

**Q:** I've had a few customers complain about white powder on their newly galvanized steel—this sounds like wet storage stain to me. What can I do, and what do I tell my customers to do to prevent wet storage stain?

**A:** Wet storage stain is a white or gray powdery deposit that can develop on newly galvanized articles when they are stacked on top of one another and moisture from the quenching process or atmosphere gets between them. The improper stacking or nesting of steel, as seen in *Figure 1*, can prevent adequate airflow to the zinc surfaces and cause premature consumption of the zinc coating. Essentially, the trapped moisture presents the natural formation of the zinc corrosion films, collectively called the patina.

The zinc patina forms from three zinc corrosion products; zinc oxide, zinc hydroxide, and zinc carbonate. The first corrosion product forms when newly galvanized steel reacts with oxygen in air to form zinc oxide. Formation of zinc oxide begins within hours after the article exits the galvanizing kettle, since zinc is very reactive.

When the coating is exposed to moisture by way of humidity, condensation, or rain, the zinc and zinc oxide react with the water to form zinc hydroxide. Some zinc oxide does not react with the water and remains on the zinc surface.

When the galvanized part is exposed to the atmosphere, zinc oxide and zinc hydroxide react with carbon dioxide in the air, and then convert into basic zinc carbonate. The zinc patina is a combination of the three zinc corrosion products, with the majority being zinc carbonate, and tightly adheres to the underlying coating. Zinc carbonate in the patina is insoluble in water and weather-resistant. The patina is prevented from forming when newly galvanized articles are stacked on top of one other and have water on their surfaces that creates an inadequate supply of carbon dioxide to the zinc materials to form the patina layer.



It is important to note the galvanizing process does not contribute to the formation of wet storage stain. Wet storage stain occurs after the steel reacts with the environment, not during the galvanizing process. The galvanizer is responsible for producing a high-quality galvanized coating in accordance with ASTM specifications and following best practices for avoiding wet storage stain for articles stored at the galvanizing facility. The galvanizer is not responsible for wet storage stain developed during transit or after delivery is complete.

Treatment of wet storage stain begins with drying the galvanized surface. As long as water remains on the zinc surface, and airflow is limited, the corrosion mechanism responsible for wet storage stain will continue, and can damage the zinc coating and underlying steel.

After the galvanized surfaces are dried, the treatment processes differ depending on the severity of the wet storage stain. Wet storage stain ranges in severity from light to medium to heavy. After drying, light wet storage stain, as seen in *Figure 2*, can be left to weather as long as it will have



**Figure 1**



**Figure 2**



**Figure 3**



**Figure 4**

**Figure 1** (Top Left): Improperly stacked galvanized pieces can result in wet storage stain.

**Figure 2** (Top Right): The section of guardrail on the left shows the effects of wet storage stain, while the right side is unaffected.

**Figure 3** (Bottom Left): In order for the galvanized coating to form the zinc patina, medium (Fig. 3) and heavy (Fig. 4) storage stain **MUST** be removed.

**Figure 4** (Bottom Right): Heavy storage stain

## Ask Dr. Galv: Wet Storage Stain

adequate airflow as the storage stain will convert to patina as it reacts with carbon dioxide. If the airflow will be restricted, or the surface is likely to have more standing water on it, then the wet storage stain must be removed by brushing it off with a stiff-bristled, nylon brush then the part can be exposed to its normal service condition.

Medium (*Figure 3*) or heavy (*Figure 4*) wet storage stain must be removed in order for the galvanized coating to form the zinc patina, otherwise the service life of the zinc coating and underlying steel can be affected. After removing the wet storage stain by brushing with a stiff-bristled, nylon brush and a cleaning solution, it is best to measure the coating thickness to ensure an adequate zinc coating remains on the base steel. When medium or heavy wet storage stain becomes black, a significant amount of the zinc coating has been consumed and the steel must be stripped and regalvanized to meet ASTM specifications.

Preventing wet storage stain is easier than treating it. Prevention includes removing standing water and providing adequate air flow over newly galvanized surfaces, as well as avoiding tightly stacking products on top of one other. When products must be stacked closely together, using spacers will increase airflow to areas susceptible to wet storage stain. Following these best practices for storing newly galvanized articles at your facility and educating your customer will go a long way toward preventing wet storage stain. By doing this you'll be providing great customer service and your customer will be happy with their high-quality galvanized steel.