14. GALVANIZING DIFFICULT STEELS

INTRODUCTION

From time to time, galvanizers is asked about galvanizing special steels or unusual steel sections that are outside the normal range of steels processed on a day to day basis through jobbing galvanizing operations. While these steels can present problems for galvanizers, it is sometimes possible to deal with these problems in the design of the components or through modifications to the hot dip galvanizing process.

In addition, steelmaking processes may vary from time to time, or steel may be sourced from imports that have variable chemistry because of the nature of the raw materials used in their manufacture in their country of origin.

GALVANIZING ALLOY STEELS

While high strength alloy steels are rarely used for structural applications, they are sometimes used as performance-critical components in assemblies or as individual manufactured items. There are three factors that effect the ability of steel to be galvanized. These are:

1. The chemical composition of the steel
2. The strength rating of the steel (the yield strength in MPa)
3. The steel's section thickness*

** This is a factor in that it determines the immersion time of the steel in the molten zinc.*

When a request is received to galvanize an unusual type of steel, the chemical composition is first checked. Most special steels contain carbon (C), phosphorous (P), manganese (Mn), silicon (Si), sulfur (S), chrome (Cr), nickel (Ni) and may also contain copper (Cu), Vanadium (Va) and other elements that are used to give the steel particular performance characteristics.

This fracture in high-strength Bisalloy plate resulted from hydrogen embrittlement induced by the acid pickling process. High strength steels such as this can be satisfactorily galvanized by mechanically cleaning the surface and avoiding the acid pickling pre-treatment stage in the galvanizing process.

WHAT IS IN ALLOY STEELS?

While there are hundreds of different types of special steels, there are generic chemistries that fit particular applications and these are useful in determining what is likely to happen when these steels are hot dip galvanized. The following list is a guide to the most prominent alloying elements likely to be in these special steels that will have an effect on their ability to be galvanized:

1. Spring steels. These steels contain high levels of silicon which can be up to 2.0%.
2. Tough steels. These steels contain high levels of manganese which may be over 1.0%
3. Hard steels. These steels contain high levels of carbon which may be over 1.0%
4. Free machining steels. These steels contain high levels of sulfur
5. Electrical steels. These steels contain high levels of phosphorous
6 Stainless steels. These steels contain high levels of nickel and chrome
7 Cast iron and steel. These items may have high carbon content, non-metallic inclusions or casting sand fused to the surface.
8 Very low alloy steel. These steels contain very low levels of alloy additions and are largely pure iron – similar to the steel from which galvanizing baths are manufactured. This type of steel has a very low reaction rate with zinc, and can cause problems in producing galvanized coatings that comply with Australian Standards. It is most frequently found in products that are formed from low-strength (under 350 MPa) steel coil.

The galvanizing characteristics of these steels are as follows:

1. High silicon steels will produce thick galvanized coatings that may be brittle because the steel reacts very rapidly with the zinc. The effects of high silicon content can be minimised by keeping immersion time in the zinc as short as possible. This becomes increasingly difficult as section thickness increases.
2. High manganese steels will produce brownish coloured coatings that may be brittle and easily damaged in handling compared to galvanized coatings on conventional steels.
3. High carbon steels can be successfully galvanized as long as their yield strength is within an acceptable range (see note below).
4. High sulfur steels are used for high-speed machined components (threaded fasteners, sockets etc) and should not be galvanized. The high sulfur steel can be severely eroded in the galvanizing process, rendering threaded items unserviceable.
5. High phosphorous steel are rarely encountered in galvanizing operations but are unsuitable for galvanizing. They react rapidly with the zinc to form thick, dark coatings that are easily damaged and may delaminate from the surface.
6. Stainless steels can be galvanized but are susceptible to liquid metal embrittlement and can fracture under load after immersion in molten zinc. Stainless steels are only galvanized incidentally if they are attached to mild steel assemblies.
7. Cast iron and steel will normally galvanize satisfactorily, but moulding sand fused to the surface will not be removed by the pre-treatment process. Cast items may require abrasive blasting prior to delivery to the galvanizing plant to remove these refractory surface contaminants.
8. Very low alloy steel has a very low reaction rate with zinc, and can cause problems in producing galvanized coatings that comply with Australian Standards. It is most frequently found in products that are formed from low-strength (under 350 MPa) steel coil.

STEEL STRENGTH AND GALVANIZING

High strength steels (over 800 MPa [115,000 psi] yield strength) are susceptible to hydrogen embrittlement arising from the pickling process in galvanizing. Pickling should be avoided for steels in this strength range.

These heavy coil springs have been successfully galvanized following handling of this high silicon material.

STEEL SIZE AND GALVANIZING

While all conventional steel structural sections can be galvanized, from time to time, unusual sections arise that may present problems. Very thick sections over 100 mm in thickness may be difficult to galvanize acceptably in a conventional galvanizing bath. The mass of these items per unit of volume is very high, and as the zinc in the galvanizing bath is only about 35 degrees above its freezing point, the zinc freezes around the item when it is immersed, and may form a layer of frozen zinc 50 mm or more in thickness.

This zinc has to be re-melted and then the item itself heated up by the zinc bath to bath temperature for the galvanized coating to form. This sequence of events may interfere with the performance of the flux on the surface of the item and cause uncoated areas on the surface.
These defects can be minimised by pre-heating the item or operating at higher galvanizing bath temperatures, which requires special galvanizing bath design.

CONCLUSION

It is possible to successfully galvanize many difficult steels, particularly spring steels or wear resistant steel (Bisalloy) which are the type most likely to turn up for galvanizing. As long as the sections can be abrasive blasted rather than pickled, an acceptable galvanized coating can be produced on these steels that will not affect their performance.


INDUSTRIAL GALVANIZERS
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SPECIFIERS MANUAL

01 - SPECIFIERS MANUAL — THIRD EDITION

Industrial Galvanizers Australian Galvanizing Division (IGAG) operates nine galvanizing plants around Australia, ranging in size from large structural galvanizing facilities to specialised small plants designed to process small parts.

The Australian Galvanizing Division has galvanized in excess of 2 million tonnes of steel products in Australia since its first plant was commissioned in 1965 and is recognized for its ability to handle complex and difficult projects, as well as routine contracts.

This experience has been collated in the Specifiers Design Manual, to assist those involved in the design of steel products and projects to better understanding the galvanizing process and allow the most durable and cost-effective solutions to be delivered to these products and projects. All sections of this Third Edition have been completely updated and additional sections have been included to provide additional technical information related to the use of hot dip galvanized steel.

In addition to its Australian Galvanizing operations, Industrial Galvanizers Corporation has a network of manufacturing operations in Australia, as well as galvanizing and manufacturing businesses throughout Asia and in the USA.

The company's staff in all these locations will be pleased to assist with advice on design and performance of hot dip galvanized coatings and products. Contact details for each of these locations are located elsewhere in this manual.

This edition of the Industrial Galvanizers Specifiers Manual has been produced in both html and .pdf formats for ease of access and distribution and all documents in the Manual are in .pdf format and can be printed if paper documents are required.

The Specifiers Manual is also accessible in its entirety on the company's web site at www.ingal.com.au.

Additional copies of the Specifiers Manual are available on CD on request.

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