3CR12®

Utility ferritic stainless steel

Adding stainless quality to life

COLUMBUS STAINLESS®
[Pty] Ltd

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3CR12®

Introduction

3CR12 is recognised as the original and now the world's most specified 12% chromium utility ferritic stainless steel.

The main advantage of these utility ferritics over other ferritic stainless steels is that they are tough, even when welded, in thickness of up to 30 mm and retain their toughness at temperatures below freezing point.

The corrosion resistance of the utility ferritics is largely determined by their chromium content and is thus similar to other 12% chromium ferritic stainless steels. In terms of atmospheric corrosion resistance, the utility ferritics are superior to mild steel, weathering steel, copper and aluminium.

When exposed to aggressive atmospheric conditions, staining may occur, but this does not affect the lifetime performance. However, if aesthetic appearance is important, it is recommended that the utility ferritics are painted or a more corrosion resistant stainless steel is used.

The utility ferritics have also found widespread use in wet sliding abrasion conditions and in aqueous environments involving exposure and/or immersion.

The applications include materials handling (bulk handling, coal, sugar, agriculture, abattoirs), road transport (passenger vehicles, coaches and buses, trucks, freight and utility vehicles), rail transport (freight, passenger rail, light rail, rail infrastructure), petrochemicals and chemical, power generation, telecommunication cabinets and electrical enclosures and water and sewage treatment.

1976 -1977

CONCEPTUALIZATION AND BIRTH

The foundation for a low-chromium ferritic stainless steel with exceptional weldability was laid by the visionary pioneers of 3CR12. A pivotal moment arrived when an off-spec 409 heat was produced, leading to the discovery of a tough, fine-grained dual-phase ferrite-martensite heat-affected zone when welded.

1978 - 1980

PRODUCTION

In 1978, Columbus Stainless achieved a significant breakthrough with the production of the first plant heat, which ultimately led to the launch of internal grade 41211 in 1980. This variant exhibited unparalleled weldability, even in thicker sections, and showcased remarkable HAZ toughness and low DBTT.

1988 - 1990s

CONTINUOUS REFINEMENT AND INNOVATION

Columbus Stainless persisted in refining the chemistry of 3CR12, culminating in the development of chemistry 41214. This innovative step involved the removal of Nickel and Titanium while maintaining austenite potential, enabling cost-effective production and positioning 3CR12 as a bridge between mild steel and alloyed stainless steel.

2000s

WELDABILITY AND SENSITIZATION PREVENTION

Collaborative research efforts with institutions like the University of Pretoria led to an in-depth understanding of sensitization modes post-welding. The creation of "Bullet-proof" 3CR12Ti (41313) with high austenite potential and Ti-stabilization showcased an unparalleled level of weldability and resistance to sensitization.

RECENT INNOVATIONS

PAST 10 YEARS

The introduction of 3CR12HP400, a higher yield strength variant, opened new design possibilities for thinner sections while maintaining outstanding weldability.

Source: www.saiw.co.za

Product range

The latest revision of the Product Catalogue should be consulted, as the product range is subject to change without notice.

The Product Catalogue is available from the Technical Department or can be found at www.columbusstainless.co.za

Specifications and tolerances

Columbus Stainless (Pty) Ltd supplies the utility ferritics to the Columbus Stainless mill specification ASTM A240, ASME SA240, EN 10028-7 and EN 10088-2.

Columbus Stainless (Pty) Ltd normally supplies material to the following tolerances:

HOT ROLLED

ISO 9444 - material processed as coil	ISO 9444-2
ISO 18286 - material processed as plate	EN 10051
ASTM A480 / ASTM A480M	EN 10029
ASME SA480 / ASME SA480M	IS 6911

COLD ROLLED

ISO 9445 / ISO 9445-2
ASTM A480 / ASTM A480M
ASME SA480 / ASME SA480M
IS 6911

Other specifications and tolerances may be available on request.

Further information is available in the Product Catalogue, which can be obtained from the Technical Department or can be found at www.columbusstainless.co.za

Further information

TECHNICAL

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COMMERCIAL

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Chemical composition

In accordance with the Columbus Stainless mill specification, ASTM A240 and EN 10088-2.

Compositions are ranges or maximum values.

	C	Si	Mn	P	S	N	Cr	Ni	Other
3CR12	0.03	1.0	2.0	0.040	0.030		10.5 - 12.5	1.5	Ti: 4(C+W) min 0.3 max
3CR12L	0.03	1.0	1.5	0.040	0.015	0.03	10.5 - 12.5	0.3 - 1.0	
410S	0.08	1.0	1.0	0.040	0.015		11.5 - 13.5	0.6	

Mechanical properties

In accordance with ASTM A240 and EN 10088-2.

	Rm (MPa)	$Rp_{0.2}$ (MPa)	Elongation (%)	Max Hardness (BHN)	Impact Energy (J/cm²)
3CR12	460	280 (<3 mm) 300 (≥3 mm)	18 (≤4.5 mm) 20 (>4.5 mm)	220	35
3CR12L	455 650	320 (≤6 mm) 280 (>6 mm)	20 (≤6 mm) 18 (>6 mm)	223	50
410S	415	205	20 (<1.27 mm) 22 (≥1.27 mm)	183	

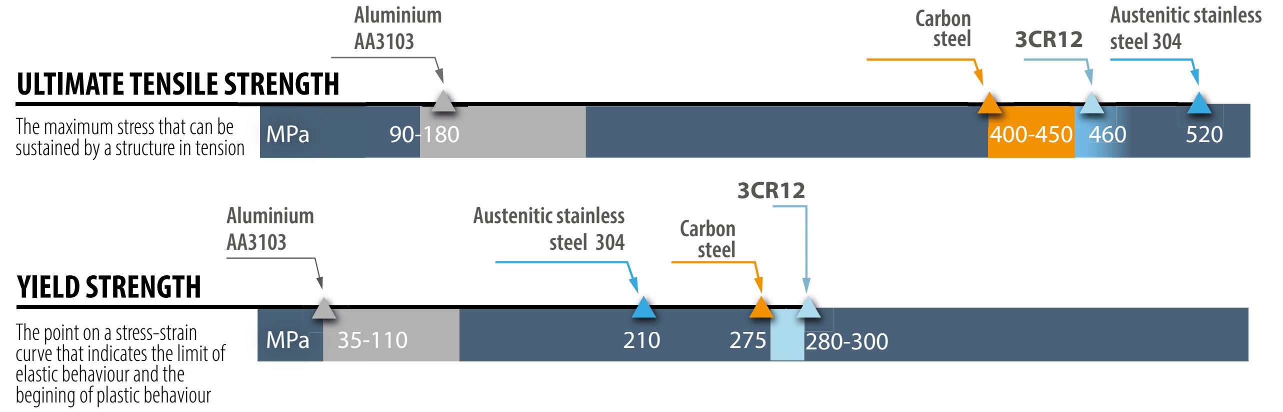
Minimum values, unless max or range is indicated.

( ) Indicates applicable gauge range.

The table assumes certification to both ASTM A240 and EN 10088-2.

Impact test is optional in hot rolled gauges only, to be agreed at time of order.

Mechanical Properties Comparison



Properties at elevated temperatures

The properties quoted below are typical of annealed 3CR12 and 3CR12L. These values are given as a guideline only, and should not be used for design purposes.

Temperature (ºC)	100	200	300	400	500
Tensile Strength (MPa)	545	464	415	368	333
0.2% Proof Strength (MPa)	350	308	280	262	236
Young's Modulus (GPa)	231	215	184	202	150

Representative creep properties

Temperature (ºC)	Stress (MPa) to Produce 1% Strain		
	1000 hours	10000 hours	100000 hours
400	315	283	270
450	195	151	134
500	88	65	56
550	34	29	28

Maximum recommended service temperature in oxidising conditions

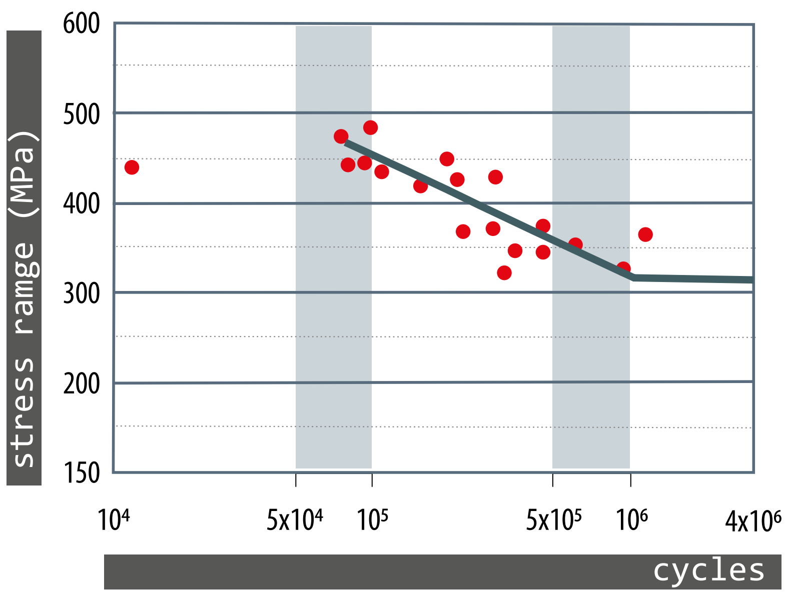
Continuous	Intermittent
620ºC	730ºC

Fatigue considerations

Fatigue data for unwelded 3CR12 is shown. The data described here refers to tests performed under constant amplitude loading (R=0, i.e. zero to tension loading) at a frequency of 10Hz.

The steel plates had a nominal thickness of 6 mm. The mean fatigue strengths at 10^5, 10^6 and $2x10^6$ cycles are 428 MPa, 311 MPa and 31 0 MPa respectively. The S-N diagram contains original data points.

The fatigue strength of welded joints in 3CR12 using austenitic stainless steel electrodes is similar to that of identical joints in constructional steels such as B54360 Grade 43A. Accepted procedures when designing for fatigue loaded structures should be followed.



Physical properties

The values given below for utility ferritics are al 20ºC, unless otherwise stated.

Density (kg/m³)		7680
Modulus of elasticity in Tension (GPa)		200
Modulus of elasticity in Torsion (GPa)		77
Specific heat capacity (J/kg K)		478
Thermal conductivity at	100ºC (W/m K)	30.0
	500ºC (W/m K)	40.0
Electrical resistivity (x10⁻⁹Ω m)		678
Mean coefficient of thermal expansion from	0 to 100ºC (x10⁻⁶ K⁻¹)	11.1
	0 to 300ºC (x10⁻⁶ K⁻¹)	11.7
	0 to 500ºC (x10⁻⁶ K⁻¹)	12.3
	0 to 700ºC (x10⁻⁶ K⁻¹)	12.8
Melting range (ºC)		1430 - 1510
Magnetic		

"Byrne Trailers is recognised as one of the leading manufacturers of livestock and bulk cargo transport in Australia, they are now manufacturing livestock trailers made from 3CR12, sheet and plate directly from Columbus, South Africa. They have reduced the tare weight of their vehicles which are 250 times more corrosion resistant than carbon steel, they need less maintenance, and finally their products are cost effective". (Text and picture courtesy of the magazine Acero Inoxidable 79. www.cedinox.es)

Thermal processing and fabrication

ANNEALING

Annealing is achieved by heating to between 700ºC and 750ºC for 90 minutes per 25 mm thickness (3.5 min/mm) followed by air cooling. Controlled atmospheres are recommended in order to avoid excessive oxidation of the surface.

MACHINING

The utility ferritics have machining characteristics similar to 430 (i.e. a machinability rating of 60 compared to mild steel of 100).

The reduced extent of work hardening compared to austenitic stainless steels eliminates the need for special cutting tools and lubricants.

Slow speeds and heavy feed rates with sufficient emulsion lubricant will help prevent machining problems.

COLD WORKING

The utility ferritics have good formability, but severe draws may require intermediate annealing. Roll forming, press braking, bending and pressing can be readily applied, but loadings will be about 30% higher than for mild steel. The minimum inner bend radius is twice the plate thickness. The utility ferritics exhibit greater spring back than mild steel and this should be compensated for by slight over bending.

STRESS RELIEVING

The utility ferritics can be stress relieved at 600ºC to 650ºC for 60 minutes per 25 mm thickness (2.5 min/mm). Stress relieving after welding is not normally required. Should this be necessary, temperatures between 200ºC and 300ºC are recommended.

WELDING

The utility ferritics have good weldability and are suited to most standard welding methods (MMA/SMAW, MIG/GMAW, TIG/GTAW, FCAW and PAW). They can be welded to other ferrous metals, for example mild and stainless steels, quite satisfactorily.

The recommended grade of electrode is the AWS 309L type. It is important that this type of over alloyed consumable is used, rather than one which matches either of the base metals, in order to avoid martensite formation in the weld. When welding a utility ferritic to itself, E308L or E316L can also be used.

The heat input should be controlled to between 0.5 kJ/mm and 1.5 kJ/mm per pass. The weld discolouration should be removed by pickling and passivating to restore maximum corrosion resistance.

HOT WORKING

The utility ferritics can be readily forged, upset and hot headed. Uniform heating of the steel in the range of 1100ºC to 1200ºC is required. The finishing temperature should not be below 800ºC.

Upsetting operations require a finishing temperature between 900ºC and 950ºC. Forgings should be air cooled.

All hot working operations should be followed by annealing and then pickling and passivating to restore the mechanical properties and corrosion resistance.

Some recommendations

Handling and transport

Before shipping, make sure every chain and steel element is not in contact with stainless steel. Raffia or wooden elements must be used at possible contact places.

When outside storage is required, material should be covered by a waterproof canvas.

Avoid contact with the ground using wooden blocks and store stainless steel and carbon steel separately. This way we avoid problems with contamination by oils, dirt or by contact among different materials.

When stainless steel has to be moved with lift trucks, the forks should be protected with nylon.

Avoid carbon steel slings, use nylon or polypropylene ones wherever possible.

Fabrication and installation

Make sure stainless steel is contamination free before starting to work. If there is any, it will be removed by pickling or mechanical means (*).

If cleaning is required, do it with pressurized water. Do not use sea or brackish water.

All tools employed in the installation must be made of stainless steel and these should have been never used with carbon steel. If this is not possible, tools must be carefully cleaned before use.

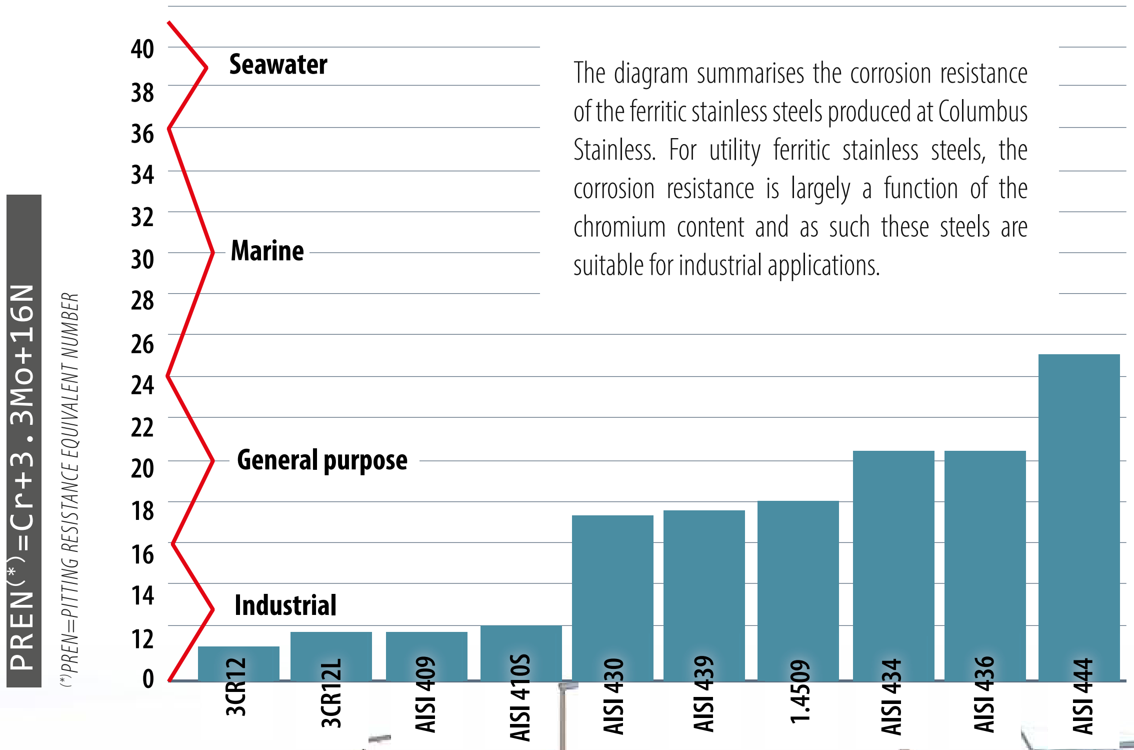
Stainless steel should be processed in machines exclusively dedicated to this material, in order to avoid contamination by projections or oxide traces from other materials.

Excessive temperature oxidation or *blueing* due to abrasive cutting, should be removed with pickling paste. Good refrigerated cutting tools help to avoid the problem.

If coating may be considered for aesthetic reasons, surface preparation is extremely important and may be performed either by acid pickling or mechanical means such as blasting.

(*) It is always advisable to contact the supplier

Resistance to corrosion



The diagram summarises the corrosion resistance of the ferritic stainless steels produced at Columbus Stainless. For utility ferritic stainless steels, the corrosion resistance is largely a function of the chromium content and as such these steels are suitable for industrial applications.

"After 40 years in service, an expensive rehabilitation was carried out using 3CR12 reinforcing bar, which guarantees high strength, less maintenance and lower life cycle cost". (*)

(*) Article from Acero Inoxidable magazine 87. www.cedinox.es

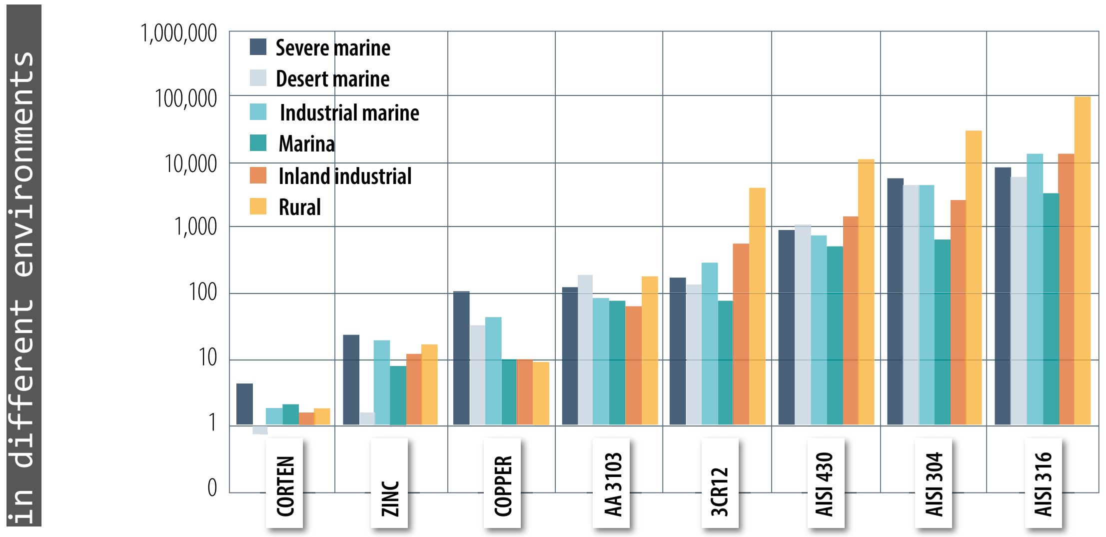
Atmospheric corrosion

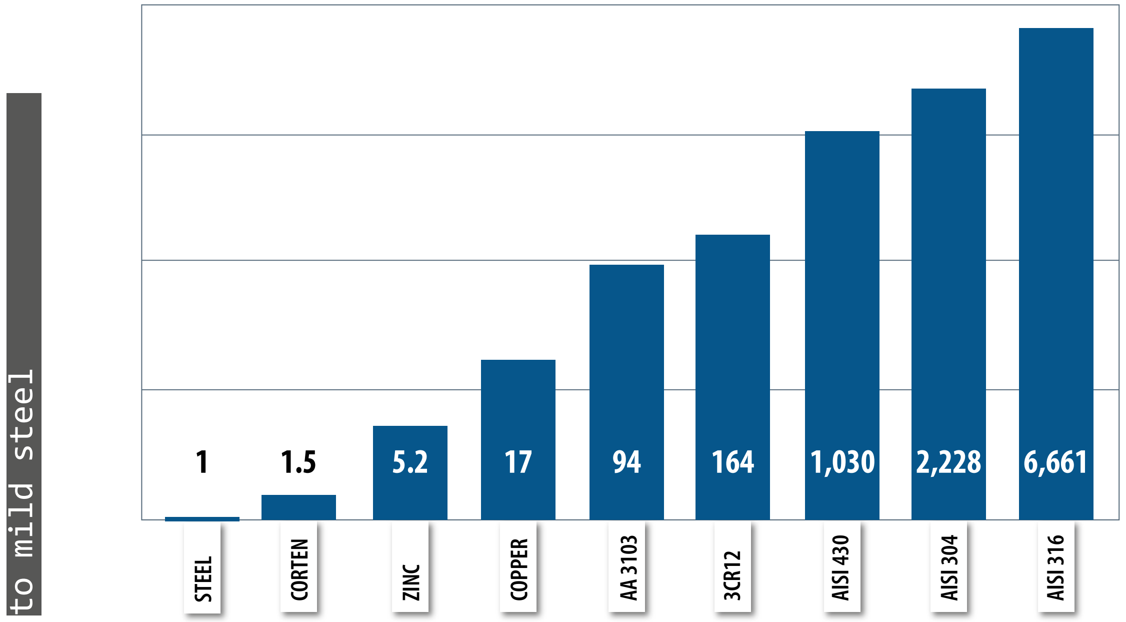
From the report 'Atmospheric Corrosion Testing in Southern Africa - Results of a Twenty Year Exposure Programme' by BG Callaghan, Division of Materials Science and Technology, CSIR, the following graphs were constructed.

The first graph shows the relative life of eight metals compared to mild steel in six different atmospheric environments. This can be summarised to give an average relative life of the different metals in atmospheric conditions and this is shown in the second graph.

In appearance, all the metals showed discolouration at the more severe sites after 20 years. None of the metals were washed during the exposure programme and this clearly emphasises the importance of keeping stainless steel clean and that stainless steel is a LOW maintenance (not NO maintenance) option in atmospheric corrosion applications 3CR12 showed some pitting, but the maximum pit depth after 10 years was 0.25 mm.

Relative life of various metals





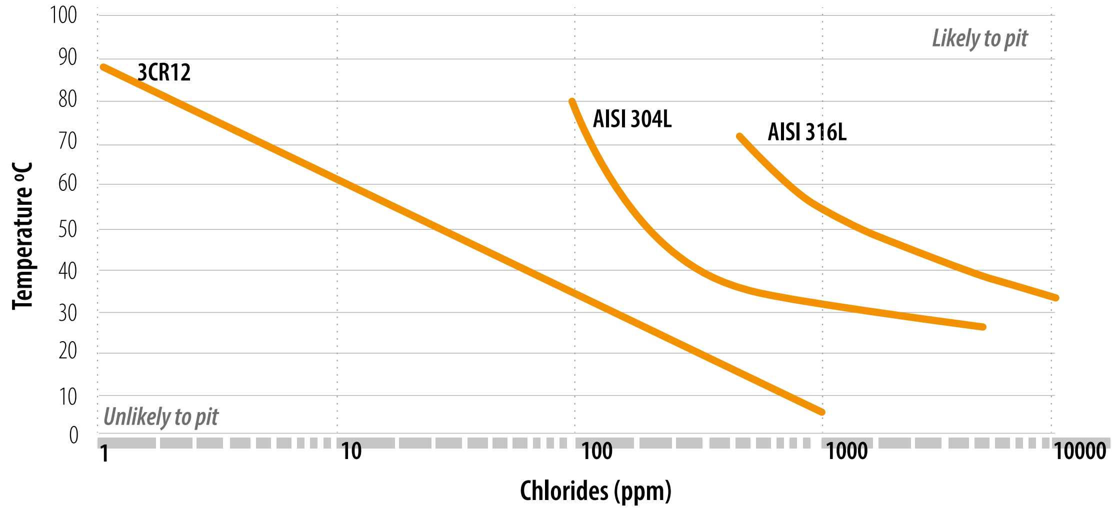
General corrosion

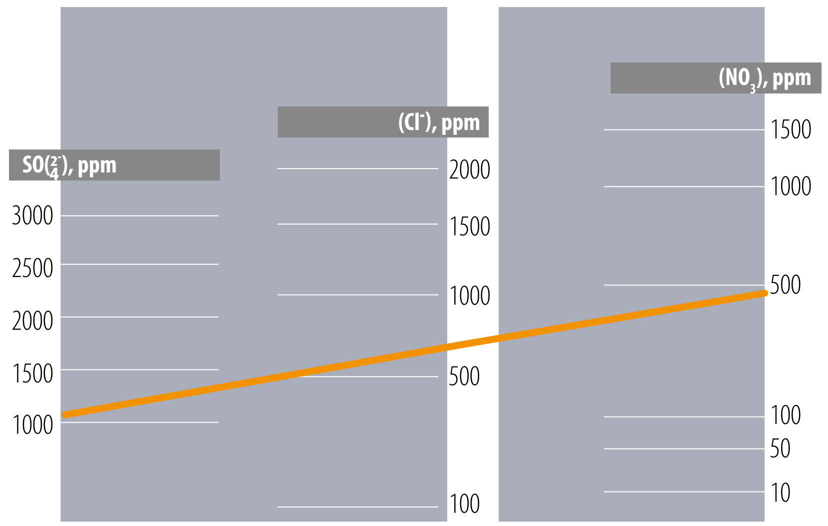
The utility ferritics are significantly more corrosion resistant than mild or low alloy corrosion resistant steels. However, they have a lower corrosion resistance than the higher chromium standard ferritic.

The utility ferritics should only be used in mildly corrosive conditions where aesthetics is not a prime requirement. A light surface patina or discolouration will form in most corrosive environments and this patina will, to some extent, retard further corrosion.

Pitting corrosion

Pitting corrosion is possible in applications involving contact with chloride solutions, particularly in the presence of oxidising media. These conditions may be conducive to localised penetration of the passive surface film on the steel and a single deep pit may well be more damaging than a much greater number of relatively shallow pits. The diagram below shows the critical temperature for initiation of pitting (CPT) at different chloride contents (+350mV vs SCE).





A model, shown in the second diagram, has been designed to predict the maximum concentration of chloride that can be permitted in water containing sulphate and nitrate ions before localised corrosion of 3CR12 takes place. A straight line, drawn between the concentrations of sulphate and nitrate, intersects the chloride axis at the maximum permissible chloride concentration for this water, at ambient temperature.

Some projects and applications

Electrification masts in Port Elizabeth (South Africa)

Tubular bus frames by TFM Pty Ltd Johannesburg

Guardrails

Hydrogen powered buses by Solaris

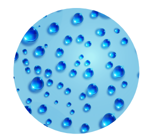
Electric buses by VDL Bus & Coach

Trailers by Byrne, Australia

Vehicles canopies, RSI

Moreland Bridge, Umhlanga, South Africa

Kelso station. Pedestrian bridge at Kwa-Zulu Natal, South Africa



Sugar plants

X-Grid packs in power station cooling towers. Expanded mesh. Rooiwal, South Africa

DAF systems in waste water treatment plants in Middelburg, South Africa

Efficient sanitation system Amalooloo, South Africa

Stoves by Bosca, Chile

C2Fresh Water, solar water purification system, South Africa

Water tanks

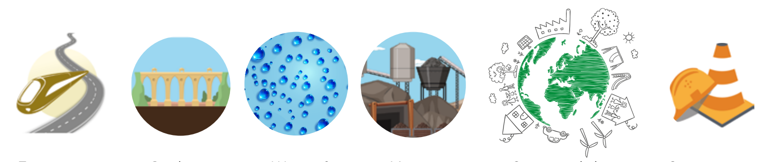
Bathroom accessories

E-houses. Turnkey modular housing

Fences
i.e.: in Armscor, The Armaments Corp.of South Africa Soc. Ltd, Everard Read Gallery, Johannesburg

Mpumatech split sets, South Africa

Processing and transport of coal i.e.: Central Coalfields Limited-CCL, National Power, British Rail, Queensland Rail and New South Wales , Belgian State Railway (SNCB), Johnstown America, Pennsylvania Power & LIght, Progress Rail Services for Illinois Central, EWS



Certificates

Columbus Stainless' product meets the following international standards:

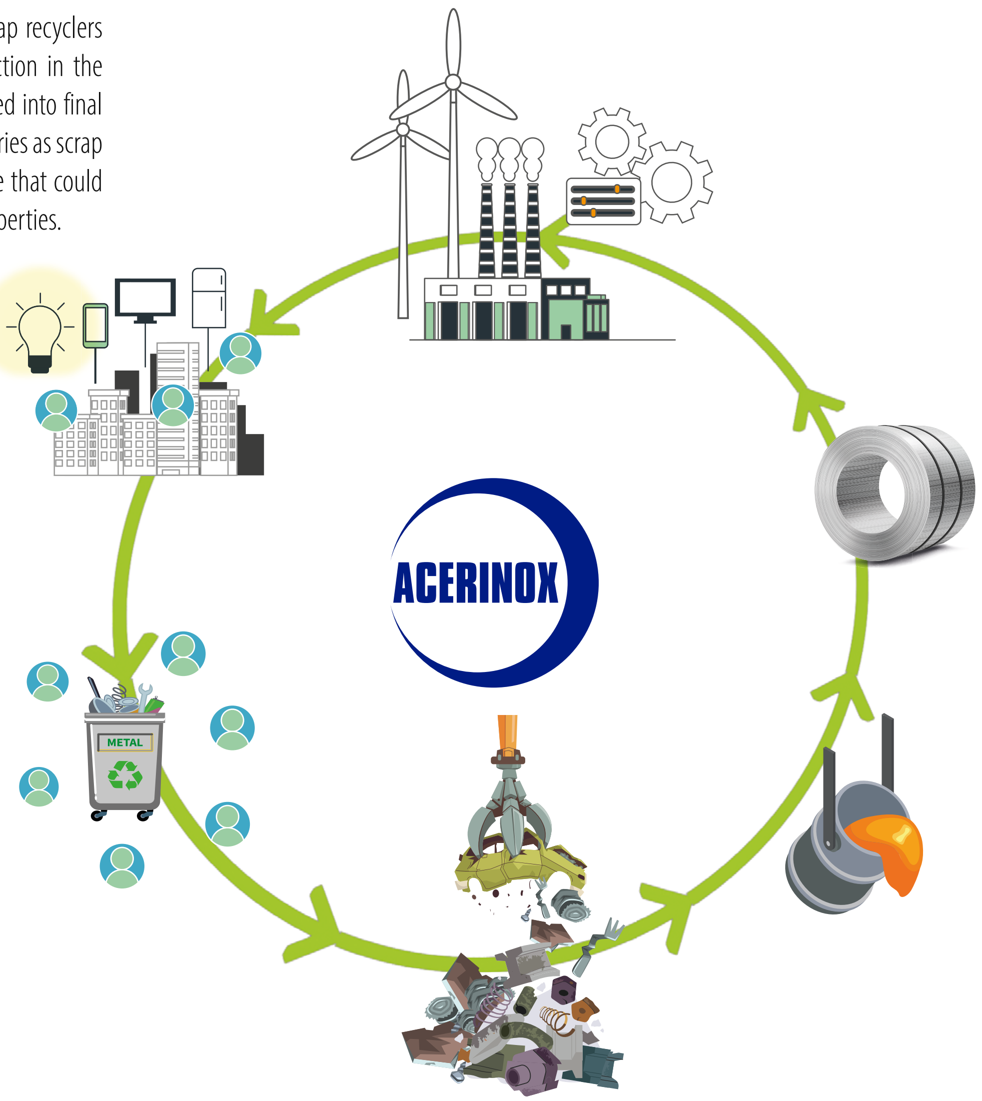
ISO 9001:2015	ISO/IEC 17025:2017	PED 2014/68/EU	BIS Certification Mark License
CPR 305/2011/EU	ISO 14001:2015	IATF 16949 QMS Letter	

Available at *www.columbus.co.za/ donwloads* or scan the c:ode:

Committed to sustainable growth

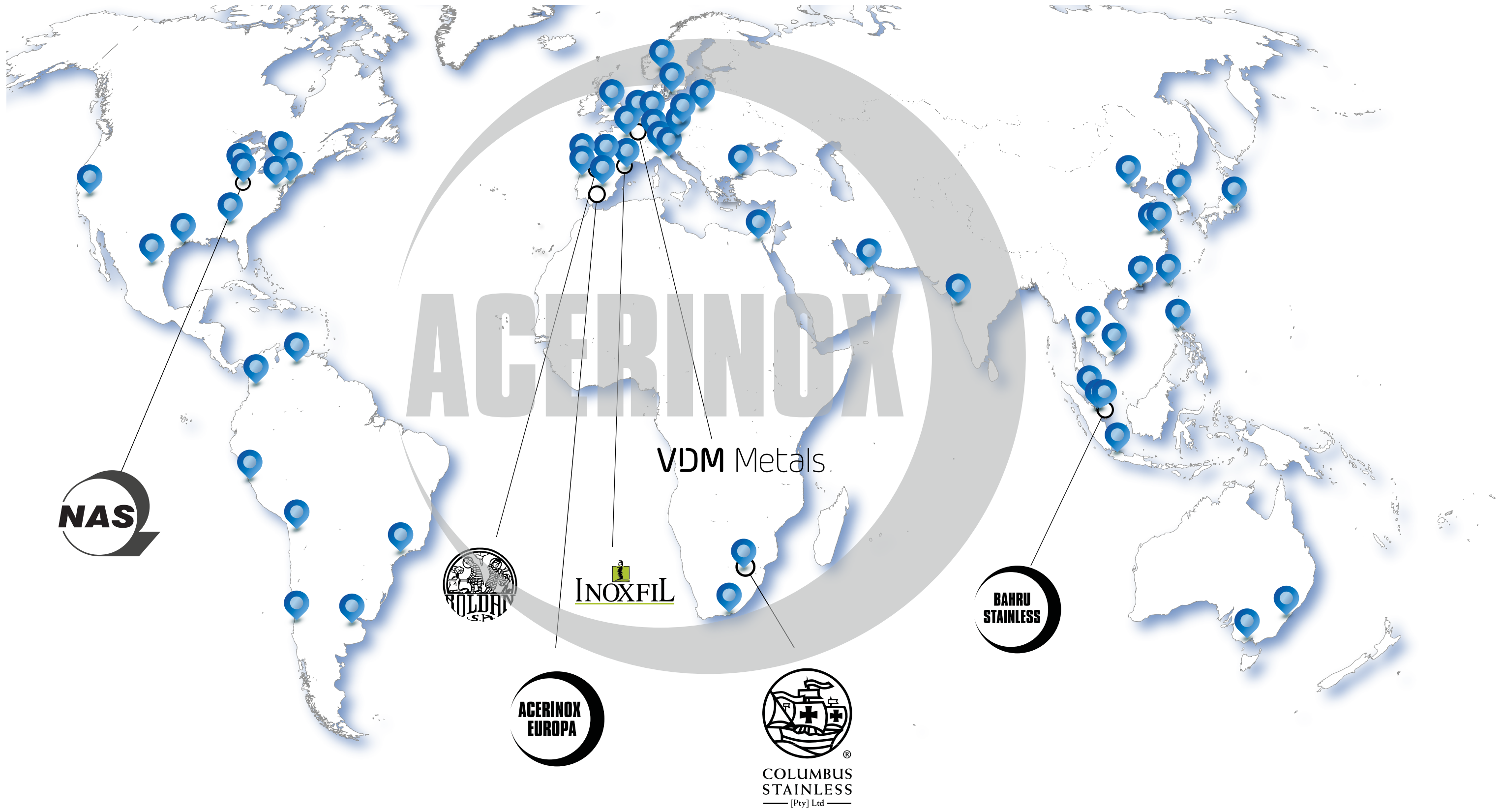
Acerinox is one of the major scrap recyclers wherever is located. The production in the factories of Acerinox is transformed into final products which return to the factories as scrap to be melted again. This is a cycle that could be infinite due to the material properties.

Columbus Stainless also ensures optimum utilisation of raw materials and energy sources by focusing on the reduction of waste in both power, water and raw materials. Not only do these reduce the impact on the environment but also reduce the costs of producing quality products.



The Acerinox group has the firm commitment to contributing to the achievement of the Sustainable Development Goals (SDGs) approved by the United Nations, particularly via manufacturing entirely and endlessly recyclable products, while also promoting innovation, education, equality policies and fight against climate change.

Acerinox: the confidence of a strong group



Acerinox is the Spanish multinational global leader in stainless steel manufacturing. With a total production capability of 3.5 million tonnes per year. Acerinox owns factories in five continents confirming its global presence, stainless steel flat products manufacturing at Acerinox Europa, North American Stainless, Columbus and Bahru Stainless; and Roldan, Inoxfil and North American Stainless for long products manufacture. In March 2020, VDM Metals, worldwide leader in high performance alloys manufacture and design, also takes part of the group.

Every Acerinox facility satisfies the quality and environmental controls required by each country legislation, apart from the application of the Environmental Management System according to ISO 14001. Furthermore, subsidiaries assume higher standards than legal requirements in areas such as quality, safety and sustainability.

Scrap plays a key role in all Acerinox fabrication processes. Thus, a great value is added bringing it back to the material life cycle, reducing the environmental impact with the use of the same material for centuries.

Columbus Stainless was founded in 1966 in South Africa. It is the only integrated stainless steel factory on the African continent and today is the main supplier of stainless steel solutions for both the domestic and the continent market.

The factory is equipped with the most efficient and technologically advanced machinery in the sector, has seen the most significant technological advances in the sector, and has a considerable competitive advantage due to its location, not only for distributing its finished products, but also thanks to its proximity to the raw material extraction sources, especially chrome. It also supplies semi-finished flat products to other Acerinox Group factories.

We manufacture the most popular grades of stainless steel, such as austenitic grades 304 stainless and 316, ferritic grades 430, 444 and 441, as well as 3CR12 – a corrosion resisting steel that we developed for improved weld-ability and low cost applications. We also supply duplex stainless steel grades 2205 and 2304 in sheet and coil.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BAHRU STAINLESS
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