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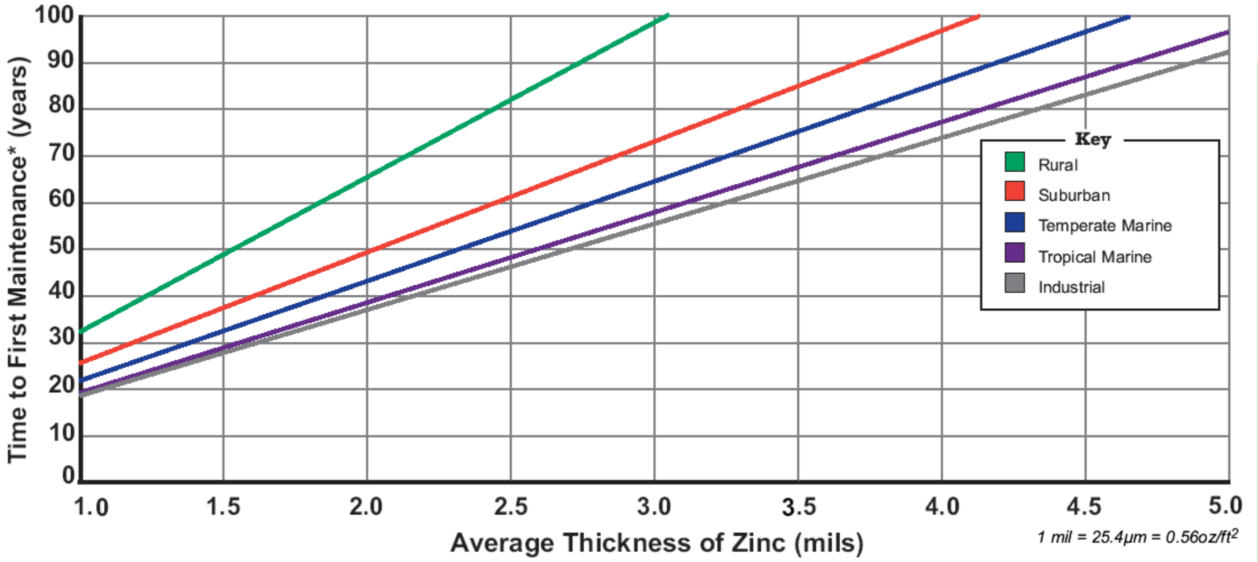
applications

E BOOK

ZINC COATINGS

Zinc metal has a number of characteristics that make it well suited for use as a coating for protecting steel products from corrosion. Its excellent corrosion resistance in most environments accounts for its successful use as a protective coating on a variety of products and in many exposure conditions. The excellent field performance of zinc coatings results from their ability to form dense, adherent corrosion product films and a rate of corrosion considerably below that of ferrous materials, some 10 to 100 times slower, depending upon the environment. While a fresh zinc surface is quite reactive when exposed to the atmosphere, a thin film of corrosion products develops rapidly, greatly reducing the rate of further corrosion.
The expected service life to first maintenance (5% red rust) of iron and steel based on the zinc coating thickness and the environment may be shown as the followed picture:



*Time to first maintenance is defined as the time to 5% rusting of the steel surface.

A number of different types of methods of applying zinc coatings to steel are available, each of which has unique characteristics. The products produced by each of these processes have different uses depending on their applicability.

HOT DIP GALVANIZING AND ELECTROGALVANIZING

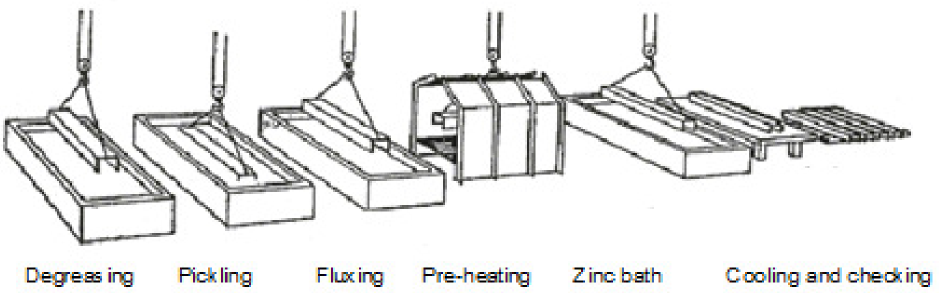
Hot-dip galvanizing process

Hot-dip galvanizing based on the Sendzimir method, applied to most of our concave profiles, is named after the Polish-born US engineer Sendzimir, who was the first (in 1937)to build a rolling mill for the continuous production of steel in rolls and large sheets.

“Hot-dip galvanizing” is the process of coating steel with a thin zinc layer, by passing the metal through a molten bath of zinc.Such process generates a mechanically resistant and durable layer that protects the steel substrate against corrosion, through the formation of a very tough iron-zinc surface alloy and electro-chemical interaction between zinc and the substrate to be protected.

Process descriptions

The protection layer is generated by the formation of a bond between the steel substrate and the molten zinc. To generate such bond, the steel surface must be clean, while often it is contaminated by foreign substances (rust, grease etc.).
Before dipping into the zinc bath, steel must be cleaned by degreasing and pickling, until achieving a chemically clean surface.
Reaction between molten zinc and steel occurs at around 450°C, a temperature at which both metals react quickly. Normally, it is enough to dip steel into the bath for a few minutes. When the galvanized part is removed from the tank, the coating has already formed, but the chemical reaction still continues in the deeper layers of the structure, until temperature falls down to 200°C.

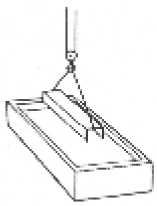


Surface pre-treatment

To achieve high-quality protection coatings, the surfaces must be perfectly clean. The chemical cleaning process consists of:
- degreasing
- pickling
- fluxing

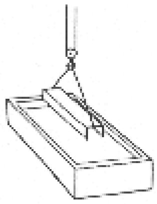
The steel surface might be contaminated by substances generated by the alloy itself, namely rust and calamine caused by oxidation, and foreign matters, such as oil, grease, soap, paint, residues from previous operations and so on.

Degreasing



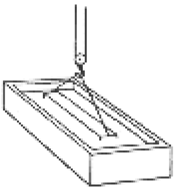
Grease and oil residues are removed by means of a degreasing bath, using water-diluted alkaline or acid solutions. This is followed by short dipping in water to rinse the part surfaces from degreasing solutions.

Pickling



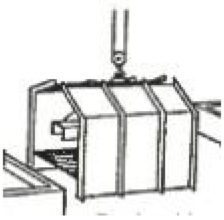
The part goes through a pickling stage, normally at room temperature, to eliminate the contaminant layers typical of steel. Generally, a diluted hydrochloric acid solution is used for this purpose: the duration of the pickling stage depends on the bath concentration and the oxidation level of the part to be galvanized.
The part is then dipped in water again to remove salt and acid residues from the surface.

Fluxing



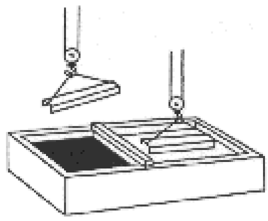
The final cleaning stage is fluxing, which covers the surface with a protective film that prevents oxidation, until the part is dipped into the molten zinc bath, improving the reaction between the iron of the steel surface and the zinc.

Pre-heating and drying



After the cleaning process, the part undergoes a pre-heating and drying phase, where the protective film applied during fluxing is dried. This operation removes surface moisture and reduces the heat gap, further enhancing the zinc-iron reaction and shortening the dipping time in the zinc bath.

Zinc bath



When all preparations have been completed, the galvanization process is carried out, dipping the part into a molten zinc bath (between 440 and 460°C).

The parts are left in the bath until they reach the same temperature as the zinc. When they are extracted, another coating builds up.
The galvanized parts are left to cool off in air or water.

Finally, the quality of the part is checked as required by the European standards:
EN 10143: Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape.
EN 10346: continuously hot-dip coated steel flat products: Technical delivery conditions.

Classification of the material according to EN 10346: DX51D

Electrogalvanizing process

Electrogalvanized coatings are applied to steel sheet and strip by electro-deposition. Electrogalvanizing is a continuous operation where the steel sheet is fed through suitable entry equipment, followed by a series of washes and rinses, into the zinc plating bath.
The most common zinc electrolyte-anode arrangement uses lead-silver, or other insoluble anodes, and electrolytes of zinc sulfates. Soluble anodes of pure zinc are also used. In this process, the steel sheet is the cathode. The coating is developed as zinc ions in the solution are electrically reduced to zinc metal and deposited at the cathode. Grain refiners may be added to help produce a smooth, tight-knit surface on the steel.

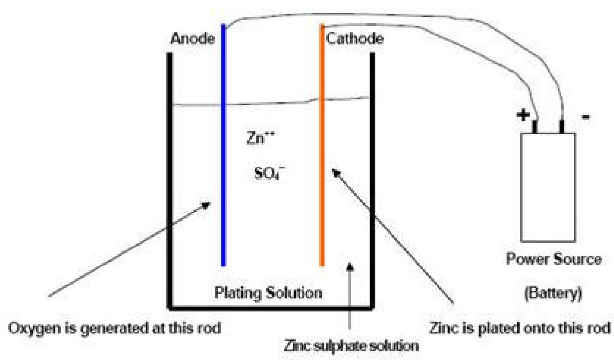
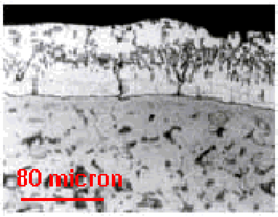


Figure 1: The common schema of the electroplating cell.

Coating Characteristics

During the galvanization process, the steel surface is covered by a layer of inter-metal steel-zinc alloy that seamlessly bonds the coating and the substrate.



Painting characteristic

The galvanized coating is paintable with suitable treatment due to the extremely thin zinc coating on the sheet, painting or other top-coating is recommended to improve the service life.

Corrosion protection

Galvanic coating offer 3 fold protection for the steel substrate

- Barrier effect protection. The coating insulates steel from the external corrosive environment.
- Cathode or “sacrifice” protection. Zinc acts as an anode and is corroded slowly, thus protecting steel: as long as there is zinc on the surface, steel will suffer no corrosion.
- The products generated from zinc corrosion, which are insoluble, compact and sticking, seal the steel surface areas that, for any reason (scratching, impact etc.), accidentally get in touch with the external environment. This offers additional protection to the substrate.

Atmospheric corrosion

The duration of the protection offered by galvanic coatings against atmospheric corrosion is very high. It depends on the coating thickness, local climate conditions and the content of aggressive agents in the atmosphere, such as nitrogen oxide (originated from urban and industrial activities) and chlorides (normally found in coastal areas).

In detail:

Corrosion in fresh water: Zinc-coated steel normally withstands the corrosive action of natural water, as well as the carbon dioxide and calcium and magnesium salts that are normally dissolved in fresh water. This kind of water supports the passivation of surface zinc, i.e. the formation of an inert and insoluble zinc oxide layer that protects zinc from contact with water.

Corrosion in salt water: Zinc coatings have a relatively high resistance to salt water. This is due to the presence of calcium and magnesium ions in water, which inhibit the corrosive action of chloride ions and support the formation of protective layers.