MOLY FERRITIC

stainlesssteel

Adding stainless quality to life

COLUMBUS STAINLESS [Pty] Ltd

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Introduction

Moly ferritic stainless steels are chromium stainless steels alloyed with molybdenum, and can be stabilised with niobium and/or titanium. Annealed **moly ferritics** are ductile and can be formed using a large variety of roll forming or mild stretch bending operations as well as the more common drawing and bending operations. They do not harden excessively during cold working. Being ferritic, they are not susceptible to stress corrosion cracking. These steels have limited weldability and should not be used in the as-welded condition for dynamic or impact loaded structures. **Moly ferritics** can undergo grain growth in the heat affected zone of weldments, which may adversely affect the mechanical properties in these zones. Applications involving welded **moly ferritics** are thus generally limited to a maximum thickness of 2.5 mm. Edge welds are not recommended for applications using **moly ferritics**. They are unsuited for use in cryogenic applications as brittle fracture could occur at sub-zero temperatures.

434

is a low carbon, molybdenum containing ferritic stainless steel. With 16 % chromium and 1 % molybdenum, the steel has better corrosion resistance than 430.

434 has excellent polishing characteristics and is therefore used in applications such as automotive trim.

434 also has good formability and corrosion resistance and this makes it suitable for applications such as dishwashers, kitchen-ware and restaurant equipment, architectural applications (except in coastal environments), nitric acid plant equipment, etc.

436

is a low carbon, niobium stabilised, molybdenum containing ferritic stainless steel. With 16 % chromium and 1 % molybdenum, the steel has better corrosion resistance than 1.4509.

Niobium stabilisation improves the steel's resistance to sensitisation in the weld heat affected zone and improves the steel's creep resistance at high temperatures. 436 has similar formability to 1.4509 and is used in applications such as automotive exhaust systems and trim, cladding, domestic appliances, etc.

444

is a low carbon, dual stabilised, molybdenum containing ferritic stainless steel.

With 18 % chromium and 2 % molybdenum, the steel has good pitting resistance and crevice corrosion resistance, similar to 316L.

444 is thus suitable for roofing and cladding in marine environments, as well as hot water tanks and geysers, heat exchanger tubing and food processing equipment.

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.columbus.co.za

Specifications and tolerances

Columbus Stainless (Pty) Ltd supplies the moly ferritics to ASTM A240, ASME SA240 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.columbus.co.za

Further information:

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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	Mo	Nb	Ni	Other
434	0.08	1.0	1.0	0.040	0.015		16.0 18.0	0.90 1.25			
436	0.08	1.0	1.0	0.040	0.015	0.04	16.0 18.0	0.80 1.25	7x(C+N)+0.1 0.8		
444	0.025	1.0	1.0	0.040	0.015	0.03	17.5 19.5	1.80 2.50		1.0	Ti: 4x(C+N)+0.2 0.8

- Stabilisation may be by use of titanium or niobium or zirconium.
- For ASTM A240, Ti+Nb>4x(C+N)+0.2.
- For EN 10088-2, according to the atomic mass of these elements and the content of carbon and nitrogen, the equivalence shall be the following:

  Nb (% by mass) = Zr (% by mass) = 7/4 Ti (% by mass); i.e. when replacing Ti with Nb, nearly double (1.75) the Nb is needed.

Mechanical properties

In accordance with ASTM A240 and EN 10088-2.

	Rm (MPa)	$Rp_{0.2}$ (MPa)	Elongation (%)	Max Hardness (BHN)
434	450 to 630	280	22	
436	480 to 560	300	25	
444	420 to 640	320	20	217

- *Minimum values, unless max or range is indicated.*
- *The table assumes certification to both ASTM A240 and EN 10088-2.*

Properties at elevated temperatures

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

Short time elevated temperature tensile strength (Mpa)

	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C
434	500	485	470	450	400	290	130
436	460	400	350	310	260	200	120
444	500	460	440	420	380	300	160

Short time elevated temperature 0.2 proof stress (Mpa)

	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C
434	300	290	280	260	220	160	60
436	280	250	230	200	170	130	80
444	370	330	310	295	270	220	130

Short time elevated temperature elongation (%)

	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C
434	28	27	24	17	12	14	27
436	28	27	23	20	19	23	35
444	30	28	26	23	21	20	22

Maximum recommended service temperature

	Continuous °C	Intermittent °C
434	730	870
436	730	870
444	850	950

- In oxidising conditions.

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Physical properties

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

		434	436	444
Density (kg/m³)		7740	7750	7750
Modulus of elasticity in Tension (GPa)		210		220
Modulus of elasticity in Torsion (GPa)		65		65
Specific heat capacity (J/kg K)		460	440	430
Thermal conductivity at	100 ºC (W/m K)	26.1	26.3	26.8
	500 ºC (W/m K)	26.3	27.0	27.1
Electrical resistivity (x10⁻⁹Ω m)		650	580	570
Mean coefficient of thermal expansion from	0 to 100 ºC ($x10^{-6} K^{-1}$)	10.4	10.9	10.8
	0 to 300 ºC ($x10^{-6} K^{-1}$)	11.0	11.9	11.6
	0 to 500 ºC ($x10^{-6} K^{-1}$)	11.3	12.4	11.9
	0 to 700 ºC ($x10^{-6} K^{-1}$)	12.1	13.4	12.5
Melting range (ºC)		1480 1530	1405 1530	1480 1495
Magnetic			**Yes**	

Moly ferritic stainless steels have added molybdenum, for extra corrosion resistance.

Typical applications include hot water tanks, solar water heaters, visible parts of exhaust systems, electrical-kettle and microwave oven elements, automotive trim, outdoor panel, chimney ducts, etc.

Thermal processing and fabrication

ANNEALING

Annealing is achieved by heating to the following temperatures for 90 minutes per 25 mm thickness (3.5 min/mm) followed by air quenching. Controlled atmospheres are recommended in order to avoid excessive oxidation of the surface.

	ANNEALING TEMPERATURE (°C)
434	820 to 920
436	750 to 850
444	870 to 970

STRESS RELIEVING

Stress relieving after welding is not normally required. Should this be necessary, temperatures between 200 °C and 300 °C are recommended for 60 minutes per 25 mm thickness (2.5 min/mm).

COLD WORKING

Moly ferritic stainless steels have good formability characteristics with useful mechanical properties. Their good ductility allows them to be readily formed by bending and deep drawing. They do not undergo significant work hardening when cold formed. 434 is slightly more prone to roping than the other moly ferritics.

HOT WORKING

Uniform heating of the steel in the range of 950 °C to 1050 °C is required. The finishing temperature should be below 750 °C and the steel should be cooled rapidly between 550 °C and 400 °C to prevent 475 embrittlement. Extended holding times above 1000 °C should be avoided as excessive grain growth may occur and ductility may be detrimentally affected.

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

WELDING

Moly ferritic stainless steels are prone to grain growth in the heat affected zone of weldments. As such, the tensile, fatigue and toughness properties in the welded condition are relatively poor. They should thus not be used for applications where tensile or dynamic loading will be experienced.

Moly ferritics are generally limited to a combined thickness in the welded condition of 2 mm for 434, 2.5 mm for 436 and 3 mm for 444. Edge welds are not recommended.

The use of austenitic filler metals such as types 308L, 309L or 316L will improve the ductility of welds to some extent but all welding procedures should nevertheless endeavour to maintain minimum heat inputs.

The weld discolouration should be removed by pickling and passivating to restore maximum corrosion resistance.

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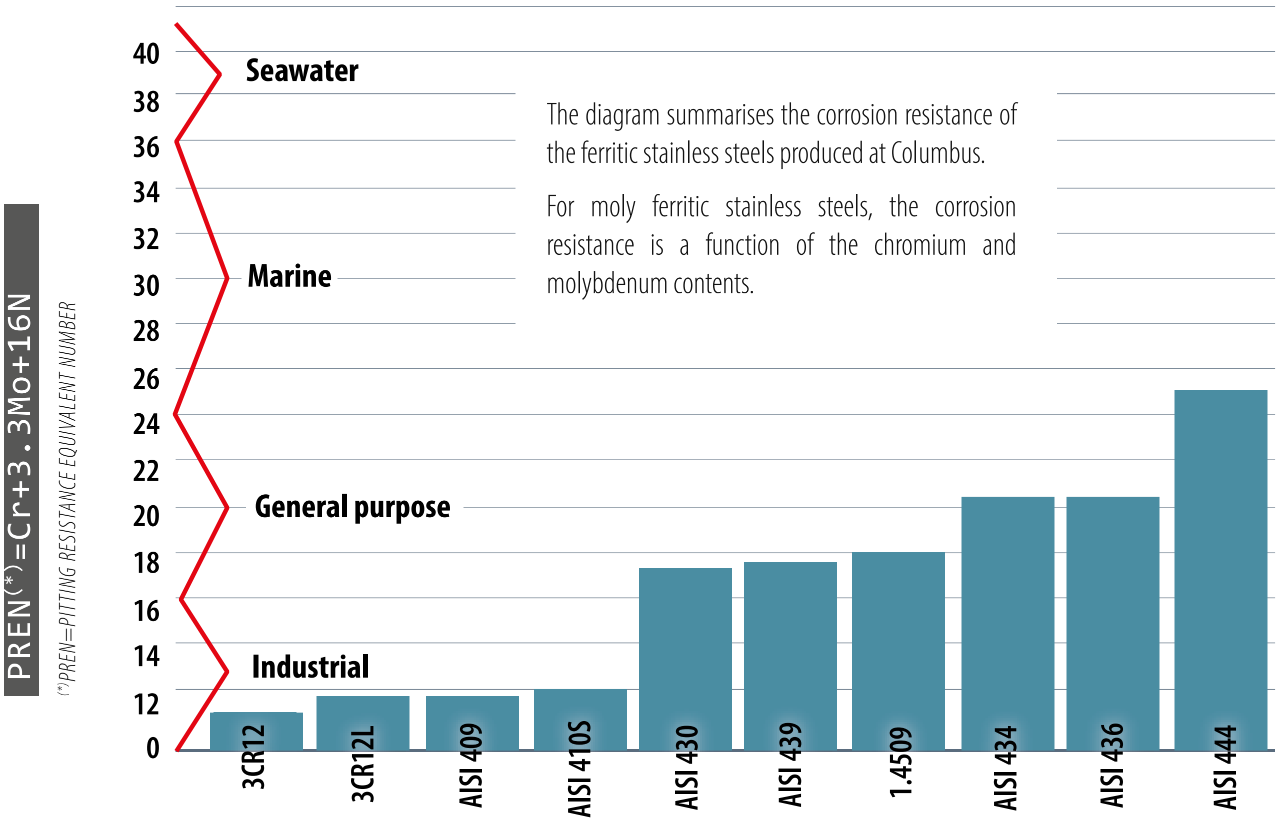
Resistance to corrosion



The diagram summarises the corrosion resistance of the ferritic stainless steels produced at Columbus.

For moly ferritic stainless steels, the corrosion resistance is a function of the chromium and molybdenum contents.

In common with other ferritic stainless steels, the **moly ferritics** are not susceptible to Stress Corrosion Cracking (SCC). 434 and 436 have similar general corrosion resistance to 430.

Their pitting resistance is, however superior to 430 but not as good as 304.

434 and 436 thus have good resistance to rural and industrial atmospheres but in marine atmosphere environments, staining may occur, unless they are regularly washed.

444 has good resistance to a wide variety of corrosive environments. With 18 % chromium and 2 % molybdenum, the steel has good uniform and pitting corrosion resistance, similar to 316L in most environments. 444 is thus suitable for use in marine atmospheres.

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

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Some applications

Exhaust manifolds

Exhaust parts

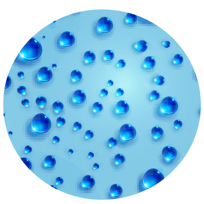
Turbo intercooler parts

Domestic hot water pumps

Heat exchangers

Wine tanks

Solar panel switch boxes



Internal parts for water pumps

Domestic hot water pumps

Certificates

Columbus Stainless' product meets the following international standards:

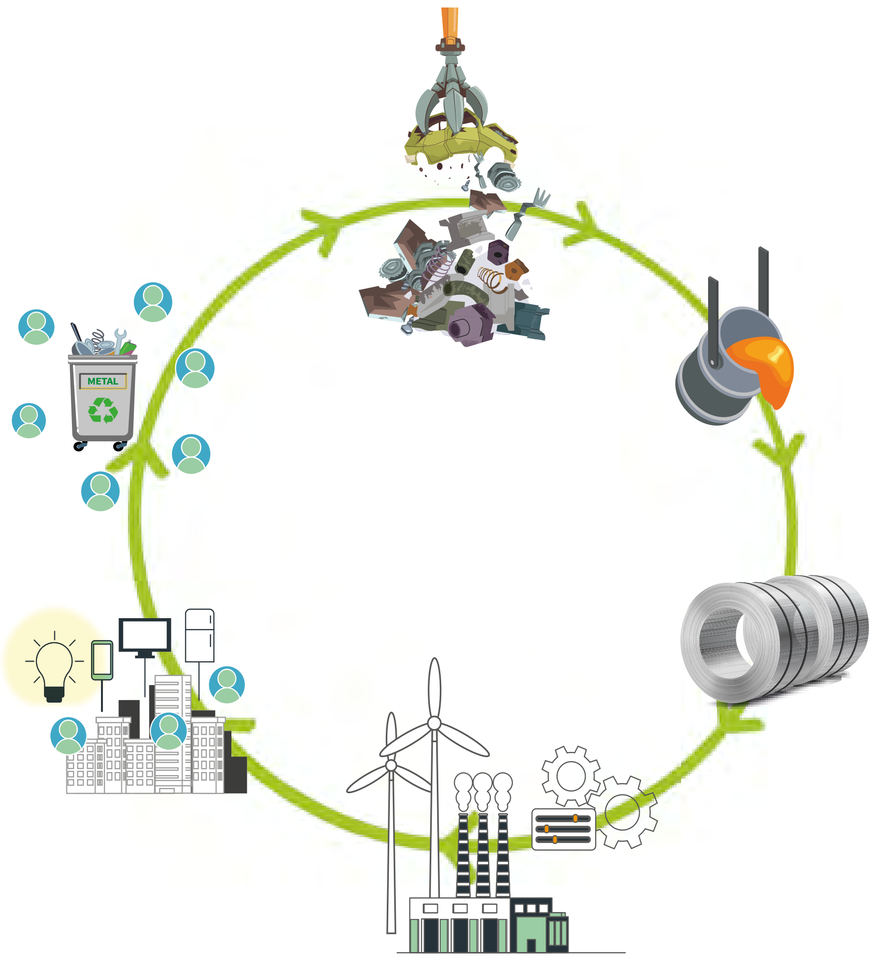
PED EU Certificate	BIS Certification Mark Licence
Annex to PED EU Certificate	BIS Certification Mark Licence Renewal
CPR 305 EU Certificate	PESR Certificate
Annex to CPR 305 EU Certificate	Annex to PESR Certificate
CPR Declaration of Performance	CPR Amend Certificate
IATF 16949 QMS Letter	Annex to CPR Amend Certificate

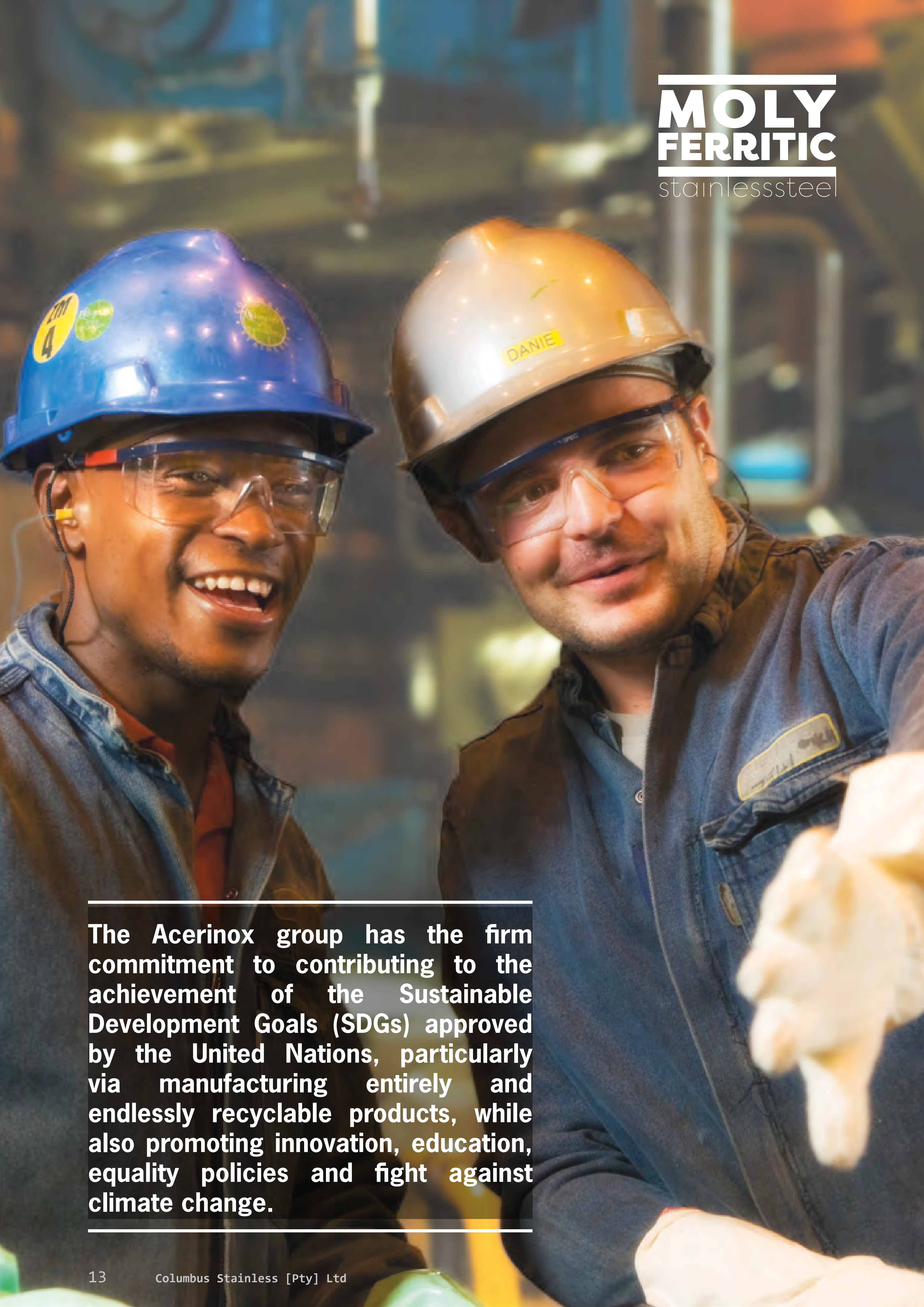
Available at www.columbus.co.za/quality/product-certifications or scan the code:

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.





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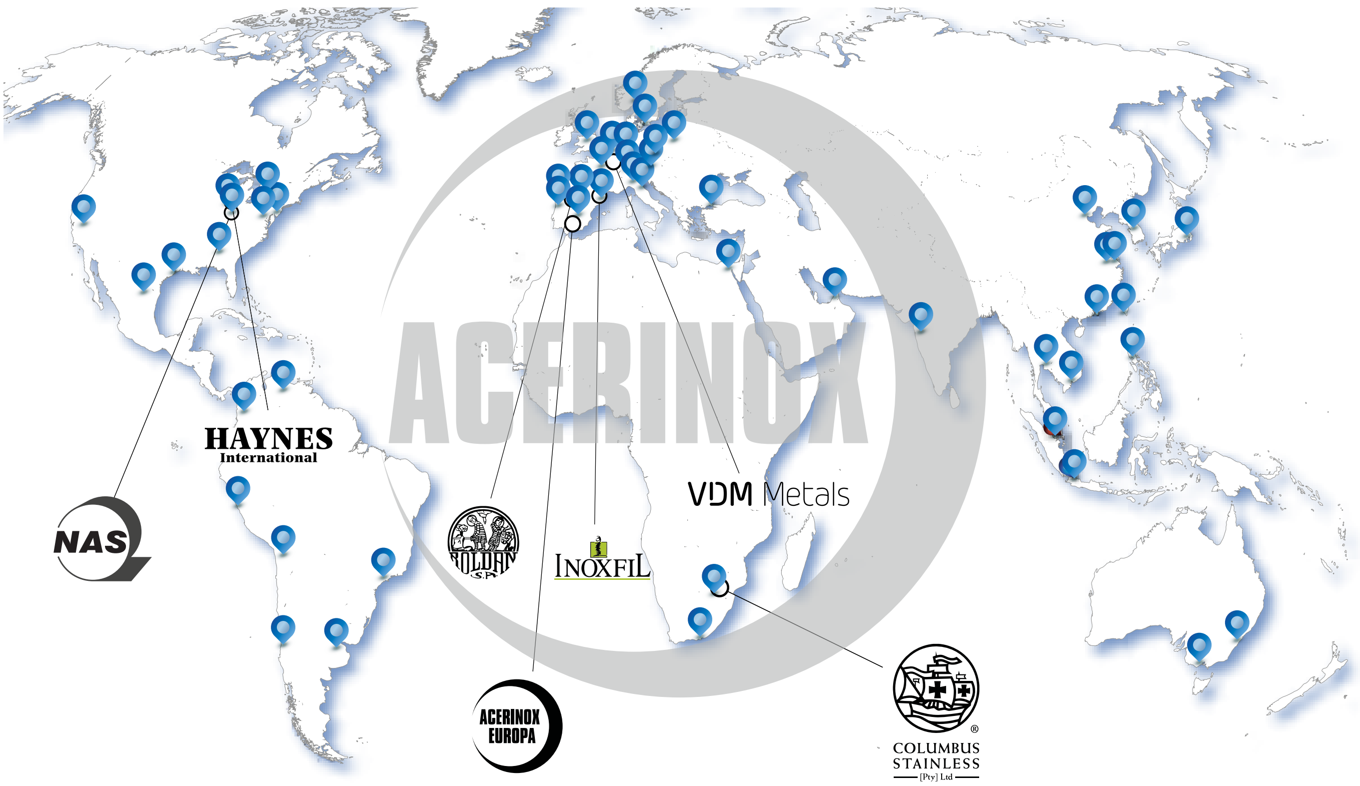
The Acerinox group has the firm commitment to contributing to the achievement of the Sustainable Development Goals (SDGs) approved by the United Nations, particularly via manufacturing entirely and endlessly recyclable products, while also promoting innovation, education, equality policies and fight 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 worldwide confirming its global presence, stainless steel flat products manufacturing at Acerinox Europa, North American Stainless and Columbus 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. In November 2024, Acerinox completes the acquisition of Haynes International, U.S. leading manufacturer and marketer of technologically advanced high-performance alloys.

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.

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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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