White Rust: Its Causes and Prevention

Overview

White rust affects galvanized coatings of all kinds. It takes the form of a bulky white powdery deposit that forms rapidly on the galvanized coating under certain specific conditions. In addition to its unsightly appearance, white rust can cause considerable damage to the coating and threaten the structural integrity of the parts the coating covers.

What Causes White Rust?

Elemental zinc's high reactivity means that it oxidizes readily. As a result, when a less reactive base material is coated with zinc, the coating oxidizes instead of the material beneath, forming a dark grey protective layer that supplants the shiny silver of the new zinc. This passivating layer is composed primarily of zinc carbonate ($Zn_5(OH)_6CO_3$). Unlike elemental zinc, zinc carbonate is highly stable and offers excellent resistance to environmental conditions, becoming non-reactive to the atmosphere and to water. The dark grey passivating layer acts as a hard shell that quickly "heals" when disturbed, bridging over scratches in the coating to keep the base material intact. The thicker the zinc layer on galvanized steel, the longer the steel will last, because there is more zinc to react and prevent moisture from reaching the base material.

Both moisture and air are necessary to the oxidation process that forms the passivating layer. Wet and dry cycles (weathering) allows this process to occur naturally. In the presence of moisture alone, however, zinc forms zinc hydroxide, which is presented as white rust. Unlike zinc carbonate, zinc hydroxide does not form a protective layer. Instead, it continues to degrade the coating on the galvanized parts until it reaches the inter-alloy point where zinc has bonded with steel to form the galvanized layer. In the continued absence of air and presence of moisture, the zinc layer will degrade completely and the base steel will begin to corrode. Once this occurs, structural weakening of the base material can render it unsuitable for use.

The progression of white rust can begin quickly upon the introduction of moisture into stacked bundles of parts. Within days, the zinc layer will begin to corrode. Figure 2 shows silo wall sheets that were not protected from the elements while waiting to be installed.

Within a matter of weeks, red rust (iron oxide) may begin to form, at which point the parts will require inspection for structural stability.

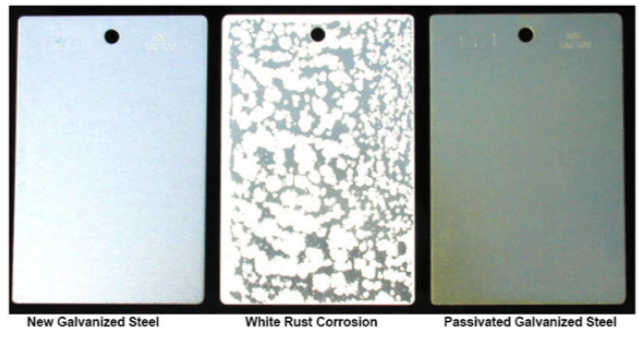


Figure 1: Examples of galvanized steel surfaces

Figure 2: Example of improperly stored silo wall sheets

How to Prevent White Rust on Galvanized Steel

White rust forms as a direct result of the improper storage of galvanized parts. Mills, transport companies, storage warehouses, and manufacturing facilities go to great lengths to keep moisture from getting between part layers, such as coating each layer of galvanized sheet steel with a thin layer of oil. Specially designed rail cars insulate coils and keep them in conditions that discourage the condensation of atmospheric moisture on the material. Manufacturing plants store coils in temperature-controlled warehouses to prevent contact with rain and snow. Stacked steel parts are stored indoors – a practice that, ideally, continues until the final assembly of the structure.

Figure 3: New silo wall sheets ready for shipment

Due to their unique shapes, grain silo parts are especially susceptible to white rust. Wallsheet bundles are shipped in a concave (curved upward) configuration to provide stability and prevent distortion. This configuration also provides a natural gutter effect to the bundles. Figure 3 shows a typical silo wall sheet bundle at the factory. Note the shiny surface and orientation of the sheets.

Bolt holes allow moisture to penetrate easily into the layers of the bundle, providing a ready environment for rust formation. Consequently, wallsheet and roof bundles must be stored in warehouses and elevated at least 2 inches (5 cm) above ground level. Condensation from the ground itself may also penetrate wallsheet bundles, creating a moist environment conducive to white rust.

If a jobsite does not offer indoor storage, preventive steps must be taken. Wallsheets should be inverted to a convex (curved down) configuration, with wood lathe placed between individual sheets. This will allow surface moisture to evaporate and encourage air flow between sheets. Roof panels benefit by a similar method of separation with lathe between panels.

Caution should be exercised when placing plastic or tarpaulins over bundles. Though these barriers form an effective deterrent to precipitation, they can also create an environment that traps moisture in the bundles. Coverings such as these are advisable only for very short periods of time.

How to Remove White Rust

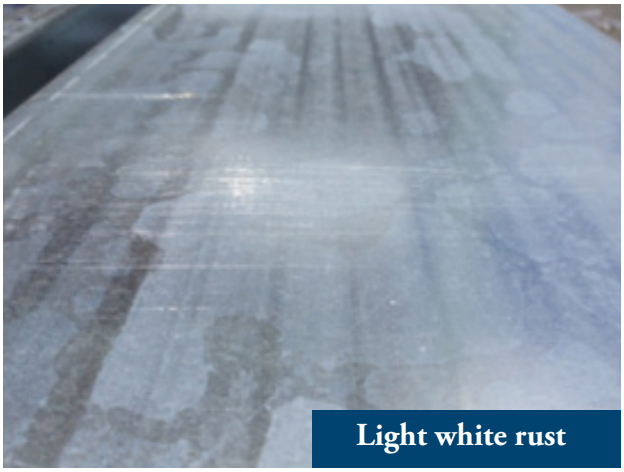
Following the basic storage procedures outlined above will generally prevent the formation of white rust on galvanized steel parts. In some cases, however, white rust may form despite all efforts to prevent it. If this occurs, the following steps can remediate any further damage.

Light white rust: This condition is characterized by a light white haze covering the face of the parts. At this amount, white rust poses little threat to the zinc coating. Exposed to normal environmental conditions, this type of white rust will naturally wash off in rain and the passivated layer will re-form naturally.

Moderate white rust: This condition is characterized by a heavier, chalky coating on the galvanized parts, and it calls for remedial action. An Oakite®31 (or vinegar) solution should be applied using a brush or other lightly abrasive pad, rinsed and allowed to dry. The part should then be painted with a light film of aluminum-based paint. This will reinforce the remaining zinc layer and protect the base steel layer.

Severe white rust: This condition is characterized by a thick, chalky coating, possibly with signs of a black powdery coating or, if most severe, red rust. In some cases, the parts may even be stuck together. At this point, the zinc coating has been removed and the base steel is beginning to corrode. If caught before the black powder forms, the part may be re-passivated by applying the same Oakite® 31 (or vinegar) solution and applying zinc-based epoxy paint or cold-galvanizing compound. If a black powder has formed, replacement parts should be ordered and the damaged parts removed from service.

Contact SCAFCO directly or one of our great dealers around the world for part numbers and pricing of replacement parts. We can even produce replacement parts for some competitor wall sheets.



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SCAFCO Grain Systems' galvanized steel silos are designed for many decades of service. Proper storage and care of silo components before they are assembled is critical to preserve their long service life. If you have any questions on how to properly store your silo before erection starts, please call us at +1 509-535-1571 or e-mail us at info@SCAFCOgrain.com.

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