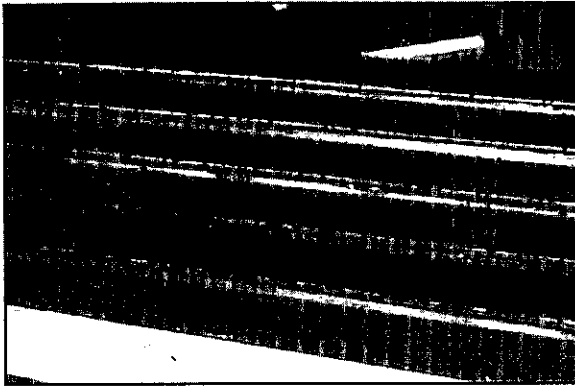


ASK DR. GALV

Q. Dear Dr. Galv: What happened to my zinc coating? When I was ready to ship the part, I noticed the coating had peeled off.

A. This question refers to the separation of the outer zinc layer from the underlying zinc/iron intermetallic layers. You can measure the coating thickness with a gauge in the area that has no zinc outer layer. If the thickness gauge records a non-zero reading, there is some intermetallic material still covering the base steel. However, if there is zero coating thickness in the measured area, the entire coating has "flaked" off of the base steel; and, this is an entirely different type of problem.

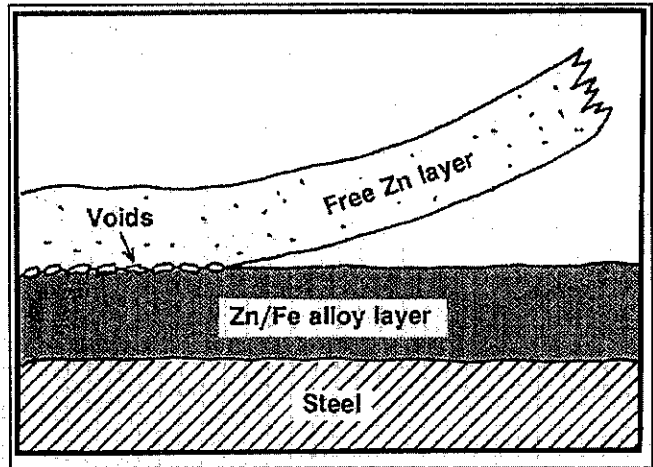


The above picture is the example of flaking on a galvanized part which often occurs when the steel is very reactive.

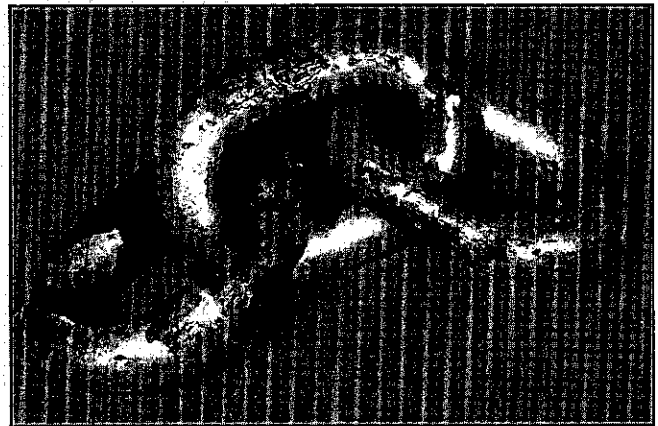
The peeling of the outer zinc layer is not associated with the composition of the base steel, whereas the flaking problem is most likely due to the galvanized coating being very brittle, often occurring when the steel is very reactive, such as when there is a high silicon or phosphorus level in the steel. Peeling usually occurs after the part has been removed from the galvanizing bath in the cool down cycle.

The cause of the peeling is metallurgical changes that occur between the outer zinc layer and the intermetallic layers. For example, in galvanized parts which are cooled very slowly, i.e. no quench, the zinc from the outer layer can diffuse into the intermetallic layer. This leaves behind a small void at the interface between the outer layer and the intermetallic layer. The void creation mechanism is referred to as the "Kirkendall Effect".

The following diagram shows schematically how the diffusion of zinc from the outer layer can create a series of voids that may link together and completely separate the outer layer from the intermetallics. If a part has a peeling problem, the chances are that other areas of the part may not have peeled yet, but could have loosely adhered zinc outer layers.



The picture below shows a part that has the outer layer of zinc peeled away from the intermetallic layers.



To prevent peeling, very slow cooling cycles should be avoided. There are some cases when parts have been quenched for short periods and then bundled or stacked so that they are close together while still hot. This can also cause peeling since the parts may not have cooled sufficiently to prevent the zinc diffusion. Make sure the parts are cooled below 300 degrees Fahrenheit before they are stacked or bundled.