33. THICKNESS MEASUREMENT OF PROTECTIVE COATINGS

INTRODUCTION

With almost all applied coatings, regardless of their technology, the factor that determines their reliability in service, given proper application, is coating thickness. With organic coatings, the coating thickness provides the barrier between the environment and the substrate. The thicker the coating, the more impermeable it is to moisture and corrodents. With galvanized coatings, coating life is determined by the corrosion rate of zinc and the thickness of the galvanized coating, so thicker galvanized coatings will always give proportionately longer lives than those that are thinner.

The durability of metallic coatings like hot dip galvanizing are dependent on their coating thickness. Measuring coating loss over time can accurately determine coating life.

With both paint and galvanized coatings, the process determines the thickness of the coating. The application and specifications related to coating thickness are defined by Australian or international standards for generic coatings, by manufacturers' data sheets, or by particular product or application specific specifications written for a particular project.

Almost without exception, coating thickness is an essential part of these specifications.

COATING THICKNESS - HOW IS IT MEASURED?

While coatings are applied to a variety of materials, the majority of coating thickness testing is done over ferrous (iron and steel) surfaces, although many digital electronic thickness gauges have the capability to measure coatings on nonferrous metal surfaces using circuitry that measures eddy currents rather than magnetic flux used on steel substrates.

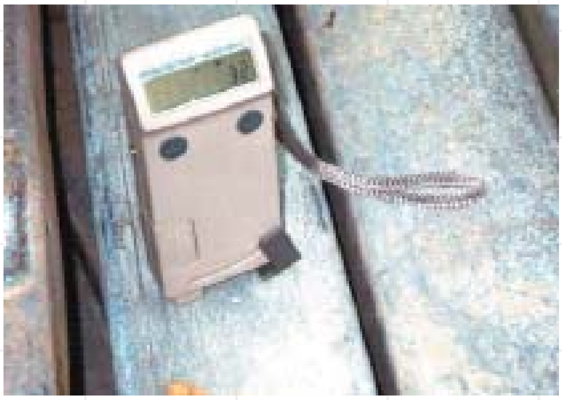
Most protective coatings over steel are applied in a thickness range from zero to 1000 microns, although most coatings, both paint and galvanizing, would commonly be in the 10-300 micron range. The accuracy of these gauges is in the order of ± 3% although some high performance instruments are rated at ± 1%. The older style mechanical banana and pull-off gauges operate with an order of accuracy of ± 10%.

Few applied coatings are uniform in thickness and acceptable variations are accommodated in specification standards. Most galvanized coatings are actually specified in terms of coating mass rather than coating thickness. The mass/m^2 is converted to theoretical thickness as a practical non-destructive method of measuring the galvanized coating. Some electronic thickness gauges have the capacity to store readings and provide statistical analysis of coating thickness data.

Calibration of coating thickness gauges is an essential element in their performance. Ferrous and nonferrous coating thickness standards are calibrated to comply with all Australian (AS 3894.3 - 1993) and international standards. Coating thickness standard sets comprise five standard plates including one zero plate and four epoxy coated reference plates. Various coating thickness standard sets are available for particular coating classes. For example, coating thickness standards for heavy duty coatings comprise 0, 75, 150, 250 and 500 micron standards while coating thickness standards for plating and anodizing include 0, 10, 15, 20 and 40 micron standards. Other standard sets are available for powder coatings, galvanized coatings and ultra high-build coatings.

COATING THICKNESS IN THE REAL WORLD

All the instrumentation used to measure coating thickness is calibrated using standards that are smooth and flat. In practice, particularly on steel surfaces, a variety of conditions may be encountered that



Electronic thickness gauges such as this Positector 6000 can measure any non-magnetic coating over a steel substrate. All coating specifications are based in applied coating thickness.

will affect the way the instruments read coating thickness. The factor that determines coating performance, if coating thickness counts, is the distance between the highest points on the substrate and the surface of the coating, as this is where failure is most likely to occur.

Industrial coatings are applied to steel surfaces that may be very smooth, hot rolled, abrasive blasted to various standards, previously rusted and pitted, oxy-cut or curved. Paint coatings, because of their surface tension effects are usually level across their surface. Hot dip galvanized coatings, because they are formed through reaction with the steel's surface, tend to follow the contour of the surface.

It is common practice to measure coating thickness after application - a logical thing to do. The condition of the steel's surface prior to coating will determine the actual thickness of the coating that needs to be adjusted to take the effects of surface condition into consideration. Thus some knowledge of the surface prior to coating would be useful in the evaluation of the coating thickness measurements.

With abrasive blasted steel, the profile produced by the blasting will be determined by the type of blasting media used, and the techniques used in the blasting. Chilled iron shot produces a different type of surface profile to grit. Some coarse blasting media can produce blast profiles exceeding 100 microns.

Unless the peaks of these coarse profiles are adequately coated, the performance of the coating will be compromised.

There are surface profile gauges that use comparative or direct measurement of surface profile prior to coating, such as the Keane-Tator Profile discs and magnifier, the PCWI Surface Profile Gauge or the Mitutoyo Dial Gauge/Testex Tape system for permanent recording of profiles, but the thickness gauges themselves can be used to give an indication of surface profile height.

By taking the average of 10 thickness readings on the uncoated steel surface, the electronic gauge that has been zero calibrated on a smooth surface will give a reading. For profile heights up to 30 microns, the gauge will generally read about 25% of the profile height. For profiles up to 50 microns, this proportion is approximately 33% and for coarse profiles around 100 microns, the gauge will read about 50% of the profile height. Thus, if a reading of 13 microns is obtained on the prepared surface, the profile height can be expected to be in the order of 40 microns.

Once the coating is applied, the reading of 100 microns would indicate that the coating thickness over the highest points in the profile is around 50 microns. The profile height is 40 microns and the actual applied coating thickness is 87 microns because the instrument registers 13 microns on the uncoated steel due to the profile effect.

While high build coatings have plenty of latitude to accommodate these factors, the new generation of low permeability polymers that depend on lower applied coating thicknesses for their cost effectiveness have to take the above factors into account. Zeroing the thickness gauge on the surface to be coated, or zeroing the instrument from the top of the profile height by using a standard coating thickness film will allow coating thickness readings to reflect the actual coverage over the highest points on the surface being measured. This will not take into account what are known as surface hackles or stray rogue peaks.

This can be very costly, as the voids in the profile must be filled. The question is, ‘At who’s cost?’ A 40 micron profile may well take up to 26 microns of the coating to fill which will be at the applicators cost. If the substrate is measured first, this would build in an allowance of 13 microns.

Other factors such as steel composition, edge and corner affects and surface flatness can affect the precision with which the instruments can determine coating thickness. For most industrial coating applications, very high levels of precision are not necessary. However, the potential for variations versus actual coating thickness needs to be taken into consideration. If too many anomalies are allowed to accumulate, the performance of the coating will be compromised because it will not meet its own application criteria for adequate performance.

INGAL

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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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