

Orange Staining – The Youth Phase (Zinc Oxidation)

Under certain conditions the finished ArmorGalv product may show some orange staining. This is nothing to be concerned about with Thermal Diffusion Galvanizing. It is caused by Carbon Dioxide starvation.

- Rusting is the process of reaction of iron with the environment in the presence of oxygen and water to form **red** residue. This process is called **oxidation or loss of electrons or loss of material in steels**.
- In the case of Zinc galvanizing, the zinc layer acts as a barrier to the surface of the steel and sacrifices itself to form oxides and carbonates. These means Zinc compensates for the loss of material by giving up its own electrons.
- Unlike most other protective coating systems that fail by other mechanisms, galvanized coatings always fail from the outside, inwards. This occurs through weathering of the zinc's surface through a range of oxidation reactions that are determined by the variables of the local environment. In the hierarchy of metals, zinc is relatively reactive, but like aluminium, relies on oxide films that develop on its surface to provide its superior corrosion resistance in atmospheric environments.
- When steel is freshly galvanised, the zinc coating has not developed any protective oxidation films. Zinc reacts with the environment to go through three oxidation stages – think of this as the “Youth Phase” where acne is experienced by some and passes after some months.
 - 1) Initial Oxidation - Zinc Oxide (Oxygen is needed) - Unstable
 - 2) Hydration - Zinc Hydroxide (Water and Oxygen are required) - Unstable
 - 3) Carbonation - Zinc Carbonate (Sufficient amount of Carbon Dioxide is required) - **Stable**These stages happen one after the other. However, Zinc Carbonate is the desired stable layer and acts as a passive layer. That implies, this layer does not allow further oxidation of the Zinc coating and acts as a barrier to improve the corrosion resistance of the metal.
- Very rapid corrosion of zinc coatings can occur in their youth period if they are stored in poorly ventilated, damp conditions. Nested galvanised products are particularly prone to this.
- Negative Influence of Packaging and Humidity
 - Where products are tightly wrapped in materials such as hessian bags and stretch wrap, or even bundled in boxes, to protect the threads from damage and plastic wrap around the bundles keep them dry, the Carbon Dioxide is denied/limited.
 - During the transporting and handling, small puncture holes can allow water to seep through leading to hessian and wrap combination acting like a trap.
 - This leads to the formation of Zinc Hydroxide, which is the **second stage** of oxidation process, halting the formation of third stage which is stable Zinc Carbonate layer due to lack of sufficient amount of Carbon Dioxide.
 - As above, – stage two is an unstable state which uses the zinc in the **Zeta (90-93%Zinc 7-10%iron) layer**. This layer is the first external alloy layer formed during Thermal Diffusion Galvanization exposed to the environment. The traces of iron in this layer reacts with the water and air to form the **orange residue**.

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- Passivation of the ArmorGalv coating is done as part of the coating process using a time-controlled phosphate immersion stage to lightly carbonate the zinc surface. This allows the natural zinc carbonate barrier layer to form in approximately 6 months in an exposed environment compared with the process taking 12 months with hot dip galvanizing.
 - When threads are dry and exposed to the environment, the surface will heal itself forming the passive Zinc Carbonate layer which will weather off the residual iron oxide that led to the formation of orange stain over the threads.
 - It can be concluded that the Thermally Diffused Zinc protective coating is still present over the substrate metal and there is no sign of red rust. The orange staining is only due to the exposure of alloy surface formed during TDG, which consists of small traces of iron. This iron has reacted with the environment to build the orange staining.

Ref: ASTM A1059 - Coating Characteristics

X1.11 Due to the presence of iron in the coating, red stains or brown spots may appear on the surface of the coated article under the influence of increased humidity or condensate. It is caused by the release of iron ions from the coating. These ions are washed away easily by water over time.