COLUMBUS STAINLESS
[Pty] Ltd

Technical Brochure

STANDARD FERRITIC STAINLESS STEELS

Adding Stainless Quality to life

www.columbusstainless.co.za

Introduction

Standard ferritic stainless steels are plain chromium stainless steels, and can be stabilised with niobium and/or titanium. Annealed standard ferritics are ductile and can be formed using a wide 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. The steels have limited weldability and should not be used in the as-welded condition for dynamic or impact loaded structures.

Standard 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 standard ferritics are thus generally limited to a maximum thickness of 2.5mm. Edge welds are not recommended for applications using standard ferritics. Standard ferritics are unsuited for use in cryogenic applications as brittle fracture could occur at sub-zero temperatures.

40910 is a 12% chromium, titanium stabilised ferritic stainless steel. It is not as resistant to corrosion or high temperature oxidation as the higher alloyed stainless steels (for example 430 or 304), but is still superior to mild steel and low alloy corrosion resisting steels and most coated mild steels.409 finds its major application in silencers, catalytic converters and tubing for motor vehicle exhaust systems.

430 and 430DDQ are low carbon plain chromium ferritic stainless steels. With 16% chromium, the steels have good corrosion resistance in moderately corrosive environments and good oxidation resistance at elevated temperatures.

They have excellent polishing characteristics and are therefore used in applications such as architectural trim.430 has good formability and corrosion resistance and this makes it suitable for applications such as catering equipment and kitchen sinks. 430DDQ has even better formability and is thus used in deep drawing applications.

439 is a low carbon, titanium stabilised ferritic stainless steel. With 17% chromium, the steel has good corrosion resistance in moderately corrosive environments.

Titanium stabilisation improves the steel's resistance to sensitisation in the weld heat affected zone 439 has similar formability to 430DDQ. They are used in applications such as evaporator tube in the sugar industry and heat exchanger tubing.

1.4509 is a low carbon, dual stabilised ferritic stainless steel. With 18% chromium, the steel has good corrosion resistance in moderately corrosive environments and good oxidation resistance at elevated temperatures. 1.4509 has good high temperature oxidation resist ance and creep resistance and this makes it suitable for use in applications in automotive exhaust systems.

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 standard ferritics to ASTM A240 and EN 10088-2.

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

HOT ROLLED

ASTM A480M
ISO 9444 - material processed as coil
ISO 18286 - material processed as plate
ASTM A480/ASTM A480M
ASME ASME SA480/ASME SA480M

ISO 18286
ISO 9444-2
EN 10051
EN 10029
IS 6911

COLD ROLLED

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

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Disclaimer

Chemical composition

In accordance with ASTM A240 and EN 10088-2.

Grade	C	Si	Mn	P	S	N	Cr	Nb	Ni	Others
40910	0.03	1.0	1.0	0.040	0.015	0.03	10.5 11.7		0.5	Ti: 6x(C+N) 0.5
430	0.08	1.0	1.0	0.040	0.015		16.0 18.0		0.75	
430DDQ	0.08	1.0	1.0	0.040	0.015		16.0 18.0		0.75	Al: 0.30 max
439	0.03	1.0	1.0	0.040	0.015	0.03	17.0 18.0		0.5	Ti: 4x(C+N)+0.2 0.8
1.4509	0.03	0.75	1.0	0.040	0.015		17.5 18.5	3xC+0.3 1.00		Ti: 0.1 0.6

Compositions are ranges or maximum values.

Mechanical properties

In accordance with ASTM A240 and EN 10088-2.

Grade	R_m (MPa)	$Rp_{0.2}$ (MPa)	El (%)	Max BHN
40910	380 to560	220	25	179
430	450 to 630	280 (≤2.5mm) 260 (>2.5mm)	20 (≤1.27mm) 22 (>1.27mm)	183
430DDQ	450 to 630	280	26	183
439	420 to 600	240	23	183
1.4509	430 to 630	250	18	180

- Minimum values, unless max or range is indicated.
- ( ) indicates applicable gauge range.
- The table assumes certification to both ASTM A240 and EN 10088-2.

PROPERTIES AT ELEVATED TEMPERATURES

The properties quoted below are typical of annealed 40910, 430 and 1.4509 steels. These values are given as a guideline only, and should not be used for design purposes.

Short time elevated temperature tensile strength (MPa)

Temperature (°C)	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C	900°C	1 000°C
40910	380	370	350	325	280	205	110			
430	475	450	420	380	315	200	105	55	30	15
439	450	420	390	350	295	215	100			
1.4509	460	425	400	380	350	295	200			

Short time elevated temperature 0.2% proof stress (MPa)

Grade	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C
40910	245	230	205					
430	270	255	230	210	180	125	50	40
439	240	225	190					
1.4509	280	255	230					

Maximum recommended service temperature

Grade	Continuous (°C)	Intermittent (°C)
40910	620	730
430	730	870
439	830	930
1.4509	850	950

- In oxidising conditions

PROPERTIES AT ELEVATED TEMPERATURES (CONTINUED)

Maximum recommended service temperature

	Stress (MPa) to produce 1% strain			Stress (MPa) to produce rupture	
Temperature (°C)	10 000 hours		100 000 hours	1 000 hours	10 000 hours
	430	1.4509	430	430	430
500	95	145	70	175	150
550	55	80	40	100	75
600	30	45	20	55	40
650	15	30	10	35	25
700	10	25	5	20	15
750	7			10	
800	5			5	

Physical properties

The values given below are for 20°C, unless otherwise stated.

		40910	430 430DDQ	439	1·4509
Density (kg/m)		7 700	7 800	7 700	7 700
Modulus of Elasticity in Tension (GPa)		200	200	220	210
Modulus of Elasticity in Torsion (GPa)		77	65		
Specific Heat Capacity (J/kg K)		460	460	460	460
Thermal conductivity at	100°C (W/m K)	23.0	26.1	25.1	24.2
	500°C (W/m K)	25.0	26.3	26.5	26.3
Electrical Resistivity ($x10^{-9}$ Ω m)		610	600	630	630
Mean Coefficient of Thermal Expansion from	0 to 100°C ($x10^{-6}$ K^{-1})	11.1	10.4	10.0	10.2
	0 to 300°C ($x10^{-6}$ K^{-1})	11.7	11.0	10.2	11.4
	0 to 500°C ($x10^{-6}$ K^{-1})	12.4	11.4	10.5	11.6
	0 to 700°C ($x10^{-6}$ K^{-1})	12.7	11.7	10.8	11.9
Melting Range (°C)		1 480	1 425	1 390	1 390
		1 530	1 510	1 460	1 460
Magnetic		Yes	Yes	Yes	Yes

Thermal processing and fabrication

ANNEALING

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

	40910	430 430DDQ	439	1.4509
Annealing Temperature (°C)	820 to 920	750 to 850	870 to 970	920 to 1 020

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 25mm thickness (2.5min/mm).

HOT WORKING

Uniform heating of the steel in the range of 950°C to 1 050°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 1 000°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 the mechanical properties and corrosion resistance.

Thermal processing and fabrication (continued)

COLD WORKING

Standard 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.

430DDQ is a 430 steel with superior deep drawability. It is suitable for drawn applications such as hollowware, sink bowls, etc. To ensure the correct allocation of material, if drawing quality is required, orders must state 430DDQ. In order to best suit a customer's end use, it is imperative that the actual end use is stated when 430DDQ is ordered.

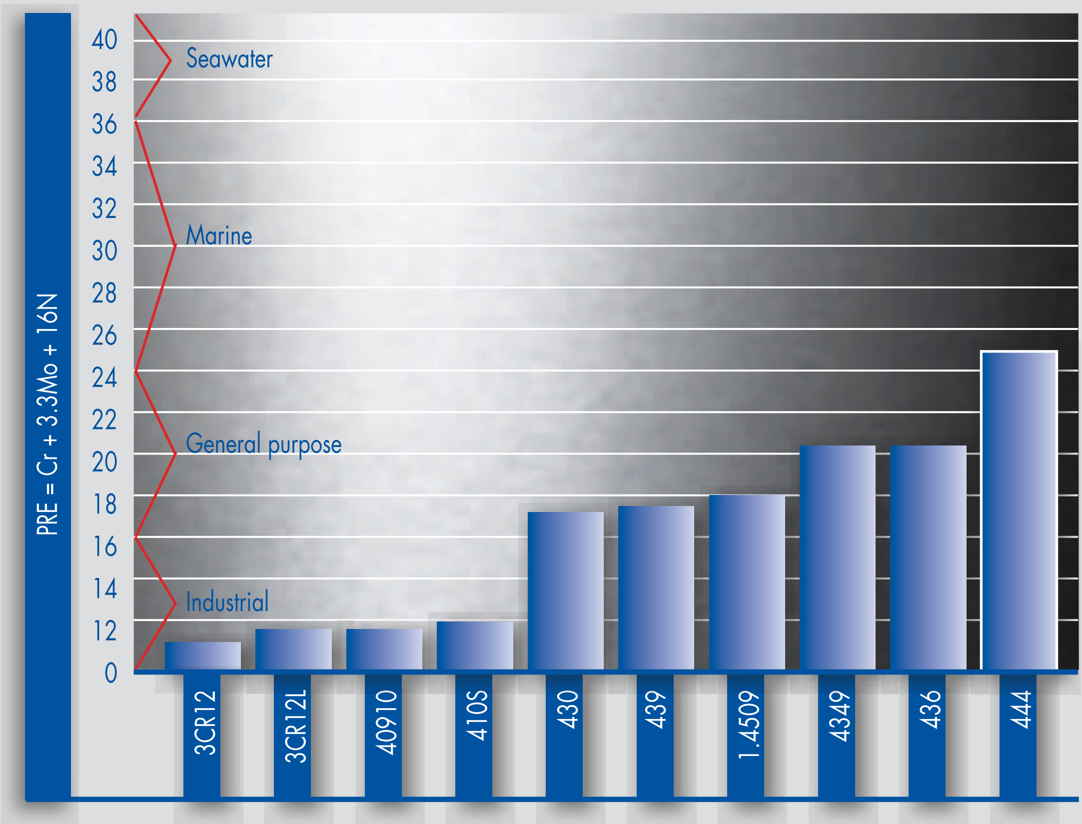
WELDING

The standard 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.

The standard ferritics are generally limited to a combined thickness in the welded condition of 2mm for 430, 2.5mm for 1.4509 and 439 and 3mm for 40910. 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.

Corrosion resistance



The above diagram summarises the corrosion resistance of the ferritic stainless steels produced at Columbus Stainless. For the standard ferritic stainless steels, the corrosion resistance is largely a function of the chromium content.

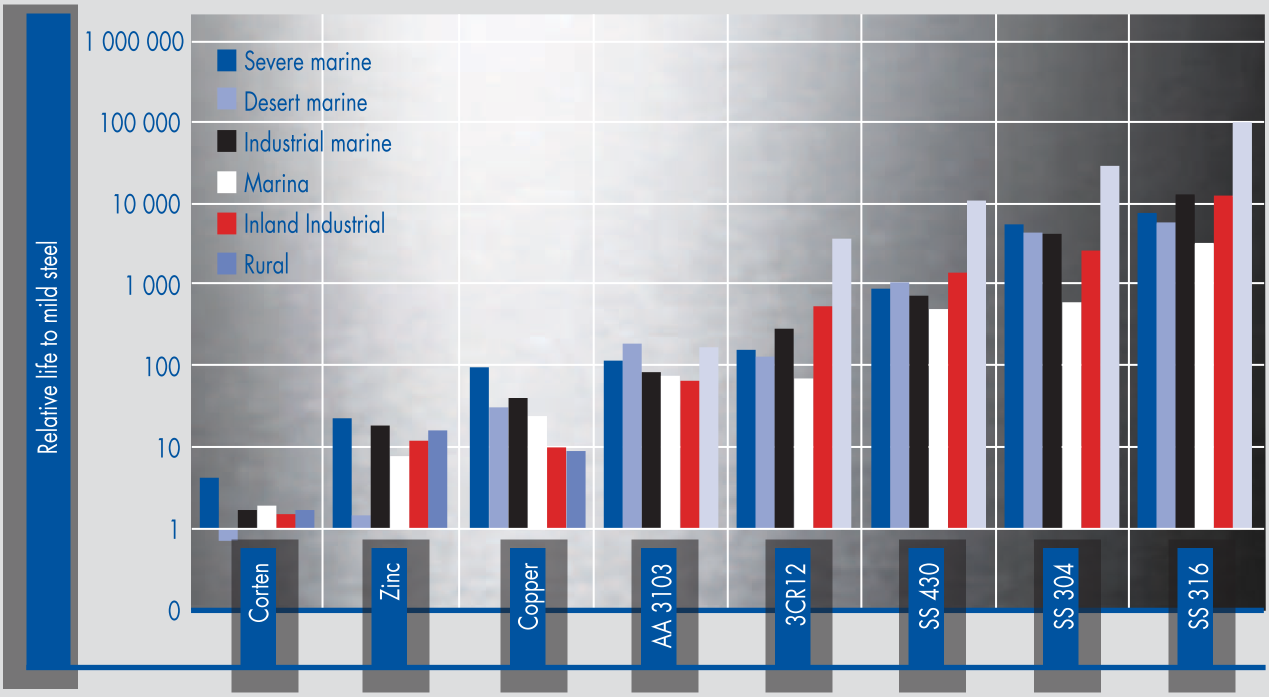
ATMOSPHERIC CORROSION

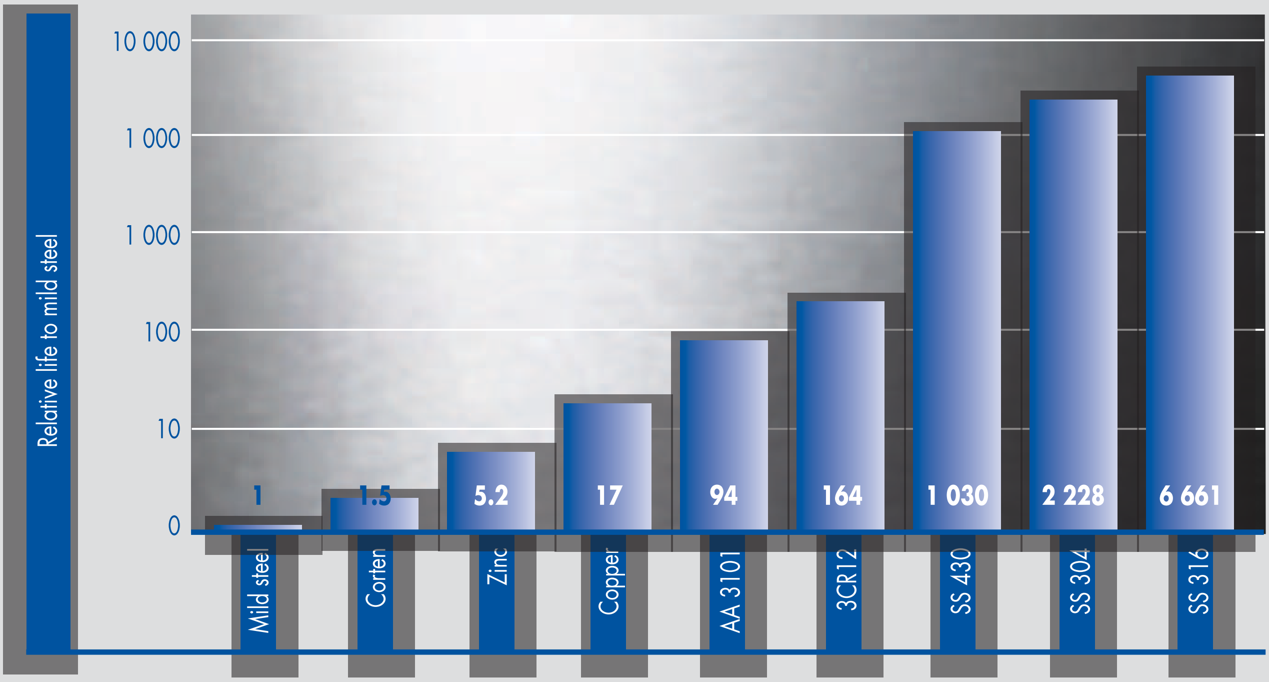
From the report 'Atmospheric Corrosion Testing in Southern Africa - Results of a Twenty Year Exposure Programme' by BG Callaghan, Division of Materials Science and Technology, CSIR, the following graphs were constructed.

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.

Corrosion resistance (continued)





GENERAL CORROSION

40910 is significantly more corrosion resistant than mild or low alloy corrosion resistant steels. However, it has a lower corrosion resistance than the higher chromium Standard ferritics.409 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.

430 has good resistance to a wide variety of corrosive environments including nitric acid and some organic acids. It is generally used for highly polished applications and in mild atmospheres such as for food processing and dairy equipment. Atmospheric corrosion resistance is good, although in highly polluted or marine environments staining may occur.

439 and 1.4509 have good resistance to a wide variety of corrosive environments.They are generally used in the automotive industry for exhaust systems. Atmospheric corrosion resistance is good, although in highly polluted or marine environments staining may occur.

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