

SOLEIL™ 4003

SOLEIL™ 4003: A cost effective, easy to fabricate 12% Cr stainless steel

SOLEIL™ 4003 is a cost effective weldable 12% Cr stainless steel combining:

- > Strength and ductility in the as delivered and as welded conditions
- > Corrosion and abrasion resistance in moderately aggressive conditions
- > Scaling resistance up to 600°C (1100°F)
- > Good welding and fabrication properties
- > Useful impact resistance

It is an attractive alternative to weathering steels, painted or galvanized steels in structural applications in natural or industrial environments.

PROPERTIES

STANDARDS

- > EURONORM EN 1.4003 X2 Cr Ni12
- > ASTM UNS S41003

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Mn	N
.015	12.2	.5	1.0	< .03

The dual phase, low carbon composition of SOLEIL™ 4003 is balanced to limit grain growth and hardening effects in the heat affected zone of welds. SOLEIL™ 4003, as opposed to older versions of low cost 12% Cr, contains no addition of titanium.

PHYSICAL PROPERTIES

Density: 7.8 kg/dm³

Interval temperature (°C)	Thermal expansion ($\alpha \times 10^{-6} \text{ K}^{-1}$)	T (°C)	Electrical resistivity ($\mu\Omega \cdot \text{cm}$)	Thermal conductivity ($\text{W m}^{-1} \text{ K}^{-1}$)	Specific heat ($\text{J kg}^{-1} \text{ K}^{-1}$)	Young modulus E (GPa)	Shear modulus G (GPa)	Poisson's ratio
20-100	10.5	20	0.60	24	460	220	85	0.3
20-200	11	100	0.67	25	480	215	82	0.3
20-300	11.5	200	0.75	25	500	210	80	0.3
20-400	12	300	0.82	26	540	200	77	0.3
20-500	12.2	400	0.90	26	620	190	72	0.3
20-600	12.5	-	-	-	-	-	-	-

PROPERTIES

Temperature interval (°F)	Thermal expansion $\alpha \times 10^{-6} \text{ F}^{-1}$	T (°F)	($\mu\Omega \cdot \text{cm}$)	Thermal conductivity (Btu.hr ⁻¹ .ft ⁻¹ .°F ⁻¹)	Specific heat $\times 10^6$ (Btu.lb ⁻¹ .°F ⁻¹)	Young modulus E $\times 10^6$ (psi)	Shear modulus G $\times 10^6$ (psi)	Poisson's ratio
68-212	5.8	68	0.60	14	0.11	31.9	12.3	0.3
68-392	6.1	212	0.67	14.5	0.115	31.1	11.9	0.3
68-572	6.4	392	0.75	14.5	0.12	30.4	11.6	0.3
68-752	6.7	572	0.82	15	0.13	29	11.2	0.3
68-932	6.8	752	0.90	15	0.15	27.5	10.4	0.3
68-1112	6.9	-	-	-	-	-	-	-

SOLEIL™ 4003 is magnetic and its Curie temperature is about 740°C (1360°F)

MECHANICAL PROPERTIES

	Y.S. 0.2		UTS		Elongation	Hardness
	MPa	ksi	MPa	ksi	%	HB
Guaranteed	>280	40	460-650	67-95	> 20	< 220
Typical	400	58	530	77	23	175

SOLEIL™ 4003 is normally delivered according to EN or ASTM A240 standards up to 75 mm (2.95") thickness. It can also be delivered up to 25 mm (1") thickness in a harder condition when so requested.

Y.S. 0.2		UTS		Elongation
MPa	ksi	MPa	ksi	%
≥ 320	46.5	460-650	67-95	> 18

Please, consult for specific requirements

HIGH TEMPERATURE PROPERTIES

SOLEIL™ 4003, thanks to its 12% chromium content, withstands oxidation up to 600°C (1100°F) in air and other oxidizing, low sulfur, low halogen environments.

It is less sensitive to 475°C (880°F) embrittlement than 17%Cr steels (series 430) and other higher alloyed ferritics.

Temperature		Y.S. 0.2		UTS		Elongation
°C	°F	MPa	ksi	MPa	Ksi	%
20	68	> 280	40	> 460	68	> 20
100	212	> 240	35	> 390	56.5	> 18
200	392	> 230	33	> 350	51	> 18
300	572	> 215	31	> 320	46.5	> 18
400	752	> 185	27	> 290	42	> 20
500	932	> 135	20	> 200	29	> 20
600	1112	> 80	11.5	> 100	14.5	> 22

IMPACT PROPERTIES

As a result of its dual phase structure, SOLEIL™ 4003 has better low temperature impact properties than fully ferritic grades. KV values at 20°C (68°F) are over 50J/cm² (30ft.lb) (average) and 35J/cm² (21ft.lb) individual.

IN SERVICE CONDITIONS

CORROSION RESISTANCE

SOLEIL™ 4003 has useful resistance in natural environments and moderate corrosive conditions.

Atmospheric corrosion

It can be used for its resistance to atmospheric corrosion where its thickness losses are much lower than those of weathering steels, and still ten times lower than for zinc or galvanized steel. It is also lower than for aluminium. However, after a few months of service, SOLEIL™ 4003 may develop a brown oxide layer which may be objectionable when cosmetic corrosion is not acceptable.

Transport systems

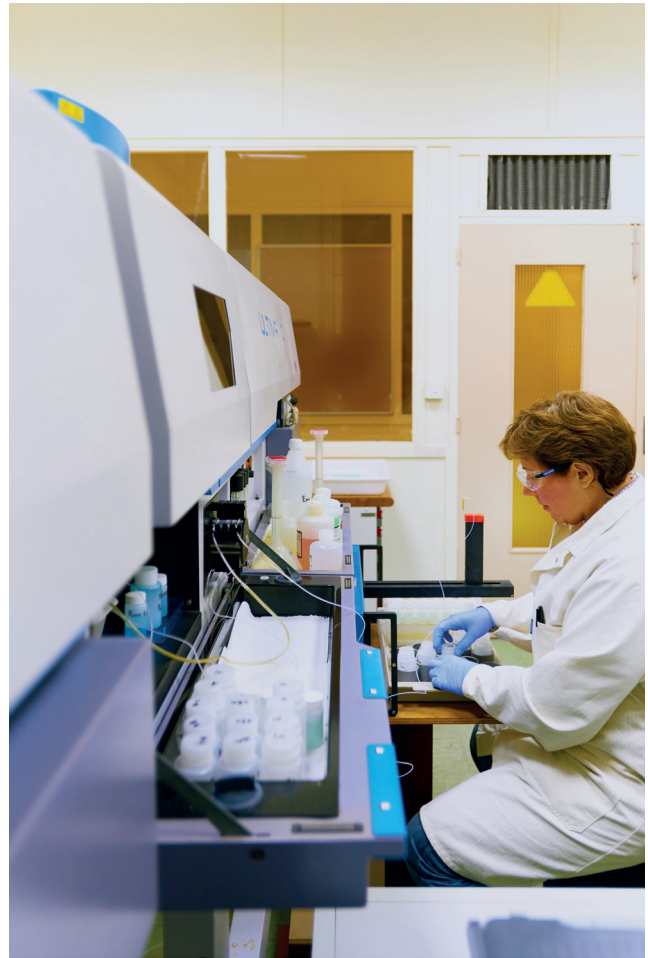
The surface of SOLEIL™ 4003 allows a regular flow of materials such as coal, ores, fertilizers, wood chips, cement and other granular products. The sliding ability of SOLEIL™ 4003 is maintained where structural steel surfaces lose their sliding properties because of oxidation and rust. SOLEIL™ 4003 therefore reduces clogging problems.

Water

SOLEIL™ 4003 has a better cavitation resistance than low alloy steels and may be used to protect HSLA steels from wear and cavitation effects in hydraulic systems, such as bends or areas of turbulent flow. However SOLEIL™ 4003 is a 12% Cr steel and may be subject to localized corrosion in water environments. Check with our specialists in case of doubt, as impurities such as chlorides, fouling, microbiological activity and temperature may require higher alloyed materials.

Wet abrasion and abrasion corrosion

In wet abrasive conditions, SOLEIL™ 4003 represents an alternative when carbon steels or even abrasion resistant steels suffer from corrosive attack or loss of sliding properties. Such applications have been found in ore mining, coal mining, ash disposal in power stations and in the sugar industry. Endless screws, conveyors, hoppers, chutes, bins, screens are examples of potential areas for combined abrasion and corrosion...



High temperature and oxidation resistance

SOLEIL™ 4003 may be used in refinery equipments to resist moderate sulfur attack, in chimneys, stacks, hot exhaust gas ducts, etc...It withstands oxidation up to 600°C (1100°F) in air or clean combustion atmospheres. The maximum service temperature limit is lower when sulfur containing impurities or chlorides are present or in reducing atmospheres. Creep must be considered when temperature exceeds approx 450°C (800°F).

DELIVERY CONDITIONS

SIZE RANGE

	Hot rolled plate
Thickness	5 to 50 mm 3/16" to 2"
Width	Up to 2930 mm Up to 115"

Above please consult.

HEAT TREATMENT AND STRUCTURE

SOLEIL™ 4003 is heat treated at 700°C (1290°F), followed by air cooling.

It exhibits a fine grain structure of ferrite and tempered martensite. Carbides may be present in small quantities, specially in the thicker plates. At -20°C (68°F), typical KV values are over 35J/cm² (21 ft.lb).

SURFACE FINISH

SOLEIL™ 4003 is delivered in the hot rolled heat treated and pickled condition.

- > ASTM : Finish 1
- > EN : Finish 1D

CUTTING

Shearing

Shearing can be used for the thinner plates. As for other stainless steels, blade clearance, stock support and tool sharpness must be controlled to optimize the quality of cuts. Clearance settings of 2,5% of plate thickness are normally recommended.

Plasma cutting

Plasma cutting of SOLEIL™ 4003 usually gives excellent results in terms of smoothness and cleanliness of cuts and the extent of the HAZ is limited. However, grinding of the plasma cut parts is recommended before welding or cold forming. The use of hydrogen containing carrier gases should be carefully evaluated when plasma cutting SOLEIL™ 4003 plates. Other methods such as sawing, abrasive cutting, water jet cutting are perfectly adapted to SOLEIL™ 4003 and give excellent results.

COLD FORMING

SOLEIL™ 4003 can be bent or roll formed using the same equipment as for carbon steel of similar strength. The minimum bending radius is twice the plate thickness. It is recommended to smooth sharp angles and remove the heat affected zone of flame cut sections by grinding before forming to avoid potential crack initiation sites.

HOT FORMING

SOLEIL™ 4003 can be hot formed at 600 - 700°C (1100 - 1290°F). In this case, the hot formed products need not be re-annealed. When forming is performed at higher temperatures (for instance 900 - 1000°C (1650 - 1830°F)) a new heat treatment at 700°C (1290°F) is required and its effect upon mechanical properties must be taken into consideration. Consult if necessary.

WELDING

SOLEIL™ 4003 is readily weldable employing the same processes as stainless steel. The parts to be welded must be clean and free of foreign material or dirt. Although the composition of SOLEIL™ 4003 has been balanced to limit grain growth in the heat affected zones, the heat input should be limited to 2 kJ/mm and interpass temperature limited to 200°C (392°F).

SOLEIL™ 4003 can be welded by SMAW, GTAW, GMAW, SAW, FCAW using filler materials type 309L, which are also used to weld CLC 4003 to carbon steel.

As for all ferritic steels, a low hydrogen practice is recommended which includes careful drying of welding fluxes and coatings, avoiding condensation on parts to be welded and protection from wet atmospheres... No post weld heat treatment is normally required for SOLEIL™ 4003. Preheating is not necessary except when welding parts at less than 5°C (40°F) where a soft preheating at 20 - 50°C (70° - 120°F) is advisable.



CLEANING AND DESCALING

As for all low alloy stainless steels, the surface condition may influence the performance in service of SOLEIL™ 4003. Discoloring or heat tints produced by welding or heating should be removed by:

- > pickling in HNO₃ - HF at 20-30°C (70-85°F) or using mild formulations of pickling pastes
- > brushing
- > glass bead or clean sand blasting
- > belt or flapper wheel polishing

A final cleaning in HNO₃ (10 - 20%) will remove imbedded ferrous particles which could initiate pitting or crevice corrosion in service. In all cases, the final cleaning procedures must be adapted to the expected conditions of storage, erection and service of the finished equipment.

APPLICATIONS

- > Agriculture and farming equipment
- > Transport systems, ore or coal railway cars high flow surfaces in material handling systems
- > Target plates in hydropower systems
- > Sugar beet processing
- > Exhaust gas ducts or chimneys
- > Refinery equipment
- > Welded structures



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Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.