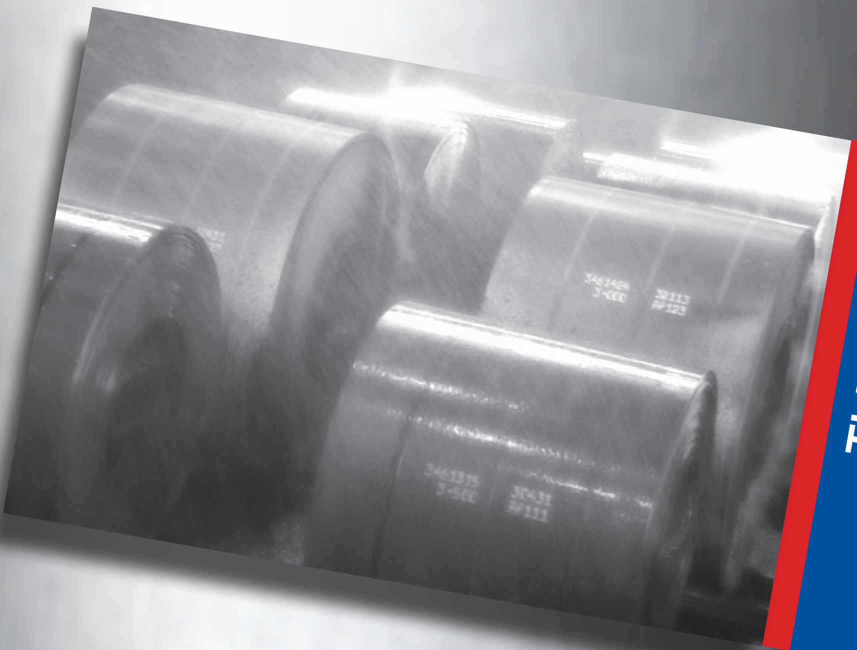
Technical Brochure



THE ATMOSPHERIC CORROSION RESISTANCE OF STAINLESS STEELS

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Introduction

Stainless steels are widely used in applications requiring good atmospheric corrosion resistance.

Atmospheric corrosion varies widely as does the corrosion resistance of different stainless steels. These issues are addressed with reference to the CSIR report (Atmospheric Corrosion Testing in Southern Africa - Results of a Twenty Year Exposure Programme, BG Callaghan, Division of Materials Science and Technology, CSIR).

Atmospheric conditions

Atmospheric conditions were classified broadly, according to the corrosiveness, as follows.

Condition	Severe marine	Desert marine	Industrial marine	Marine	Inland industrial	Rural
Temperature	high	moderate	high	moderate	moderate	moderate
Humidity	high	moderate	high	moderate	Low	Low
Wind-borne salts	yes	yes	no	no	no	no
Rainfall	summer	infrequent	summer	winter	summer	summer
Early morning sea mists	no	yes	no	no	no	no
Pollution	moderate	low	high	low	high	low

The corrosion rate of the following metals were measured in the above environments - mild steel, corten weathering steel, zinc, copper, aluminium (3103) and stainless steels (3CR12, 430, 304 and 316) - at various time intervals from two to 20 years.

Certain metals experienced a variation in corrosion rate over time, but these variations were small compared to the variations between environments or metals.

In general, the corrosion rate of mild steel and corten decreased with time (due to the accumulation of corrosion product on the surface), while aluminium, zinc, copper and the stainless steels had time independent corrosion rates.

The average corrosion rate of mild steel is shown in the different environments in Figure 1. This clearly ranks the environments and the results are consistent with the conditions presented in the above table.

Further information

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Figure 1 - Corrosion rate of mild steel

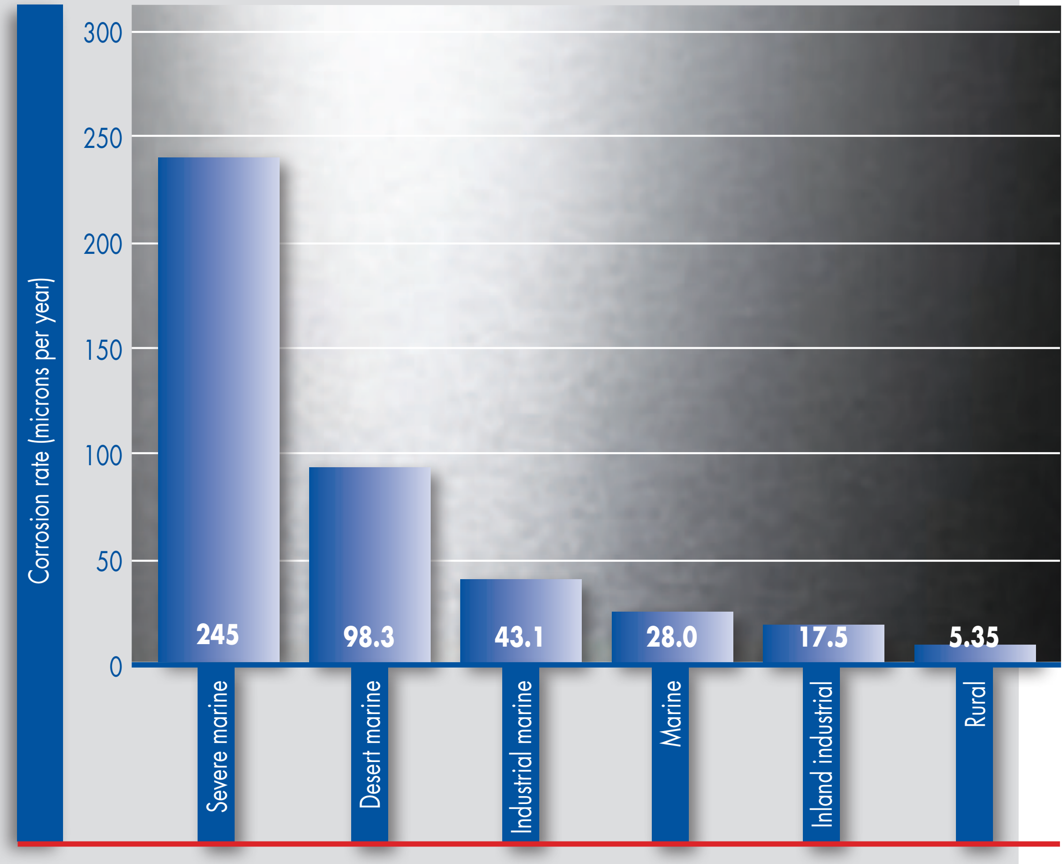
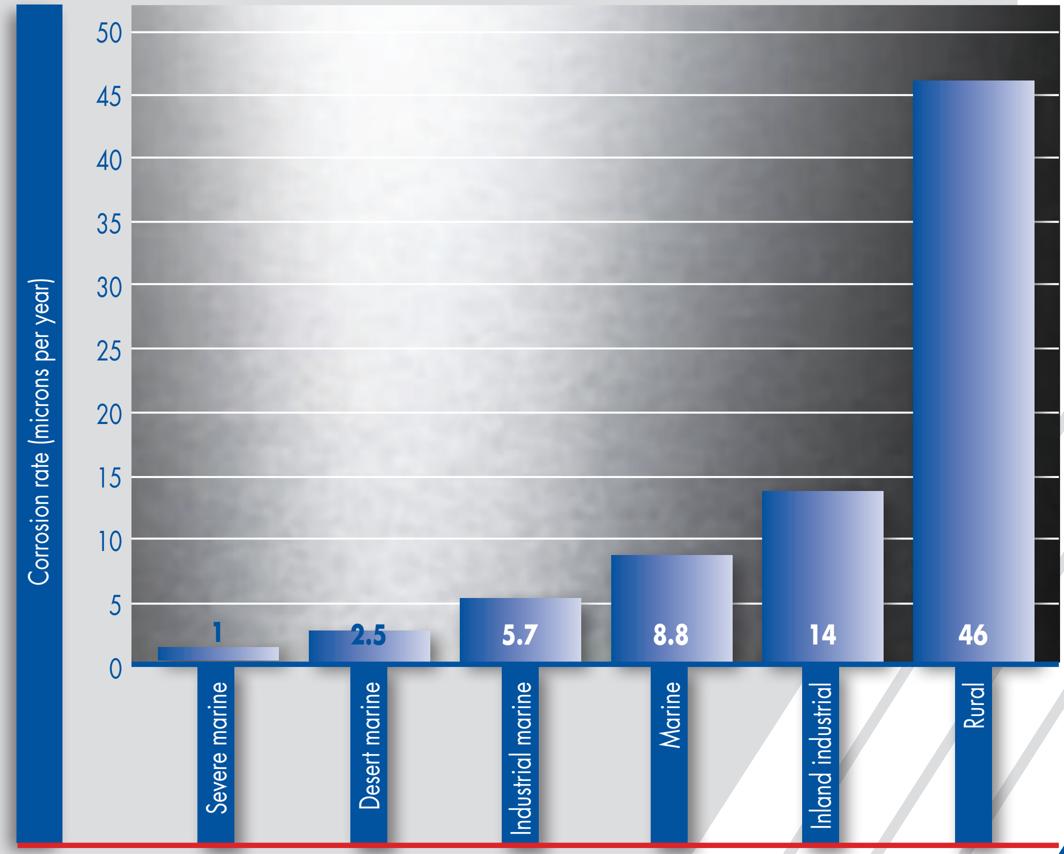


Figure 2 - Relative mild steel life to severe marine



Atmospheric conditions (continued)

If the corrosion rate is converted to a relative life, Figure 2 for mild steel can be derived. From this, it can be seen that mild steel in a rural environment is expected to last 46 times longer than in a severe marine environment. Using a similar conversion, Figure 3 can be derived and shows the relative life of the eight other metals to mild steel in the six different environments.

Finally, Figure 4 shows the average relative life of the different metals in atmospheric conditions. This figure allows the metals to be ranked overall and also gives some generalised information about the relative atmospheric corrosion resistance of the various metals. (The scale of Figures 3 and 4 are logarithmic to better compare the different orders of magnitude of the lives of the different metals.)

Figure 3 - Relative life to mild steel

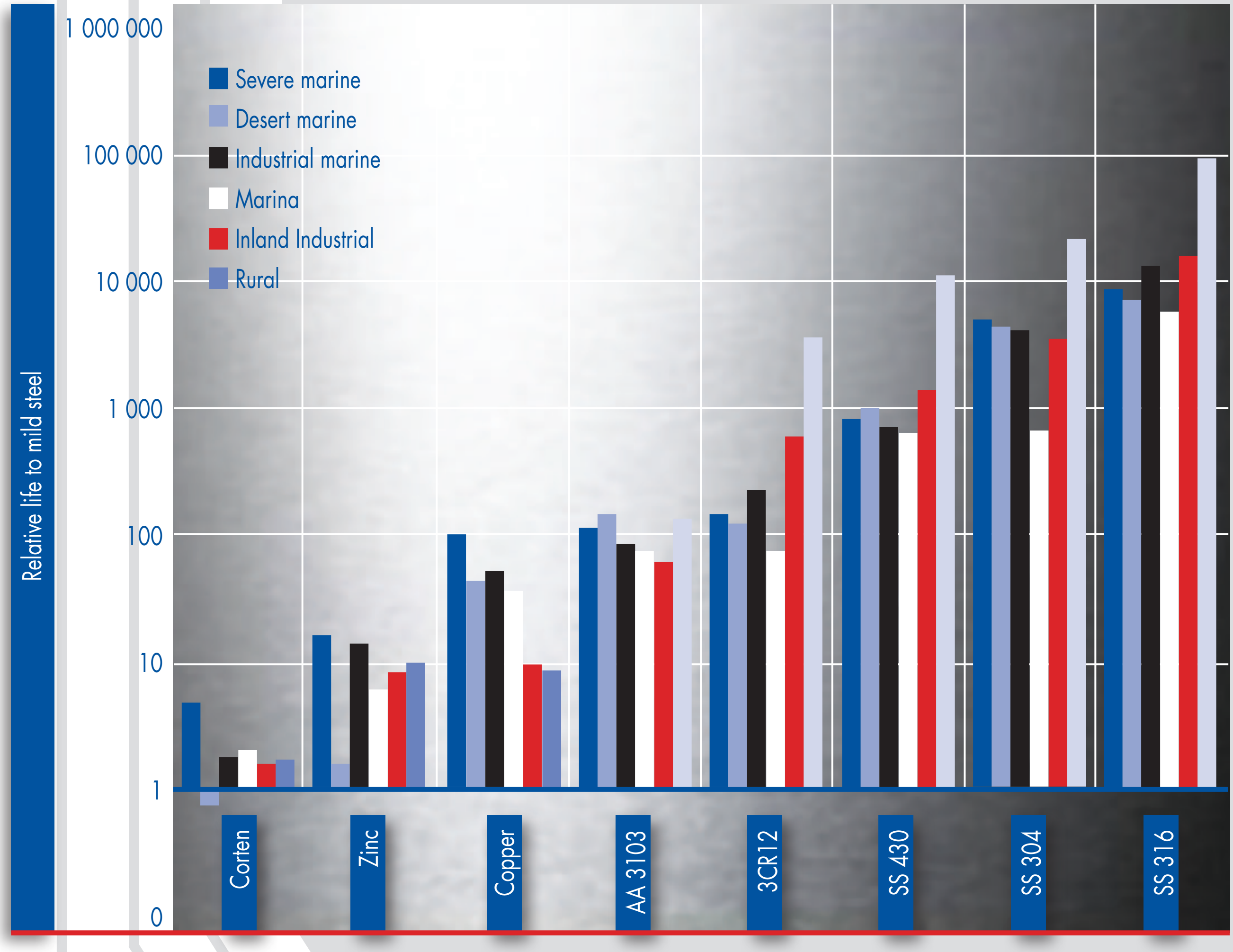
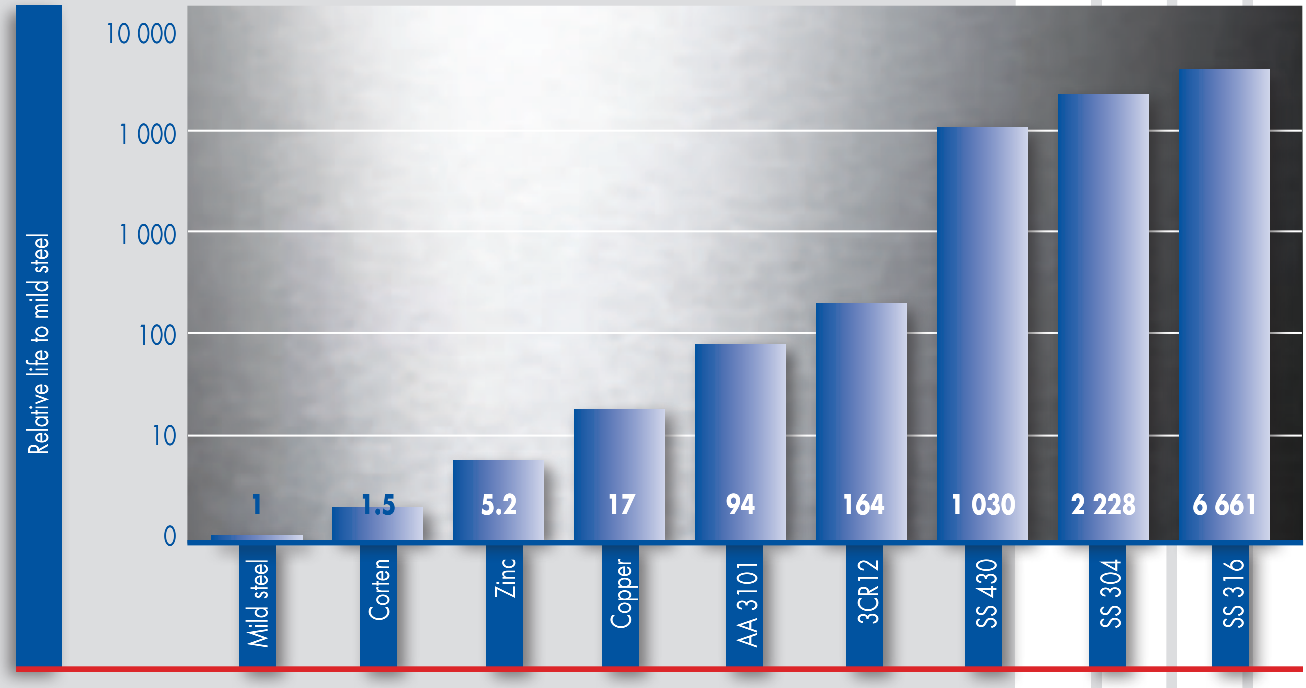


Figure 4 - Overall relative atmospheric life

Finally, Figure 4 shows the average relative life of the different metals in atmospheric conditions. This figure allows the metals to be ranked overall and also gives some generalised information about the relative atmospheric corrosion resistance of the various metals. (The scale of Figures 3 and 4 are logarithmic to better compare the different orders of magnitude of the lives of the different metals.)



In appearance, all the metals showed discolouration at the more severe sites after 20 years. Even the most corrosion resistant alloy tested here, 316 stainless steel, showed severe staining.

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. All the stainless steels and aluminium showed some pitting. However, 3CR12, even in the most corrosive environment, only had a pit depth of 250μm after 10 years.

As far as corrosion rates are concerned, in most environments, Corten gives an advantage over mild steel. A zinc alloy would last up to 20 times longer than mild steel, but if it is used as a coating (i.e. galvanised steel), once the zinc is consumed, the corrosion rate of the galvanised steel would be the same as for mild steel.

With a typical galvanised coating being about 15μm, the galvanising would be penetrated in one to five years in most marine environments, although in inland environments, the coating would last between 15 and 50 years.

3CR12 has a similar performance to aluminium in marine environments and is superior in inland environments. The other stainless steels have even better corrosion resistance than 3CR12 and this is to be expected from their higher chromium and/or molybdenum contents.

3CR12 is an excellent material for atmospheric applications, even in the most demanding environments, if aesthetics are not important. Otherwise, coated 3CR12 has proven to be very successful.

Where aesthetics are important, the following guidelines can be applied - 430 should be reserved for rural environments, 304 for inland industrial applications and 316 for marine applications. Duplex and ferritic substitutes for 304 and 316 are available which can provide a more cost effective alternative.