



Wet Storage Staining of Galvanized and Galvannealed Steel Sheet

Introduction

Most cold formed steel building products, whether painted or unpainted, are manufactured from a sheet steel material that has some form of metallic coating applied. This metallic coating can be zinc (galvanized), zinc-iron alloy (galvanneal) or a 55% aluminum-zinc alloy (Galvalume™). The metallic coating is available in a range of thicknesses to provide the degree of corrosion protection and service life required. One of the concerns expressed by installers relates to the presence of wet storage staining on the products, how this staining impacts the long term performance, and what can be done to remove it. The purpose of this fact sheet is to address some of these issues, allay some fears, and give guidance on proper storage techniques.

What are the Metallic Coatings?

Galvanized:

Galvanizing is a metallic layer of pure zinc covering both sides of the sheet. The zinc coating is specified in terms of the mass of zinc per square meter, total both sides, and ranges from 120 to 275 g/m² (ie. Z120 to Z275). There is also a thin inter-metallic layer of a zinc-iron alloy that forms between the steel sheet and the zinc coating. The surface finish can be changed to suit the end use from the natural full spangle to matte finishes intended for painting.

Galvanneal:

Galvanneal is a metallic zinc-iron alloy coating that consists of approximately 10% iron by weight and is most commonly supplied to the construction industry as a ZF75 coating weight (75 g/m²). The presence of iron in the coating structure provides the product the features of good paintability and weldability. These features have given the product wide use in many automotive, construction and manufacturing applications. Galvanneal like other metallic coatings is susceptible to staining if it becomes wet in a nested condition and remains wet for an extended period. Storage stain of galvanneal can change the appearance from white to a dark grey colour, and eventually after prolonged wet exposure the surface could turn to a reddish brown colour as moisture reacts with the surface iron. The stain is the result of a surface reaction and does not impede the protective properties

of the coating nor does it affect the structural integrity of the deck. The stain is only superficial and the galvanneal coating can be painted if required.

Aluminum-zinc Alloy:

The aluminum-zinc alloy coated material is sold in Canada under the trade name Galvalume and is 55% aluminum by weight. The aluminum-zinc coating is specified in terms of the mass per square meter, total both sides, and ranges from 150 to 180 g/m² (ie. AZM150 to AZM180). The alloy of zinc and aluminum combines the enhanced atmospheric corrosion protection of aluminum with the superior galvanic corrosion protection of zinc. This fact sheet deals with the formation of wet storage stain on zinc coated products. In general the guidelines given should be followed for aluminum-zinc alloy coated sheets as well, but the supplier should be contacted for additional guidance on treatment options.

What is Wet Storage Stain?

“Wet storage stain” is a term used in the galvanizing industry to describe the zinc corrosion products that can form on a galvanized steel surface during storage. This staining is also referred to as “white rust”, which is the term generally applicable to all zinc corrosion products. Wet storage stain is voluminous, white, powdery, and bulky and is formed when closely packed galvanized articles are stored under damp and poorly ventilated conditions. The crevices formed between the articles can attract and absorb moisture, in the form of rain or condensation, and retain the wetness more readily than the surface exposed to the open air. Without free airflow and carbon dioxide the stable zinc oxides that give the galvanized coating its extended corrosion protection are not allowed to form. White rust is simply the chemical compound *zinc hydroxide* which forms when zinc is in contact with moisture and is not converted to a zinc carbonate passive film because the tightly packed sheets are not freely exposed to carbon dioxide containing air. Zinc hydroxide (white rust) will continue to form as long as the surfaces are wet and starved of carbon dioxide.¹ Once the wet sheets have been separated and allowed to dry the staining will remain, however, no further staining will occur.

Often the white rusting appears to be quite heavy when, in fact, the amount of zinc corroded is small. This occurs because zinc hydroxide is somewhat voluminous and builds up in areas of wetness. Although wet storage stain can affect the appearance of the galvanized steel articles in some situations, it is generally not harmful in terms of the long-term corrosion performance.

Treatment of Galvanized Steel with Wet Storage Stain

Galvanized sheet steel affected by wet storage stain can usually be cleaned, but generally cannot be restored to its original high luster appearance. The stain, depending on the severity, irreversibly alters the surface characteristics of the zinc to varying degrees. Nevertheless, there are treatments that are helpful in improving the appearance, depending on the severity of the problem.

Light white rusting:

This is characterized by the formation of a light film of white powdery residue. If left alone it may wash off in service with normal weathering. If it is deemed necessary to remove the white rust it can usually be done with a stiff bristle brush (nylon). If brushing alone is insufficient, rub or brush the surface with a mixture of mineral oil and sawdust. The mild abrasive action may remove the stain, although this treatment is not of much help for advanced wet storage stain.

Moderate white rusting:

If the stain is not too severe, it may be removed by washing with a 10% (by volume) acetic acid solution, followed immediately by a thorough rinsing with water to neutralize the surface. The removal can be assisted by the use of a stiff bristle brush (nylon). The sheets must be dry before restacking. This treatment may remove some of the metallic lustre, even in non-stained areas.

Severe white rusting:

The zinc hydroxide corrosion product will dissolve readily in weak acidic solutions. Ordinary household white vinegar has been found very effective and environmentally benign. Commercial products like CLR™, widely advertised for scale and stain removal, can also be effective. Alternatively, a solution of 5% (by volume) of phosphoric acid in water, with a wetting agent added, can be brushed onto the sheets. In all cases proper safety precautions are necessary as well as approved disposal of cleaning liquids. After cleaning, the sheets must be immediately well-rinsed to neutralize the surface and then thoroughly dried. This treatment will remove some of the metallic luster, even in non-stained areas.

Dark grey or black staining:

If the stain has progressed to dark grey or black in colour, removal may not be possible. One method of restoring the protective value of the zinc coating, and improving the appearance of storage stain damaged sheets, is to apply a good, colour matched zinc-rich paint. The surface must be thoroughly brushed, rinsed and dried beforehand. After a period of time weathering will largely remove any difference in appearance between the zinc-rich paint and the original galvanized surface.

Note: Any field painting that may be required to cover wet staining is the responsibility of the buyer, not the deck supplier.

Site Storage

The key to addressing wet storage staining is prevention. Metallic coated sheet steel building products should normally be delivered to the jobsite as required for erection, but if site storage becomes necessary, the following requirements should be observed:

- (1) tilt bundles for drainage;
- (2) block bundles off ground for effective drainage and ventilation;
- (3) block long bundles to prevent sagging;
- (4) store away from chemically corrosive substances (e.g. salt, cement, fertilizer), away from materials that could contaminate the surface (e.g. diesel oil, paint, grease), and away from site traffic;
- (5) cover the bundles with a tarpaulin (avoid impermeable material such as plastic) and ensure that adequate ventilation is provided under the cover to prevent condensation; and,
- (6) store the material indoors if it must be left for an extended period.

For More Information

For more information on sheet steel building products, or to order any CSSBI publications, contact the CSSBI at the address shown below or visit the website at www.cssbi.ca

¹ Xiaoge Gregory Zhang, *Corrosion and Electrochemistry of Zinc* (New York, NY: Plenum Press, 1996): 236-237.