Hot Dip Galvanizing Data Sheet GA

2.15 Cathodic protection and the protection of edges

1. General

In any anticorrosion process care must be taken to ensure that the system has no weak points. The adage "A chain is only as strong as its weakest link" is particularly true here.
One area that experience has shown to be potentially problematical is that of minor blemishes (such as scratches and abrasions) that can arise during transport or assembly of steel components. A further problem is that of edges of worked articles, which on the one hand are constantly subject to particular mechanical stresses and on the other hand, due to their varied shapes, to a high risk of corrosion. If in addition to this the anticorrosion system on the edges of the worked articles is not very effective, problems can arise in protecting them against corrosion.
In both problem areas nature has endowed zinc coatings with favourable properties.

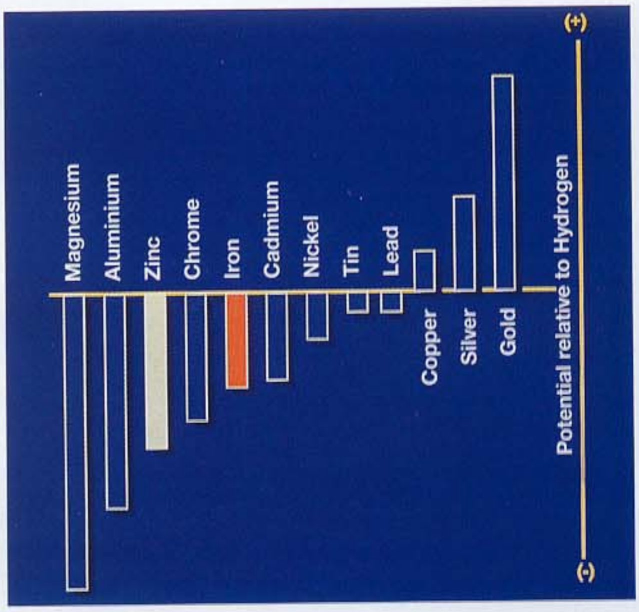

Fig. 1: Electrochemical potential series (schematic).

2. Cathodic protection

All metals possess a so-called normal potential, which characterises their readiness to oxidise and thus release positive ions. As this property varies greatly depending on the particular metal, the relative behaviour of metals may be represented in an electrochemical potential series (Figure 1). In this Table noble metals (for example gold and silver), with their positive potential, are placed on the right-hand side, whilst relatively base metals (magnesium, aluminium and zinc, for example) are located in the negative region on the left-hand side.
This Table clearly shows that from the electrochemical point of view zinc is less noble than iron. This property of zinc is advantageous in the field of corrosion protection. If damage occurs in zinc-coated steel components which locally destroys the coating to such an extent as to expose the underlying material steel, a galvanic cell is formed if a sufficient quantity of moisture (electrolyte) is present (Figure 2).
The coupling of iron and zinc, such as is found in steel components zinc-coated by firing, causes the formation of cathodic and anodic areas when their surfaces are damaged. As a general rule zinc constitutes the anodic area and steel the cathodic area here. As a result of the difference in potential the more negative zinc, the anode, continuously releases zinc ions, which are deposited on the nobler cathode, iron.
This electrochemical reaction forms decomposition products, with the result that rust does not spread or even become established on scratches and abrasions. When the zinc coating is damaged it is the zinc from the intact coating adjacent to the damaged area that provides protection against corrosion by means of a remote protective effect. The effectiveness of this protective mechanism must not of course be overestimated

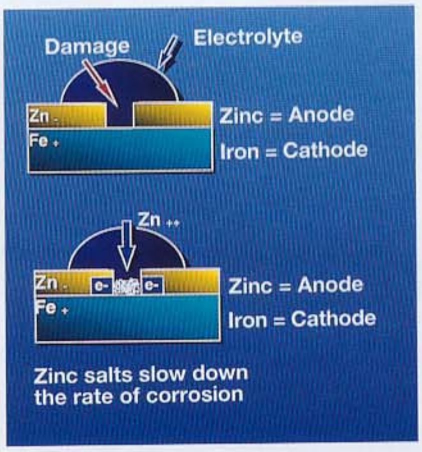

Fig. 2: The cathodic protection effect of zinc coatings.

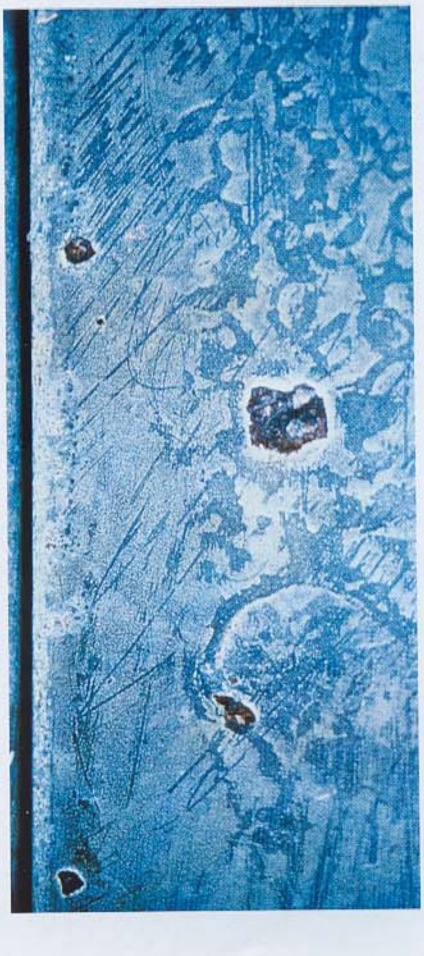

Fig. 3: Cathodic protection on damaged surface areas of a zinc coating

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and varies greatly according to the environmental conditions, the environmental humidity and the conductivity of the electrolytes. In practice, however, it seldom extends for distances of more than about 5mm. In other words, the length of a scratch is not limited though its breadth should not exceed 5mm. Cut edges on zinc-coated sheet metal, which are produced only after zinc-coating and are therefore not coated with zinc, also benefit from this electrochemical protection.

A brown discoloration of the damaged area indicates that the electrochemical reaction is temporarily inhibited (for example, due to the quantity of electrolyte being too small). This phenomenon is nevertheless relatively insignificant and not to be equated with a general failure of the cathodic protection. More serious damage must however be remedied by conventional methods (for example by zinc spraying or by application of zinc rich paint. Cathodic protection provides, without any additional cost or effort, an effect which ensures that minor damage to the system (which is often deliberately overlooked) does not become a problem.

3. Edge protection

In corrosion technology component edges are always more problematical than smooth surfaces of a structure. Component edges can be attacked more intensively by corrosive media and are always at greater risk from mechanical damage than other areas. For this reason, there is a definite impairment of the edge protection on components with conventional anticorrosion systems (Figure 4) unless special measures are taken (for example, special edge-protecting coatings).

One indication of this edge effect is "edge repulsion", which causes liquids to withdraw from the edges of components on account of their surface tension and to assume the form of drops. This has the result that a layer of liquid on the edge of a component is always thinner than on the adjacent smooth surface areas. However, as the efficiency of most corrosion protection systems is proportional to their thickness, a problem can arise from this.

During hot dip galvanizing the molten zinc reacts with the base steel to form a series of alloy layers. These iron-zinc alloys build up parallel to the surface of the component. On component edges this layer of alloy fans out and the intermediates spaces thus formed are filled by metallic zinc. The result of this is that zinc coatings on corners and edges are at least as thick as those on smooth surfaces (Figures 5, 6).

Here the laws of physics work to the advantage of zinc coatings which have no weak spots.

Reduction of maintenance on critical components	
Smooth surfaces	0 %
Corners and cavities	10–20 %
Near welds	30–35 %
Nuts and bolts	50–60 %
Edges	60 %

Fig. 4: Reduction of maintenance on critical component areas.

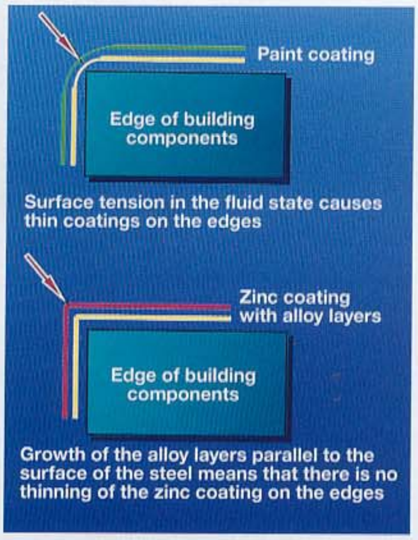

Fig. 5: Withdrawal from edges / protection of edges (schematic).

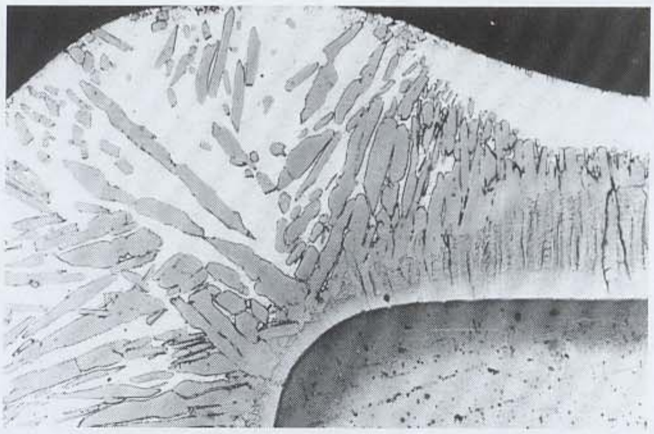

Fig. 6: Zinc coating on a component edge (micro-edge).

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