STEEL GEAR

Stainless steel fixtures & fittings

Material Guide

There are a vast array of different stainless steel types which can cause a lot of confusion.

The most popular grades are :

1. A2 (or 304) Stainless - good corrosion protection
2. A4 (or 316) Stainless - better corrosion protection

A4 A2

Generally - pick A4 grade if parts are used in any marine environment or, on land but close to the sea.

For Specific information on all the different grades available and further information on suitability of use/welding etc see :

The technical library of the British stainless steel association:

http://www.bssa.org.uk/topics.php

Here you will find further categories such as Corrosion & Oxidisation :
http://www.bssa.org.uk/topics.php?category=9

Corrosion mechanisms in stainless steel

Introduction

Stainless steels are generally very corrosion resistant and will perform satisfactorily in most environments. The limit of corrosion resistance of a given stainless steel depends on its constituent elements which means that each grade has a slightly different response when exposed to a corrosive environment. Care is therefore needed to select the most appropriate grade of stainless steel for a given application. As well as careful material grade selection, good detailing and workmanship can significantly reduce the likelihood of staining and corrosion.

Pitting corrosion

Pitting is a localised form of corrosion which can occur as a result of exposure to specific environments, most notably those containing chlorides. In most structural applications, the extent of pitting is likely to be superficial and the reduction in section of a component is negligible. However, corrosion products can stain architectural features. A less tolerant view of pitting should be adopted for services such as ducts, piping and containment structures. If there is a known pitting hazard, then a molybdenum bearing stainless steel will be required.

Crevice corrosion

Crevice corrosion is a localised form of attack which is initiated by the extremely low availability of oxygen in a crevice. It is only likely to be a problem in stagnant solutions where a build-up of chlorides can occur. The severity of crevice corrosion is very dependent on the geometry of the crevice; the narrower (around 25 micro-metres) and deeper the crevice, the more severe the corrosion. Crevices typically occur between nuts and washers or around the thread of a screw or the shank of a bolt. Crevices can also occur in welds which fail to penetrate and under deposits on the steel surface.

Bimetallic (galvanic) corrosion

Bimetallic (galvanic) corrosion may occur when dissimilar metals are in contact in a common electrolyte (e.g. rain, condensation etc.). If current flows between the two, the less noble metal (the anode) corrodes at a faster rate than would have occurred if the metals were not in contact.

The rate of corrosion also depends on the relative areas of the metals in contact, the temperature and the composition of the electrolyte. In particular, the larger the area of the cathode in relation to that of the anode, the greater the rate of attack. Adverse area ratios are likely to occur with fasteners and at joints. Carbon steel bolts in stainless steel members should be avoided because the ratio of the area of the stainless steel to the carbon steel is large and the bolts will be subject to aggressive attack. Conversely, the rate of attack of a carbon steel member by a stainless steel bolt is much slower. It is usually helpful to draw on previous experience in similar sites because dissimilar metals can often be safely coupled under conditions of occasional condensation or dampness with no adverse effects, especially when the conductivity of the electrolyte is low.

The prediction of these effects is difficult because the corrosion rate is determined by a number of complex issues. The use of potential tables ignores the presence of surface oxide films and the effects of area ratios and different solution (electrolyte) chemistry. Therefore, uninformed use of these tables may produce erroneous results. They should be used with care and only for initial assessment.

Austenitic stainless steels usually form the cathode in a bimetallic couple and therefore do not suffer corrosion. Contact between austenitic stainless steels and zinc or aluminium may result in some additional corrosion of the latter two metals. This is unlikely to be significant structurally, but the resulting white/grey powder may be deemed unsightly. Bimetallic corrosion may be prevented by excluding water from the detail (e.g. by painting or taping over the assembled joint) or isolating the metals from each other (e.g. by painting the contact surfaces of the dissimilar metals). Isolation around bolted connections can be achieved by non-conductive plastic or rubber gaskets and nylon or teflon washers and bushes. This system is a time consuming detail to make on site and it is not possible to provide the necessary level of site inspection to check that all the washers and sleeves have been installed properly.

The general behaviour of metals in bimetallic contact in rural, urban, industrial and coastal environments is fully documented in PD 6484 'Commentary on corrosion at bimetallic contacts and its alleviation'.

Stress corrosion cracking (SCC)

The development of stress corrosion cracking (SCC) requires the simultaneous presence of tensile stresses and specific environmental factors. It is uncommon in normal building atmospheres. The stresses do not need to be very high in relation to the proof stress of the material and may be due to loading and/or residual effects from manufacturing processes such as welding or bending. Caution should be exercised when stainless steel members containing high residual stresses (e.g. due to cold working) are used in chloride rich environments (e.g. swimming pools enclosures, marine, offshore).

General (uniform) corrosion

General corrosion is much less severe in stainless steel than in other steels. It only occurs when the stainless steel is at a pH value < 1.0. Reference should be made to tables in manufacturers' literature, or the advice of a corrosion engineer should be sought, if the stainless steel is to come into contact with chemicals.

Intergranular attack and weld decay

When austenitic stainless steels are subject to prolonged heating between 450-850^0 C, the carbon in the steel diffuses to the grain boundaries and precipitates chromium carbide. This removes chromium from the solid solution and leaves a lower chromium content adjacent to the grain boundaries. Steels in this condition are termed 'sensitised'. The grain boundaries become prone to preferential attack on subsequent exposure to a corrosive environment. This phenomenon is known as weld decay when it occurs in the heat affected zone of a weldment.

Grades of stainless steel which have a low carbon content (~0.03%) will not become sensitised, even for plate thicknesses up to 20 mm when welded by arc processes (giving rapid heating and cooling). Furthermore, modern steelmaking processes mean that a carbon content of 0.05% or less is generally achieved in the standard carbon grades 304 and 316, so these grades will not be prone to weld decay when welded by arc processes.

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