Galvanization

What Is Galvanizing

Galvanizing is one of the most widely used to methods for protecting metal from corrosion. It involves applying a thin coating of zinc to a thicker base metal, helping to shield it from the surrounding environment. The next time you are in your car, take a look at the street signs and lamp posts you pass. A large number of them will have a mute, silver color on them. That "silver" is actually the coating of zinc.

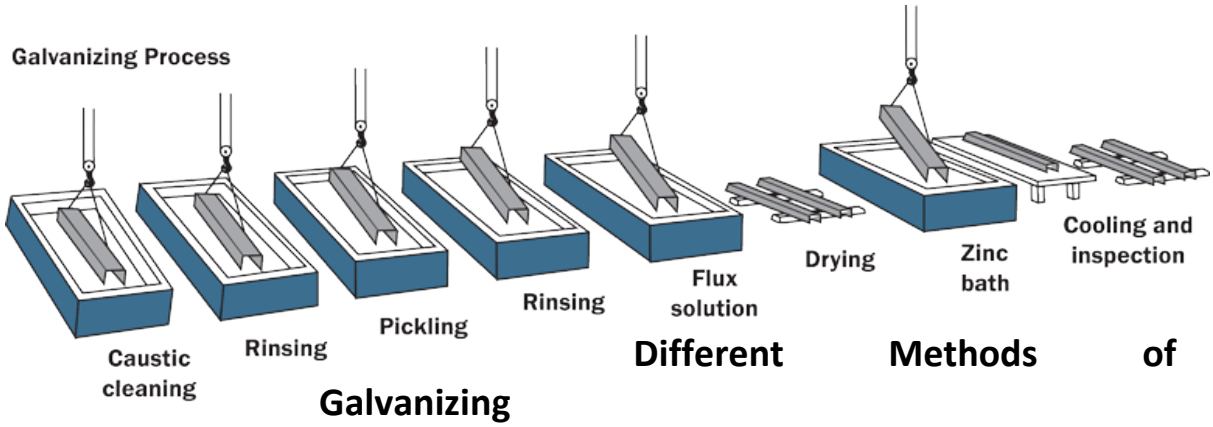
Why Galvanize?

Quite simply, galvanizing a metal gives it anti-corrosion properties. Without the protective zinc coating, the metal would remain exposed to the elements and potentially oxidize and corrode much faster. Galvanized Steel is a cost effective alternative to using materials such as austenitic stainless steel or aluminum in order to prevent corrosion.

How Does It Work?

Galvanizing can protect metal is a number of ways. Firstly, it creates a protective coating that shields the metal from the surrounding environment. The layer of zinc prevents water and moisture and other elements in the air from corroding the steel underneath. Should the zinc coating be scratched deep enough, the metal would become exposed and susceptible to corrosion.

Galvanizing can also protect metal through a process called "galvanic corrosion". Galvanic corrosion occurs when two metals of a different electrochemical make up are placed into contact with one another with an electrolyte present, such as salty water. Depending on the atomic structure of the two metals, one metal is the anode and the other is the cathode. The anode corrodes more rapidly than it would by itself and the cathode corrodes at a slower pace than it would by itself. The reason zinc is used for galvanizing is because it has an affinity towards being the anode when in contact with many different types of metals. Since the zinc coating in contact with the base metal is usually the anode, it slows the corrosion of the base metal, or the cathode.



Different Methods of Galvanizing

There are several different processes for galvanizing metal:

Hot-Dip Galvanizing

As the name implies, this method involves dipping the base metal into a molten pool of zinc. First, the base metal must be cleaned either mechanically, chemically, or both to assure a quality bond can be made between the base metal and the zinc coating. Once cleaned, the base metal is then fluxed to rid it of any residual oxides that might remain after the cleaning process. The base metal is then dipped into a liquid bath of heated zinc and a metallurgical bond is formed.

The advantages of this method are that it is economical; it can be performed quickly and to complex shapes. However, the final coating can be inconsistent relative to other galvanizing processes.

Pre-galvanizing

This method is very similar to hot-dip galvanizing but is performed at the steel mill, usually on materials that already have a specific shape. Pre-galvanizing involves rolling metal sheet through a similar cleaning process to that of the hot-dip galvanizing process. The metal is then passed through a pool of hot, liquid zinc and then recoiled.

An advantage of this method is that large coils of steel sheet can be rapidly galvanized with a more uniform coating compared to hot-dip galvanizing. A disadvantage is that once fabrication of the pre-galvanized metal begins, exposed, uncoated areas will become present. This means that when a long coil of sheet is cut into smaller sizes, the edges where the metal is cut are left exposed.

Electro-galvanizing

Unlike the previous processes, electro gralvanizing does not use a molten bath of zinc. Instead, this process utilizes an electrical current in an electrolyte solution to transfer zinc ions onto the base metal. This involves electrically reducing positively charged zinc ions to zinc metal which are then deposited on the positively charged material. Grain refiners can also be added which helps to ensure a smooth zinc coating on the steel. Similar to the pre-galvanizing process, electrogalvanizing is typically applied continuously to a roll of sheet metal.

Some advantages of this process are a uniform coating and precise coating thickness. However, the coating is typically thinner than the coating of zinc achieved by the hot-dip galvanizing method which can result in reduced corrosion protection.

All galvanizing consists of four fundamental steps:

1. Surface preparation

2. Pre fluxing
3. Galvanizing
4. Finishing

The preparation steps consist of cleaning and pickling operations that free the surface of dirt, grease, rust and scale. The preflux step serves to dissolve any oxide that may have formed on the iron or steel surface after pickling and prevents further rust from forming. Clean, oxide-free work is galvanized by immersion into molten zinc. Finishing operations include quenching, removing excess zinc and inspection.

Surface Preparation

The purpose of surface preparation in the hot-dip galvanizing process is to obtain the cleanest possible steel surface by removing all of the oxides and other contaminating residues. Thorough surface preparation is paramount as zinc will not react with unclean steel. In order to move the steel parts through the cleaning steps and galvanizing bath, the articles are hung using chains, wires, or specially designed dipping racks

Cleaning steel to prepare for the hot-dip galvanized coating consists of three steps:

1. **Degreasing/Caustic Cleaning**

First the steel is immersed in an acid degreasing bath or caustic solution to remove organic contaminants such as dirt, oil, and grease from the surface of the steel. After degreasing the steel is rinsed with water.

2. **Pickling**

Next the steel is “pickled” in a dilute solution of either hydrochloric or sulfuric acid which removes oxides and mill scale. Once all oxidation has been removed from the steel, it is again rinsed with water and sent to the final step of the surface preparation.

3. **Fluxing**

Finally, the steel is dipped in the flux. The purpose of the flux is to clean the steel of all oxidation developed since the pickling of the steel and to create a protective coating to prevent any oxidation before entering the galvanizing kettle. One type of flux is contained in a separate tank, is slightly acidic, and contains a combination of zinc chloride and ammonium chloride. Another type of flux, top flux, floats on top of the liquid zinc in the galvanizing kettle, but serves the same purpose.

After degreasing, pickling, and fluxing, the surface of the steel is a near white metal clean, completely free of any oxides or other contaminants that might inhibit the reaction of the iron and molten zinc in the galvanizing kettle.

Galvanizing

Once the steel has been completely cleaned, it is ready for immersion in the zinc bath. The galvanizing kettle contains zinc specified to ASTM B6, a document that specifies any one of three grades of zinc that are each at least 98% pure. Sometimes other metals may be added to the kettle to promote certain desirable properties in the galvanized coating.

The galvanizing kettle (Figure 5), is heated to a temperature ranging from 820-860 F (438-460 C), at which point the zinc is in a liquid state. The steel products are lowered into the galvanizing kettle at an angle, and stay in the bath until the steel heats to the bath temperature. Once the diffusion reaction of iron and zinc is complete, the steel product is withdrawn from the zinc kettle. The entire dip usually lasts less than ten minutes, depending upon the thickness of the steel.

The coating, as seen in Figure 6, is typical for low silicon steels with silicon impurities less than 0.04% and where the thickness of the coating is limited by the inter-diffusion of iron and zinc.

Post Treatment:

When the steel is removed from the galvanizing kettle, it may receive a post-treatment to enhance the galvanized coating. One of the most commonly used treatments is quenching. The quench tank contains mostly water but may also have chemicals added to create a passivation layer that protects the galvanized steel during storage and transportation. Other finishing steps include removal of zinc drips or spikes, by grinding them off.

What is dross?

Dross is defined as a byproduct of the galvanizing process that forms by reactions between molten zinc and loose particles of iron in the galvanizing kettle. It collects on the bottom of molten zinc.

What is Ash?

Ash is defined as a byproduct of the galvanizing process that forms by oxidation of molten zinc with surrounding air. It floats over the surface of molten zinc which is removed periodically after each dip.
