Industeel

ArcelorMittal

SIRIUS™ 310S

SIRIUS™ 310S: A 25% Cr - 0.6% Si Heat Resistant Stainless Steel

SIRIUS™ 310S grade is a fully austenitic stainless steel containing 25% Cr, 20% Ni and 0.6% Si additions. The alloy is well known for its multi - purpose high temperature corrosion resistance behaviour. Carbon additions are optimized in order to provide improved creep resistance properties. Alloy **SIRIUS™ 310S** can be easily welded. The alloy is designed for high temperature applications up to 1100°C (2010°F) in oxidizing atmospheres. The alloy can be also used in slightly oxidizing atmospheres, nitriding, cementing, sulphurising conditions as well as with thermal cyclings, but the maximum temperature of use will be reduced.

PROPERTIES

STANDARDS

> EURONORM: EN 1.4845 X8 CrNi 25 - 21

> ASTM: 310S UNS S31009

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Si	N	Others
< .1	25	20	.6	-	-

PHYSICAL PROPERTIES

Density: 7.9 kg/dm^3

Interval temperature (°C)	Thermal expansion (αx10^{-6} K^{-1})	T °C (°F)	Resistivity ($\mu\Omega$.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	15.5	20 (68)	90	14	480	200	75
20 - 200	16	200 (392)	100	16	560	185	70
20 - 400	17	400 (752)	110	18	680	170	64
20 - 600	18	600 (1112)	120	20	780	155	58
20 - 800	18.5	800 (1472)	125	22	870	135	53
20 - 1000	19	1000 (1832)	130	24	930	120	45

MECHANICAL PROPERTIES

Temperature		Y.S. 0.2%		Y.S. 1%		UTS		Elongation
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	245	35	265	38	550	80	45
100	212	200	29	220	32	500	72	45
200	392	170	25	180	26	460	66	45
400	572	145	21	155	22	420	61	45
600	752	120	17	125	17	360	52	45
800	1472	95	14	100	14	125	18	45
1000	1832	(20)	(3)	(22)	(3)	(30)	(4)	45

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

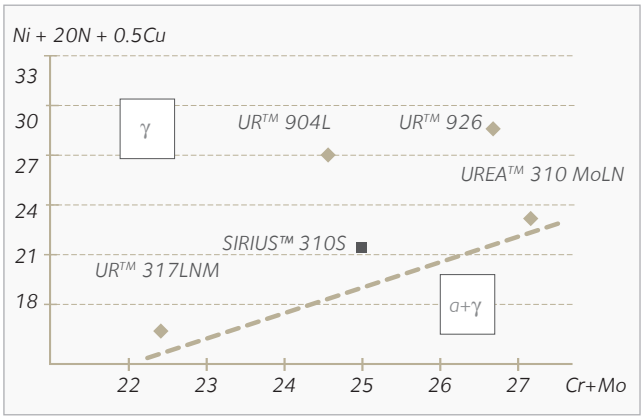
CREEP PROPERTIES

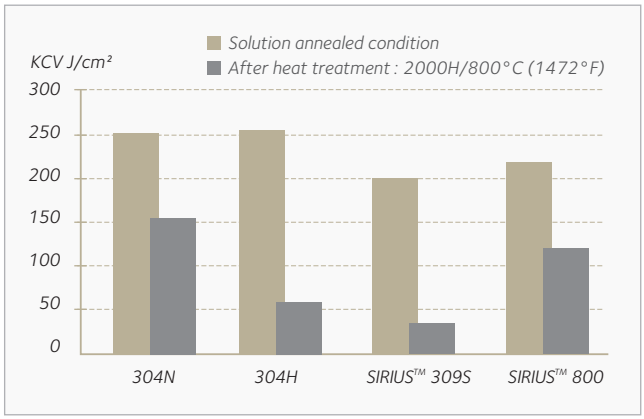
Typical creep properties

Temperature		Creep strain MPa			Creep rupture MPa		
°C	°F	1000h	10000h	100000h	1000h	10000h	100000h
600	1112	120	100	40	200	140	80
700	1292	50	35	20	80	45	20
800	1472	20	10	8	35	20	8
900	1652	10	6	3	15	10	5
1000	1832	5	3	1.5	9	4	2

STRUCTURE

SIRIUS™ 310S grade is a fully austenitic stainless steel with some carbide precipitations. Carbon additions have been optimized to improve creep properties.





When heated between 650 and 950°C (1202 - 1742°F) the alloy is subject to intermetallic phase precipitations which reduce its toughness properties. In order to restore part of the toughness properties, a solution annealing treatment at 1100 - 1150°C (2012 - 2102°F) is required.

CORROSION RESISTANCE

Wet corrosion resistance

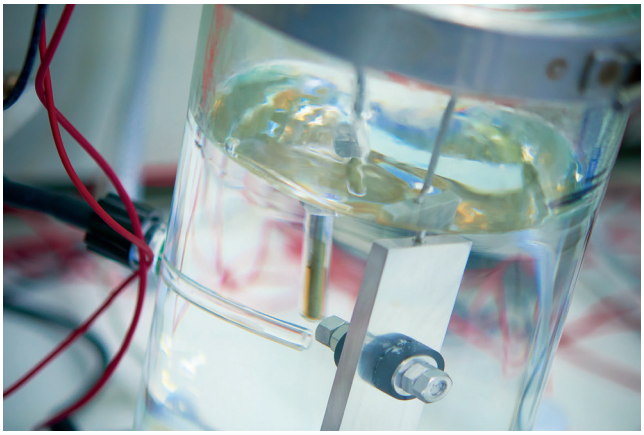
Alloy SIRIUS™ 310S is not designed to resist in wet corrosion solutions. This is explained by the higher carbon content of the grade which is optimized for creep properties purposes. After long term exposure at high temperature, the grade may even be more susceptible to intergranular corrosion phenomena due to intergranular precipitations effects. Nevertheless, due to its high chromium content (25%) the grade is much more corrosion resistant than most of the other heat resistant steels.

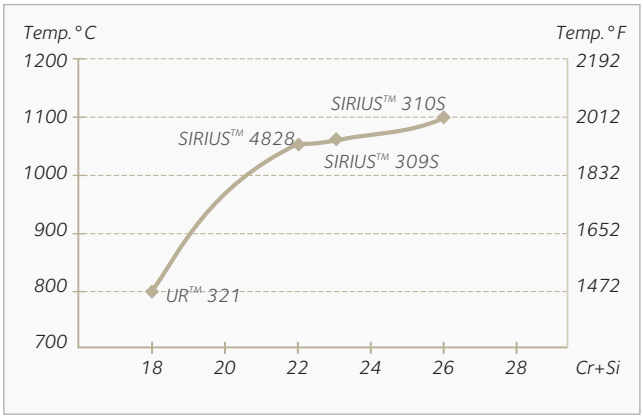
High temperature corrosion resistance

The fully austenitic microstructure combined with the high additions of chromium (25%) and silicon (0.6%), make alloy SIRIUS™ 310S very resistant to high temperature corrosion phenomena in most of the inservice conditions. Typical working temperatures are as follow:

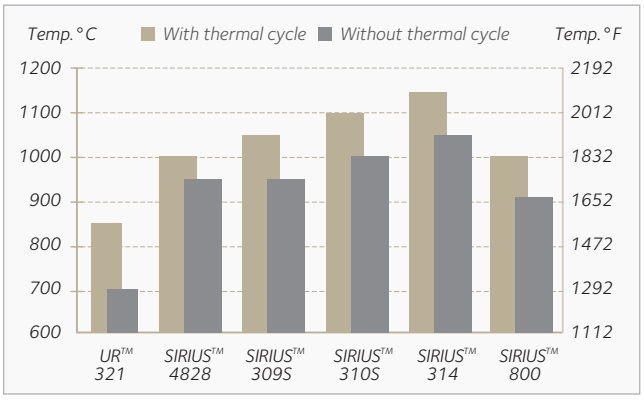
- **Oxidating atmospheres with a maximum sulphur content of 2 g/m³: 1050°C (1922°F) continuous service; 1100°C (2012°F) peak temperature.**
- **Oxidating atmospheres with sulphur content higher than 2 g/m³: 950°C (1742°F) maximum.**
- **Low oxygen atmosphere containing atmospheres with a maximum 2 g/m³ sulphur content: 1000° C (1832°F) maximum.**
- **Low oxygen atmosphere with a sulphur content higher than 2 g/m³: 750° C (1382°F) maximum.**
- **Nitriding or carburizing atmospheres: 900 to 1000°C (1652 to 1932°F) maximum.**

The alloy is not designed for reducing and nitriding or carburizing atmospheres where higher nickel contents alloys (SIRIUS™ 600 or 800 family) are prefered.
Nevertheless, SIRIUS™ 310S performs better in those conditions than most of the heat resistant stainless steels.





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

DELIVERY CONDITIONS

SIZE RANGE

	Hot rolled 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™ 310S 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™ 310S 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™ 310S 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 E310 - 15 (AWS A - 5 - 4 or ASME SFA5 - 4) electrodes or AWS/ASME ER 310 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 fluxes when considering weldings with SAW method of flux cored electrodes or argon as shielding gases. Interpass temperature is limited at 150°C (302°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. 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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