 mm Up to 46 ft

Other sizes are available on request, including 4100 mm (161.4") width plates.

PLATE PROCESSING

HOT FORMING

Hot forming should be carried out in a temperature range of 1200 - 950°C (2192 - 1742°F) after the piece has been uniformly heat treated. Final full annealing heat treatment at 1000 - 1150°C (1832 - 2102°F) followed by rapid quenching is generally recommended after hot forming, particularly when temperature drops below 1000°C (1832°F) during hot forming operation. Use non sulphur and tighly oxidizing atmospheres for heat treatments.

COLD FORMING

SIRIUS™ 314 grade can be easily cold formed without any problem. The austenitic structure makes the alloy very ductile. Its behaviour is equivalent to 316 grades. Cold forming on aged structures, after long term exposure at high temperature, is not recommended since the alloy is sensitive to intergranular carbide precipitations and intermetallic phase precipitations, mainly between 650 and 900°C (1202 and 1652°F).

PICKLING

In most of the applications, SIRIUS™ 314 may be used in the non pickled conditions since the high temperature oxide scale formed during heat treatment is very protective in most of the applications. If pickling is required, stronger etching conditions are to be used than those recommended for 304 grades. This is explained by the high chromium and silicon additions of the grade. Typical conditions are HNO_3 10 - 20%+ HF 1,5 - 5% + H_20 for 20 minutes at 50 - 60°C (122 - 140°F). Do not over etch in order to avoid intergranular corrosion effects.

WELDING

Alloy SIRIUS™ 314 may be welded with most of the welding processes. This includes: TIG, PLASMA, MIG Weldings as well as SMAW, SAW and FCAW processes. Use AWS/ASME E309 - 15 (AWS A - 5 - 4 or ASME SFA5 - 4) electrodes or AWS/ASME ER 309 wires while for the final passes AWS/ASME E309 - 15 (AWS A - 5 - 9 or ASME SF5 - 9) electrodes or AWS/ASME ER 309 wires are recommended. The best toughness results will be obtained with basic products when considering weldings with SAW, SWMW or FCAW with argon as TIG shielding gases. Interpass temperature is limited at 120°C (248°F). Usual precautions for stainless steels including cleaning and degreasing of weld areas, protection against weld spatters must be taken. Grind the start and the finish of each filler pass before to start with next filler pass. Heat input must be limited at 1,5 KJ/mn max, and interpass temperature must be kept below than 120°C (248°F). Mechanical methods including grinding and polishing will be used to remove oxide, slag incrustations, heat tint or other surface contamination. Etching with pastes are also allowed but avoid overetching.

APPLICATIONS

> **Furnaces:** burners, heat recupertors, doors, circulating fans and pipings... for the most critical conditions.

> **Pyrometallurgy:** smelter and steel melting equipments, rollers for continuous casting equipments...

> **Heat treatment furnaces:** walking beams, doors, burners grids, heat recuperators including for nitriding and cementary gases...

> **Sintering or cement plants:** feeding and discharging systems, burners and burners shield, wind boxes...

> **On/Offshore - Refineries:** candelabra, catalytic recovery systems, recuperators...

> **Fluidised bed furnaces:** grids, wind boxes, pipings...

YOUR CONTACTS

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