

Hot Dip Galvanized Information Sheet No.5

Hot Dip Galvanizing compared to Zinc Thermal Spray

In order to conduct such a comparison it is necessary to first understand the two processes.

Hot Dip Galvanizing

Hot dip galvanizing is a metallurgical process that results when “perfectly” cleaned steel is immersed into molten zinc at 450°C. In other words the coating is achieved by way of a chemical reaction between the molten zinc and the steel, forming a series of zinc iron alloys that provide a “chemical bond” between the steel and the protective coating. Adhesion is achieved as part of the process and is not dependent on human intervention.

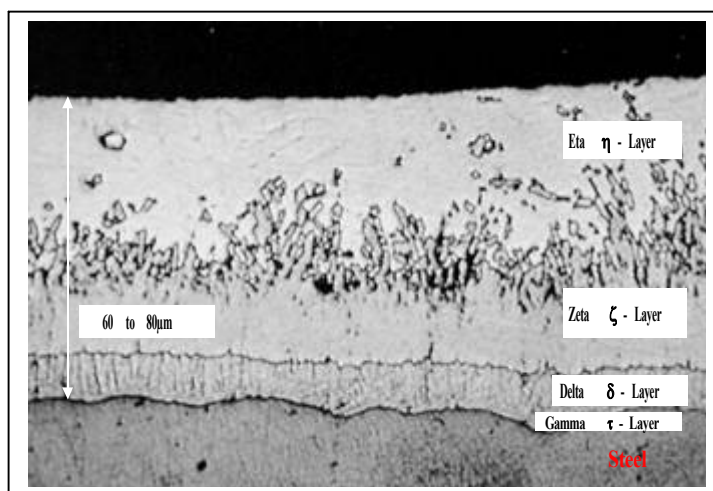


Figure 1: Typical hot dip galvanized coating on Aluminium “Killed Steel”
Micrograph x 200 magnification

Zinc Metal Spray

This form of coating is achieved by passing a zinc wire through an oxygen/acetylene fired gun that melts the zinc ($\pm 750^\circ\text{C}$) forming minute molecules of molten zinc that are then sprayed onto the steel surface. By the very nature of the process, adhesion of the zinc to the steel is a mechanical bond, as illustrated in the micrograph of this form of coating. There is no metallurgical (chemical) bonding of the coating to the steel surface.

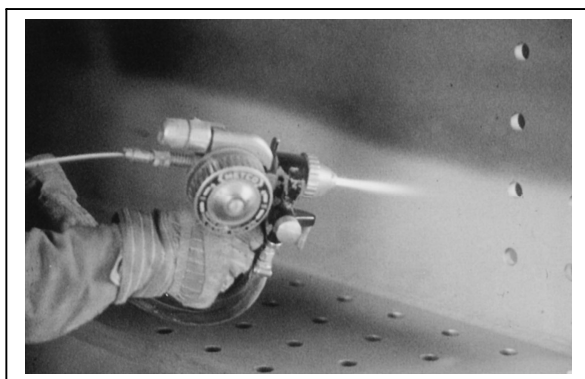


Figure 2: Hot Zinc Metal Spray Gun

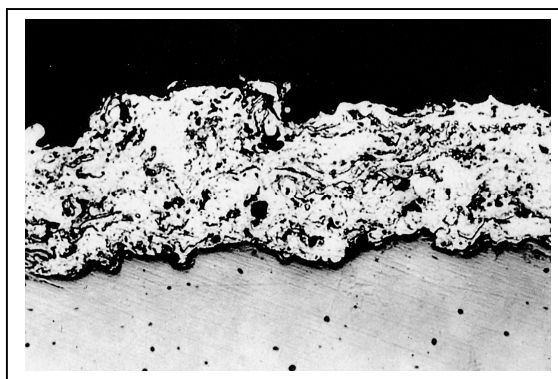


Figure 3: Typical Hot Zinc Metal Sprayed Coating
Micrograph x 200 magnification

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Having briefly illustrated the two processes and their respective micrographs, we can draw some comparisons based on the coating itself.

Comparison of Hot Dip Galvanizing & Zinc Metal Spray

Factor or Characteristic	Hot Dip Galvanizing (HDG)	Zinc Metal Spray (ZMS)
Zinc is a sacrificial material, i.e. it is electro-negative to steel and will corrode in preference to steel and thereby provide cathodic protection. It follows that the thicker the coating the longer its service life.	As HDG is a “dipping” process following metallurgical laws, all surfaces are coated with a uniform thickness of between 50 to 60µm. Heavier coatings of +120µm can also be achieved if required.	ZMS is generally hand applied and subject to variations in thickness, is non-uniform and does not necessarily coat all surfaces. The coating is subject to the operator preparing the surface and applying the coating. Coating thickness is a function of time and operator skill, but generally found to be ±30µm.
Corrosion protection is provided by: <ol style="list-style-type: none"> 1. Barrier protection, i.e. separating the steel from the corrosive environment 2. Cathodic Protection, i.e. zinc is the anode (electro-negative to steel) and steel the cathode. 	Both coatings provide “barrier protection” and “cathodic protection”. HDG is uniform and non-porous, i.e. it provides a total and continuous barrier. 1 st line of defense is barrier protection. 2 nd line of defense is cathodic protection.	ZMS has “voids” (note the dark spots on the micrograph) and can sometimes be non-continuous if not applied by a trained operator, especially if applied on a construction site. 1 st line of defense could be compromised.
Distortion	Distortion is limited to very thin material, <1mm, which is not normally HDG by the batch process. When distortion is expected, steps are taken to prevent the problem. Literally thousands of tons of steel are HDG without any distortion problems.	ZMS will not result in distortion, but over blasting could result in damage to very thin material.
Coating of sealed “hollow” fabricated sections with the possibility of an explosion.	These items are successfully HDG on a daily basis without exploding. The successful and professional HDG will carry out such activities without any such problem. It is of course interesting that HDG also coats the internal surfaces of vessels and hollow sections, which would otherwise not be able to be coated due to access issues.	Small, inaccessible hollow sections cannot be coated by ZMS. Internal corrosion problems can be more serious due to the fact that these surfaces are normally hidden. One cannot ZMS the internal surfaces of small diameter pipes.

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Size Limits	HDG items are generally limited to the bath size, which in SA goes up to 14m structures. Larger structures have however been successfully HDG and site welded followed by ZMS of the weld area with an additional, extra 30µm over and above the specified coating.	ZMS of large structures to a comparable specification (SANS 121 – ISO1461) would be substantially more expensive than if it was HDG. It becomes uneconomical to correctly clean and prepare steel for ZMS on large structures. It is very rarely necessary to resort to this approach.
Hydrogen embrittlement	It has been claimed that HDG fasteners suffer from hydrogen embrittlement. Fasteners are successfully HDG up to grade 8.8 without any special requirements. Should it be necessary to HDG grade 10.9 bolts, a code of practice is followed in order to prevent this particular problem. Annex B SANS 10094	ZMS of threaded articles could damage the threads due to the “shot blast” effect leading to assembly problems as well as inconsistent coatings.

In general, hot dip galvanizing is the most practical and economical corrosion protection coating available for carbon steels. Corrosion is a function of the environment, coating thickness, integrity and adhesion characteristics.

All coatings, irrespective of the type, require proper and adequate cleaning and preparation prior to the application of the barrier protection. The majority of coatings require strict supervision to ensure compliance with this requirement.

Hot dip galvanizing is called “an honest coating” in that if the steel is not correctly and adequately cleaned prior to coating, it will not galvanize! Inspection is therefore easier and limited to the end product. Likewise site inspection is also made easier and practical.

Should you require additional detail, we would be most willing to discuss the subject further. We can also provide additional information on duplex coatings (hot dip galvanizing plus a top paint coating), which you may find of interest.