CLC 4003

A cost effective, easy to fabricate 12%Cr stainless steel

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

- strength and ductility in the as delivered and as welded condition
- 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.

STANDARDS

EN 10088 - 2
EN 10028 - 7 } **1.4003 X2CrNi12**

ASTM A 240
ASME SA 240
ASTM A 1010 } **UNS S41003 (CLC 4003 also complies with UNS S 41008)**

CHEMICAL ANALYSIS

Typical values (weight-%)

C	Cr	Ni	Mn	N
0.015	12.2	0.5	1.0	<0.03

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

MECHANICAL PROPERTIES

CLC 4003 is normally delivered according to EN or ASTM A240 standards up to 75mm thickness

Properties	**Rp 0.2 *(YS)* MPa *(ksi)***	**Rm *(TS)* MPa *(ksi)***	**El. %**	**HB**
Guarantee	≥ 280 *(40)*	460 - 650 *(67 – 95)*	> 20	< 220
Typical	400 *(58)*	530 *(77)*	23	175

It can also be delivered up to 25mm *(1")* thickness in a harder condition when so requested.

Rp 0.2 (*YS*) MPa (*ksi*)	Rm (*TS*) MPa (*ksi*)	El. %
≥ 320 *(46,5)*	460 – 650 *(67 – 95)*	> 18

Please consult for specific requirements.

HIGH TEMPERATURE PROPERTIES

CLC 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 °C *(°F)*	Rp 0.2 *(YS)* MPa *(ksi)*	Rm *(TS)* MPa *(ksi)*	El. %
20 *(68)*	> 280 *(40)*	> 460 *(67)*	> 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, CLC 4003 has better low temperature impact properties than fully ferritic grades.
KV values at 20°C *(68°F)* are over 50J/cm^2 *(30ft.lb)* (average) and 35J/cm^2 *(21ft.lb)* individual.

At –20°C, typical KV values are over 35J/cm2 *(21 ft.lb)*.

PHYSICAL PROPERTIES

Density : 7,800 kg/m^3
Thermal expansion

Between (°C)	10^{-6} K^{-1}	Between (°F)	10^{-6} ° F^{-1}
20 - 100	10,5	68 – 212	5.8
20 - 200	11,0	68 – 392	6.1
20 - 300	11,5	68 – 572	6.4
20 - 400	12,0	68 – 752	6.7
20 - 500	12,2	68 – 932	6.8
20 - 600	12,5	68 - 1112	6.9

	20°C	100°C	200°C	300°C	400°C
Thermal conductivity W.m^{-1} . K^{-1}	24	25	25	26	26
Specific heat J.kg^{-1} . K^{-1}	460	480	500	540	620
Electrical resistivity µΩ.m	0,60	0,67	0,75	0,82	0,90
Young modulus E GPa	220	215	210	200	190
Shear modulus G GPa	85	82	80	77	72
Poisson's ratio	0,3	0,3	0,3	0,3	0,3

CLC 4003 is magnetic and its Curie temperature is about 740°C *(1360°F)*.

	68°F	212°F	392°F	572°F	752°F
Thermal conductivity $Btu.h^{-1}.ft^{-1}.°F^{-1}$	14	14,5	14,5	15	15
Specific heat $Btu.lb^{-1}.°F^{-1}$	0,11	0,115	0,12	0,13	0,15
Electrical resistivity µΩ.m	0,60	0,67	0,75	0,82	0,90
Young modulus E 10^6.psi	31,9	31,1	30,4	29,0	27,5
Shear modulus G 10^6.psi	12,3	11,9	11,6	11,2	10,4
Poisson's ratio	0,3	0,3	0,3	0,3	0,3

HEAT TREATMENT AND STRUCTURE

CLC 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.

SURFACE FINISH

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

ASTM : Finish 1
EN : Finish 1D

CORROSION RESISTANCE

CLC 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, CLC 4003 may develop a brown oxide layer which may be objectionable when cosmetic corrosion is not acceptable.

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

Water :
CLC 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 CLC 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, CLC 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, oil sands exploitation, slurry pipes, 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 :
CLC 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).*

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 CLC 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 carefullly evaluated when plasma cutting CLC 4003 plates.

Other methods such as sawing, abrasive cutting, water jet cutting are perfectly adapted to CLC 4003 and give excellent results.

FORMING

Cold forming :

CLC 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 :

CLC 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

CLC 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 CLC 4003 has been balanced to limit grain growth in the heat affected zones, the heat input should be limited to 2kJ/mm and interpass temperature limited to 200°C *(392°F)*.

CLC 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 CLC 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 CL 4003.

Discoloring or heat tints produced by welding or heating should be removed by :

- pickling in HNO_3 - 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 HNO_3 (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 forming 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
- Cement storage bins
- Sewage plant equipment
- Oil sand slurry piping
- Welded structures

AVAILABLE DIMENSIONS

Hot rolled plates :

- 5 to 75mm thick *(3/16 to 3")*
- Width up to 3050mm *(120")*

NOTE : These technical data and information represent the best of our knowledge at the time of printing. However ,they may be subject to some slight variations due to our ongoing research programs on corrosion resistant grades. We therefore suggest that critical information be verified at time of enquiry or order.
Furthermore ,the real service conditions are specific for each application. The data presented here are given only for the purpose of description, and may only be considered as guarantees when our company has given written formal approval .Further information may be obtained from the following address.

For any information :

INDUSTEEL Belgium
266, rue de Châtelet
B6030 MARCHIENNE-AU-PONT
TEL (32) 71 44 16 99
FAX (32) 71 44 19 56
www.industeel.info