Industeel

ArcelorMittal

SIRIUS™ 815

SIRIUS™ 815: A rare earth containing heat resistant steel

SIRIUS™ 815 grade is a fully austenitic stainless steel containing 21 Cr, 1.7 Si, 0.17N and Rare Earth elements (cerium, lanthane,...) which make the alloy particularly well designed for high temperature applications.
The nitrogen additions stabilize the austenitic microstructure, particularly at high temperatures. The alloy is less susceptible to embrittlements effects occuring after long term exposure. Creep properties are enhanced, due to high chromium and nitrogen. Rare Earth elements (Ce, La,...) are added in order to anchor the oxide protective film and improve the resistance of the steel to oxide spaling. As a result, the alloy is much more resistant to high temperature thermal cycling effects in oxidizing atmospheres compared to grade 310.
SIRIUS™ 815 grade may be used up to 1100°C (2012°F) in oxidizing environments. Thermal cycling effects, sulphur containing atmospheres and low oxygen contents reduce the high temperature resistance of the steel.

PROPERTIES

STANDARDS

> EURONORM: EN 1.4835 - 10095 - X9 Cr Ni Si N Ce 21-11-2

> ASTM: UNS S30815

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Si	N	Others
0.08	21	11	1.7	0.17	RE*: 0.04

**RE: Rare Earth elements like Cerium, Lanthane...*

PHYSICAL PROPERTIES

Density: 7.9 kg/m³

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	16	20 (68)	90	15	500	200	75
20 - 200	17	200 (392)	105	17	530	185	70
20 - 400	18	400 (752)	117	20	570	170	64
20 - 600	18.5	600 (1112)	130	23	600	155	58
20 - 800	19	800 (1472)	140	25	630	135	53
20 - 1 000	19.5	1000 (1832)	145	28	660	120	48

MECHANICAL PROPERTIES

Typical tensile properties after solution annealing heat treatment

°C	Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	°F	YS 0.2% ksi	YS 1.0% ksi	UTS ksi	A/ Elongation%
20	350	370	680	68	51	54	98	40
100	260	280	620	212	38	41	90	-
200	220	240	570	392	32	35	83	-
400	180	195	520	752	26	28	75	-
600	160	180	450	1112	23	26	65	-
800	(120)	(125)	(260)	1472	(17)	(18)	(38)	-

Results obtained on 10mm hot rolled plates.

CREEP PROPERTIES

Typical values (MPa)

Temperature		Creep strain (1%) MPa			Creep rupture MPa		
°C	°F	1000h	10000h	100000h	1000h	10000h	100000h
600	1112	200	125	80	240	160	90
700	1292	72	45	25	110	65	35
800	1472	35	20	11	50	27	15
900	1652	16	10	6	24	12	8
1000	1832	7	5	3	12	7	4
1100	2012	(4)	(2.5)	(1)	(9)	(4)	(2)

For minimum creep properties values, consider a reduction of about 20% on typical values.

STRUCTURE

The SIRIUS™ 815 grade exhibits a fully austenitic microstructure with small carbo-nitride precipitations. The structure is optimised in order to obtain the improved creep properties as well as better structure stability at high temperature i.e. the alloy is less prone to intermetallic phase precipitations which reduce the ductility of the alloy. After long term, high temperature service, the mechanical properties of the alloy are reduced. A full annealing heat treatment at 1100°C (2012°F) restores its ductility.

IN SERVICE CONDITIONS

CORROSION RESISTANCE

Wet corrosion resistance

The alloy is not designed to resist wet corrosion. The alloy is sensitive to intergranular corrosion due to its microstructure optimised for creep properties. Intergranular corrosion are not applicable to this grade.

High temperature corrosion resistance

> **Oxidation** - SIRIUS™ 815 is particularly designed to resist oxidation. Its chemistry i.e. chromium, silicon and Rare Earth elements additions is balanced in order to form a thin adhesive and protective oxide film on the surface which reduces further oxidation during in service application. The alloy is suitable even for cyclic temperature variations. The maximum service temperature in static oxidation conditions is approximately about 1150°C (2102°F).

> **Sulphurising atmospheres -** Sulphur is often present in oil, gases... as residual element. As a result, furnace gases may contain various levels of sulphur species which are known to attack nickel based alloys and nickel containing steels at high temperature. Due to its thin, compact, adhesive superficial protective film made of oxides and low nickel content SIRIUS™ 815 resists better to sulphur attack than alloys with a high nickel content and/or a rough, non compact superficial film of oxides. The grade is not suitable for use in reducing atmospheres containing sulphur species or elemental sulphur. In that case, nickel free steels are recommended.

> **Carburizing atmospheres** - Carburizing atmospheres, like those produced when oil residues are cracked may result in heavy carbon pick-up with formation of carbides in the steel. As a result, oxidation resistance is reduced as well as the resistance to sulphur attack. This is particularly the case in carburizing, reducing environments. In such applications, nickel based alloys will be prefered (800 or 600 alloys). Due to its thin compact adhesive superficial protective film, SIRIUS™ 815 grade reduces pick up of carbon when oxygen level in the gases is sufficient to form a protective film.

> **Nitriding atmospheres -** Nitrogen pick-up at high temperature in furnaces using cracked amonia or N_2/H_2 mixtures as protective gases, may result in severe embrittlement problems particularly in reducing atmospheres. For such applications, nickel based alloys containing chromium and silicon additions (Sirius™ 800 or 600 grades) are prefered. In mixed gases containing enough oxygen to form a protective oxide superficial layer on SIRIUS™ 815, the pick - up of nitrogen is delayed. In that case, Alloy SIRIUS™ 815 has improved properties compared to other stainless steels due to the specific properties of its oxide superficial layer.

DELIVERY CONDITIONS

SIZE RANGE

	Hot rolled plates	Clad plates
Thickness	6 to 40 mm 0.236" to 1.58"	6 to 150 mm 1/4" to 6"
Width	Up to 2900 mm Up to 114"	Up to 3300 mm Up to 130"
Length	Up to 12000 mm Up to 472"	Up to 14000 mm Up to 551"

HOT FORMING

Hot forming should be carried out in a temperature range of 1150°C - 900°C (2102 - 1652°F) after the piece has been uniformely heated. Final full annealing heat treatment at 1020 - 1090°C (1868 - 1994°F) may be performed. Quenched annealing heat treatment is nevertheless not generally required since the material is designed for high temperature applications.

COLD FORMING

SIRIUS™ 815 grade can be cold formed without any problem. Its austenitic microstructure makes the alloy very ductile. The high nitrogen additions increase the mechanical properties. This explains why more strength is generally needed compared to standard austenitic grade. Long term high temperature service may reduce the ductility of the steel. Cold worked and aged structures may require a preliminary solution annealing heat treatment to restore the ductility of the steel.

PICKLING

Residual high temperature oxides improve the resistance of the steel to scaling. If the oxides must be removed, use sand blasting or controlled pickling solutions. Don't use strong pickling paste or solution even to clean up the welds due to possible intergranular corrosion.

WELDING

SIRIUS™ 815 grade is easily welded by following processes:
- GTA (TIG) welding - both normal and automatic
- GMA (MIG) welding
- Plasma welding or SMAW

Use SIRIUS™ 815 type products or as an alternative 309 type products. Nickel based filler materials containing Nb additions are not recommended since intermetallic intergranular precipitations may occur at fusion line. The SIRIUS™ 815 alloy is less sensitive to hot cracking phenomena than high nickel heat resistant steels. No pre or post welding heat treatments are required. Limit interpass temperature to 150°C (302°F). If necessary, stress relieve in the 900 - 1000°C (1652 - 1832°F) temperature range.

Usual precautions for stainless steels welds including cleaning and degreasing of weld areas, protection against weld spatters must be taken. Grind the start and finish of each filler pass before to start with the next filler pass. Mechanical methods, including fine grinding and polishing, will be prefered to pickling to remove oxide, slag, incrustations, heat tints or other surface contaminations. Strong pickling pastes should be avoided since the alloy is susceptible to intergranular corrosion in the as welded condition.

MACHINING

Operation	Tool	Lubrication	CONDITIONS		
			Depth of cut mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)
Turning	High speed steel	Cutting oil	6 (0.23)	0.5 (0.019)	12 - 17 (37 - 50)
			3 (0.11)	0.4 (0.016)	19 - 24 (62 - 80)
			1 (0.04)	0.2 (0.008)	25 - 30 (83 - 100)
	Carbide	Dry or cutting oil	6 (0.23)	0.5 (0.019)	72 - 82 (236 - 269)
			3 (0.11)	0.4 (0.016)	87 - 97 (285 - 318)
			1 (0.04)	0.2 (0.008)	105 - 115 (344 - 377)
			Blade width mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)
Parting off	High speed steel	Cutting oil	1.5 (0.06)	0.03 (0.0012)	19 - 24 (62 - 79)
			3 (0.11)	0.04 (0.0016)	20 - 25 (66 - 82)
			6 (0.23)	0.05 (0.0020)	21 - 26 (69 - 85)
			Drill Ø mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)
Drilling	High speed steel	Cutting oil	1.5 (0.06)	0.025 (0.0010)	10 - 14 (32.8 - 45.9)
			3 (0.11)	0.06 (0.0024)	11 - 15 (36.1 - 49.2)
			6 (0.23)	0.08 (0.0031)	11 - 15 (36.1 - 49.2)
			12 (0.48)	0.10 (0.0039)	11 - 15 (36.1 - 49.2)
				Feed mm/t (inch/t)	Speed m/min (feet/min)
Milling profiling	High speed steel	Cutting oil		0.05 - 0.10 (0.002 - 0.0039)	11 - 21 (36 - 68.9)

APPLICATIONS

> **Sintering plants:** grids, burners, suction boxes

> **Blast furnaces and cooling ovens:** heat recuperators, charging mechanisms, circulation and pipering

> **Steel melting, smelters:** extraction oods, flue gas ducts, dampers...

> **Continuous casting plants:** rollers, pre-heaters for ladles...

> **Rolling mills:** flue gas ducts, burners, electrical resistance components for furnace, rollers...

> **Heat treatment furnaces:** working beams, doors, burners, heat recuperators...

> **Cement plants:** feeding and discharging systems, rotary kilns, refractory anchors, burners and burner shields, gates, plates, wind boxes...

YOUR CONTACTS

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