Industeel

ArcelorMittal

SIRIUS™ 309S

SIRIUS™ 309S: A 23% Cr - 13% Ni Heat Resistant Stainless Steel

SIRIUS™ 309S grade is a fully austenitic stainless steel containing 23% Cr, and 13% Ni 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™ 309S** can be easily welded. With its high chromium and low nickel contents, the alloy is designed for high temperature applications up to 1000°C (1832°F) in sulphur containing atmospheres. Higher sulphur content in gases will result in lower maximum temperature of uses. The alloy can be also used in slightly oxidizing atmospheres, nitriding, cementing conditions as well as with thermal cyclings, but the maximum temperature of use will be reduced.

PROPERTIES

STANDARDS

> EURONORM: EN 1.4833 X12 CrNi 23 - 13

> ASTM: 309S UNS S30908

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Si	N	Others
< .08	23	13	< .75	-	.04 < C < .08

PHYSICAL PROPERTIES

Density: 7.9 kg/dm^3

Interval temperature (°C)	Thermal expansion (αx10^{-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	14.5	20 (68)	80	14	500	200	75
20 - 200	15	200 (392)	90	17	520	185	70
20 - 400	16	400 (752)	100	19	560	170	64
20 - 600	17	600 (1112)	110	21	600	155	58
20 - 800	18	800 (1472)	115	24	640	135	53
20 - 1000	18.5	1000 (1832)	120	25	680	120	45

MECHANICAL PROPERTIES

Temperature		Y.S. 0.2%		Y.S. 1%		UTS		Elongation
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	240	34	260	38	540	78	40
100	212	190	27	210	30	500	72	-
200	392	160	23	190	27	460	66	-
400	572	145	21	155	22	420	61	-
600	752	120	17	125	17	360	52	-
800	1472	80	14	90	14	120	18	-
900	1652	40	5	50	7	70	10	-
1000	1832	(20)	(3)	(22)	(3)	(30)	(4)	-

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

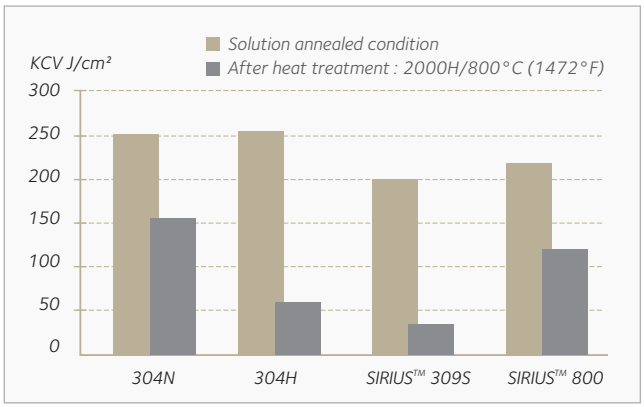
CREEP PROPERTIES

Typical creep properties

Temperature		Creep strain MPa			Creep rupture MPa		
°C	°F	1000 H	10000 H	100000 H	1000 H	10000 H	100000 H
600	1112	120	80	40	190	120	65
700	1292	50	25	20	75	36	16
800	1472	20	10	8	35	18	7.5
900	1652	8	4	3	15	8.5	3
1000	1832	4	2.5	1.5	8	4	1.5

STRUCTURE

SIRIUS™ 309S 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.



IN SERVICE CONDITIONS

CORROSION RESISTANCE

Wet corrosion resistance

Alloy SIRIUS™ 309S 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 (23%) 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 (23%) and low nickel (13%) additions make alloy SIRIUS™ 309S very resistant to high temperature corrosion phenomena in most of the in-service conditions. Typical working temperatures are as follow:

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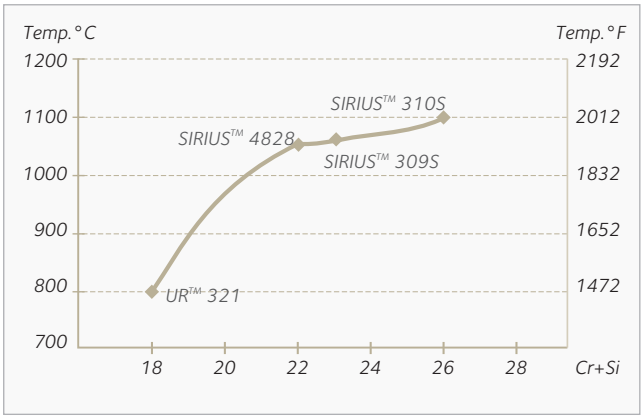
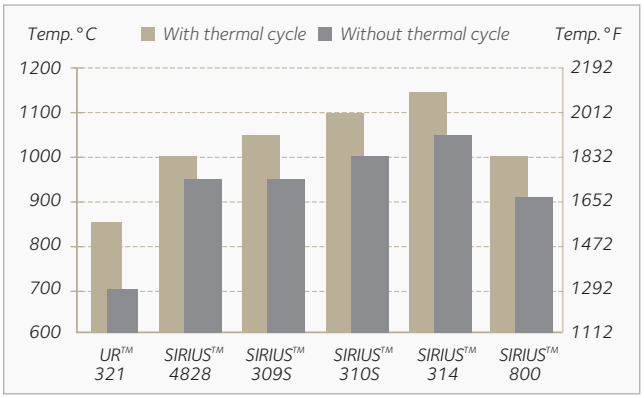
- **Oxidating atmospheres with a maximum sulphur content of 2 g/m³: 1050°C (1922°F) continuous service; 1100°C (2012°F) peak temperature.**
- **Oxidating atmospheres with sulphur content higher than 2 g/m³: 950°C (1742°F) maximum.**
- **Low oxygen atmosphere containing atmospheres with a maximum 2 g/m³ sulphur conten: 1000° C (1832°F) maximum.**
- **Nitriding or carburizing atmospheres: 850 to 950°C (1562 to 1742°F) maximum, depending of the inservice conditions. Higher nickel containing grades are generally recommended in those conditions.**

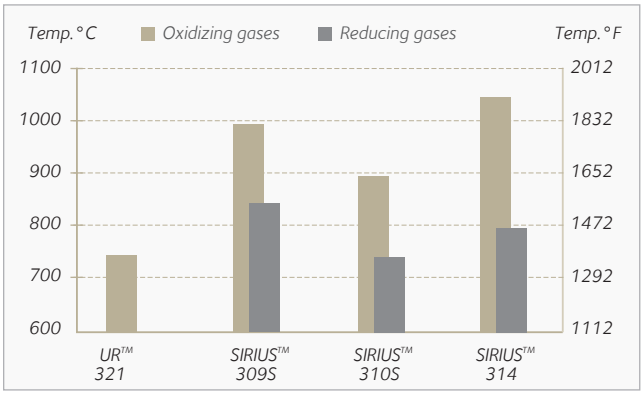
The alloy is not designed for reducing and nitriding or carburizing atmospheres where higher nickel contents alloys (SIRIUS™ 600 or 800 family) are prefered. Nevertheless, SIRIUS™ 309 performs better in those conditions than most of the heat resistant stainless steels.



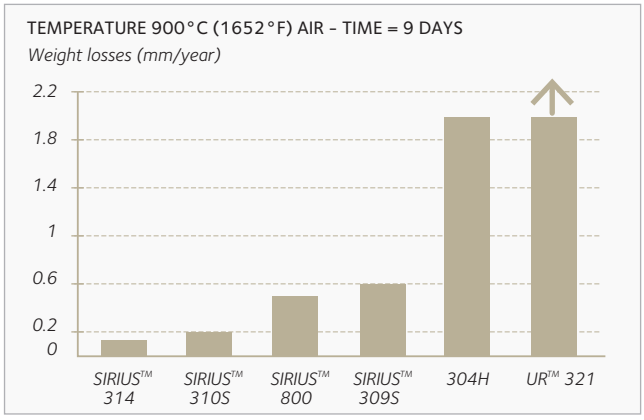
Effect of chromium and silicium additions on the peak temperature when considering the resistance to high temperature oxydation.



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



Corrosion resistance at high temperature tin sulphured atmosphere



Corrosion test at high temperature 900°C (1652°F) - Air - 9 days

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™ 309S 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™ 309S 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™ 309S 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 - L 16 or 15 (AWS A - 5 - 902 or ASME SF5 - 9) 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 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 recuperators, doors, circulating fans and pipings... for the most critical conditions.

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

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

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

YOUR CONTACTS

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