35 - AN INTRODUCTION TO THE HOT DIP GALVANIZING PROCESS

INTRODUCTION

The hot dip galvanizing process was developed in the 18th Century, with the fi rst hot dip galvanized products (galvanized iron sheeting) being imported to Australia in the 1850's.

It was found that molten zinc would react with steel to form a metallurgically bonded protective coating that had superior durability to any other coatings for atmospheric exposure.

While all early hot dip galvanized items were manufactured by dipping them in batches in a molten zinc bath, different technologies have been developed to more effi ciently apply zinc-based coatings to continuously manufactured products such as wire, sheet and tube.

The characteristics of the coatings applied by these continuous galvanizing technologies are quite different to those of coatings applied by the traditional batch galvanizing process. These processes are described in more detail in Chapter 35 of this manual.

The main difference in the nature of these galvanized coatings is the time that the steel is immersed in the molten zinc alloy. This time is very short (a few seconds) in continuous galvanizing processes – and much longer (typically 4-8 minutes) in the hot dip galvanizing process. The resulting zinc-based coatings produced by these processes are metallurgically quite different in their characteristics and performance.

The hot dip galvanizing process involved immersion of steel fabrications in molten zinc at 455°C until the steel reaches the molten zinc temperature. Oxide residues are formed from the combined reaction between the fl ux, the steel and the zinc, which are here being skimmed off the surface as the work emerges from the zinc bath.

THE HOT DIP GALVANIZING PROCESS

Steel fabrications or sections are delivered to the galvanizing plant. These items may contain steels of differing chemistry and surface condition and may be coated with preconstruction primers or other applied protective coatings, including continuously applied zinc coatings.

The hot dip galvanized coating is the result of a metallurgical reaction between the steel and the molten zinc, and this reaction will not occur if the steel's surface is contaminated with paint, grease, oil or rust. If any of these surface contaminants are present, the coating will not form and 'misses' will result in the galvanized coating.

For this reason, the pre-treatment of the steel sections or fabrications to remove grease, oil, paint and rust is critical to the successful application of the galvanized coating.

Large fabrications such as this spiral staircase can be hot dip galvanized by double-dipping. The first stage of the process is shown here.

DEGEASING AND PAINT REMOVAL

The grease, oil and paint is removed by immersing the fabrication in a hot sodium hydroxide (caustic soda) bath. Where steel fabrications have been recycled and have been previously painted with industrial paint coating, abrasive blasting may be required to remove these types of coatings that are resistant to the caustic degreasing process.

ACID PICKLING AND RUST REMOVAL

The steel is then rinsed and pickled in 10% hydrochloric acid to remove mill scale, rust and other surface oxides. Heavily corroded steel will generally require abrasive blasting to remove heavy rust to prevent processing delays in the pickling process and to avoid over-pickling of the steel sections that may not be heavily corroded in the same fabrication.

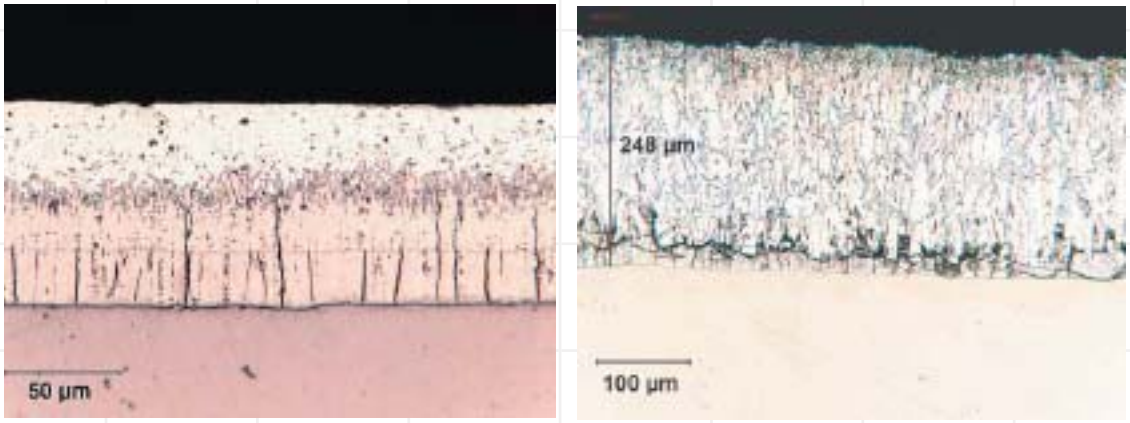
PREFLUXING

After pickling, the item is again rinsed and then immersed in a hot zinc ammonium chloride prefl ux solution. This prefl ux solution conditions the steel surface to facilitate the reaction between the steel and the molten zinc.

GALVANIZING

The prefl ux is allowed to dry on the steel's surface and then the fabrication is immersed in the molten zinc (Temperature 455°C). The steel must be heated to about this temperature for the zinc-steel reaction to occur. Heavy sections take longer to heat up, hence their longer residence time in the molten zinc bath.

This zinc-steel reaction produces a crystalline layer of zinc-iron alloy, with the iron content varying from around 10% at the steel surface to 4% at the zinc surface. When the steel is withdrawn from the molten zinc, a thin layer of zinc remains on the surface of the coating, giving hot dip galvanized coatings their shiny appearance. The melting point of zinc is only 35o below the bath temperature and any free zinc on the surface of the work quickly solidifi es. An exception can occur with reactive steel. The zinc-steel reaction can continue after the steel fabrication is withdrawn from the molten zinc, and all the 'free' zinc on the surface will be converted to zinc-iron alloy. This is grey in colour and the galvanized coating will thus have a matte silver-grey appearance.



These two micrographs illustrate the effect of steel chemistry on the characteristics of the hot dip galvanized coating. The micrograph on the left shows the appearance of a coating on normal steel, with the alloy layers (the crystalline, darker section of the coating) being coated with a layer of zinc (the lighter area). The micrograph on the right shows the appearance of a coating on reactive steel. This coating is 100% alloy layers and much thicker than the standard coating

QUENCHING AND PASSIVATION

After the fabrication is withdrawn from the galvanizing bath, it is quenched in a weak sodium dichromate solution. This process quickly cools the item so that it can be handled for unloading from dipping equipment and also applies a low level of chromate passivation to the galvanized coating's surface.

Freshly applied galvanized coatings are susceptible to rapid oxidation (white rusting) if exposed to rain water or condensation, as the zinc takes time (usually 2-3 weeks) to develop its patina of stable oxides that give it its exceptional anti-corrosion performance. The chromate passivation provides temporary protection to the new zinc surface to allow the patina to develop.

Quenching of the items may be deferred or not done at all, if the fabrication is of a design that is likely to distort if cooled quickly.

INSPECTION AND DRESSING

Depending on the design (size, shape, confi guration) of the steel section or fabrication, it will be subject to inspection and dressing as the final stage of the galvanizing process. The dressing process may involve removal of drainage spikes and touch-up of areas of coating affected by contact with jigs or lifting chains essential to the handling of the item through the process.

NOTE: This chapter is intended to explain the hot dip galvanizing process. Other important issues in ensuring quality, such as design for galvanizing, are covered in detail in other chapters of this Manual.


INDUSTRIAL GALVANIZERS
INDUSTRIAL GALVANIZERS
INGAL
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.

PUBLISHER:
Industrial Galvanizers Australian Galvanizing Division,
PO Box 503, MOOROOKA
QLD 4105
Ph: 07 38597418

EDITOR:
John Robinson,
Mount Townsend Solutions Pty Ltd
PO Box 355, JESMOND NSW 2299
Ph: 0411 886 884
Email: mt.solutions@optusnet.com.au

LAYOUT AND DESIGN:
Adrian Edmunds,
Nodding Dog Design
Ph: 0402 260 734
Email: adrian@noddingdogdesign.com
Web: www.noddingdogdesign.com