

Introduction

Normally, galvannealed steel-sheet product has a very uniform matte-grey appearance, as is shown in the following photograph:

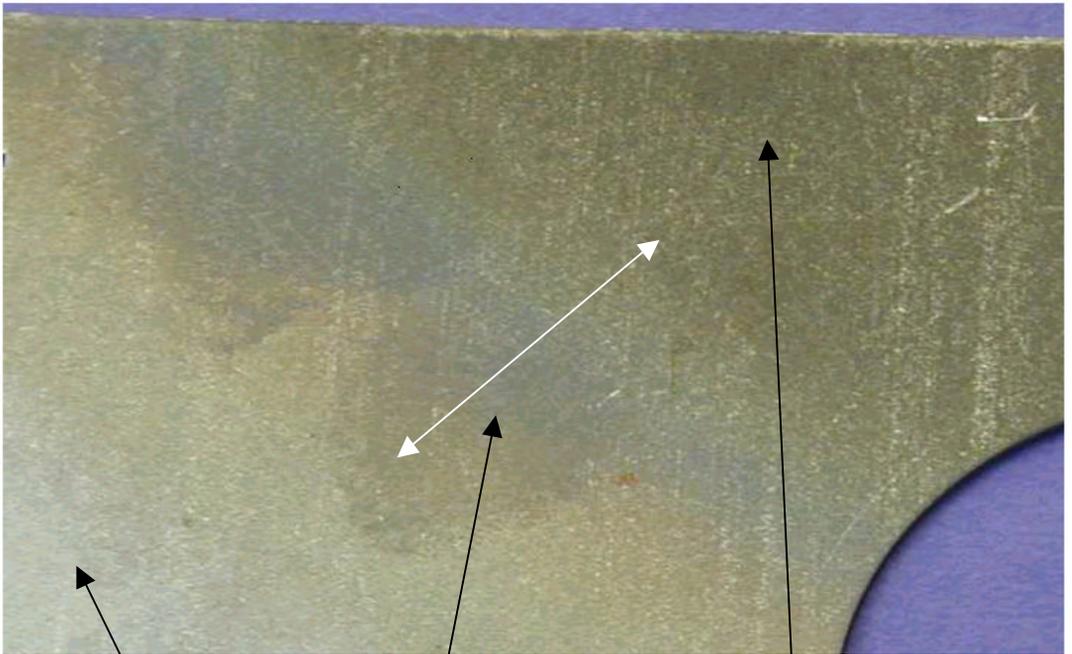


The color may be slightly lighter or darker, reflecting a lower or higher percent iron in the coating.

At times, the users of galvannealed sheet have complained about localized dark stains on the surface of the galvannealed coating. Often, if stains are present, they have a dark grey-to-black appearance. Usually, the dark-stained areas simply transition to a lighter grey around the periphery of the dark spot, but at times, there is anything from a straw-colored to a dark purple hue around the edges of the stained areas.

The dark areas can be small or large (less than 1 inch to many inches in diameter), they may be rounded or very irregular-shaped, they may be uniformly darkened, they may exhibit variable darkening, or they may show a gradation in darkness as they transition to the unaffected areas.

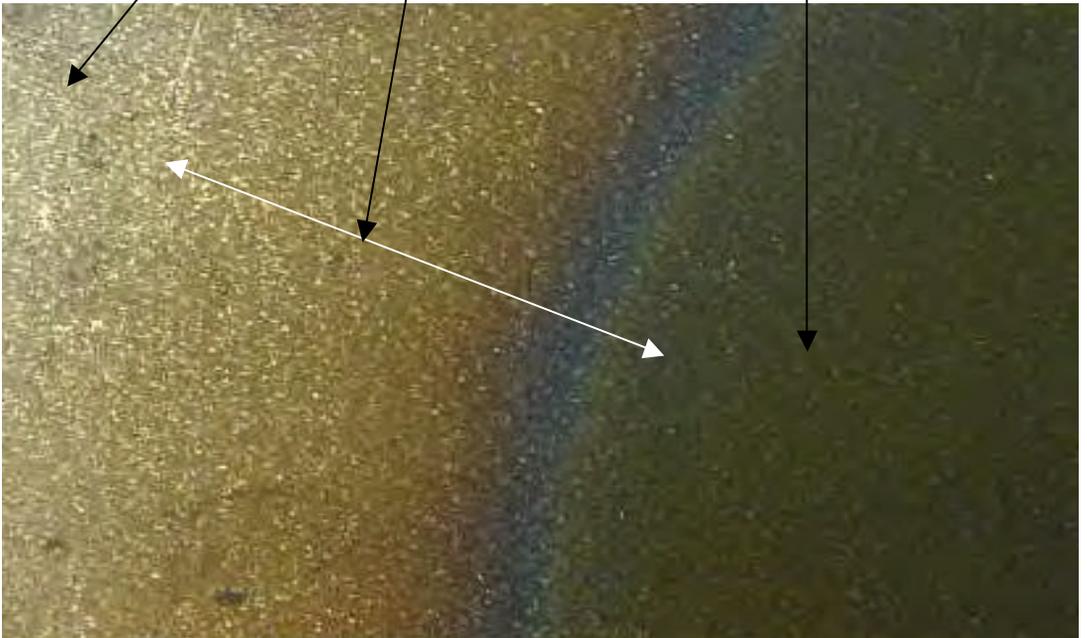
The following two photographs of galvannealed coatings show areas of dark stain and the transitioning to a normal grey appearance.



Normal gray appearance

Transition region showing different shades of color

Dark stained region



Regardless of the color or shape, there is one primary cause for this darkening. It is caused by the **presence of moisture**, either from intrusion during storage, or shipping, or from condensation within the coil during storage.

With galvanized sheet product, if moisture gets trapped between the adjacent wraps in a coil, or between sheets in a lift, the usual appearance is "white rust". Most users of galvanized sheet are familiar with this behaviour. The white color is that of the corrosion products (usually zinc hydroxide) that form when moisture begins to corrode the zinc in the absence of free air circulation. Typically, white rust is present as a flocculent, loose powder. For a detailed discussion of white rust, please refer to GalvInfoNote #7.

For galvanized sheet product, a similar type of degradation (corrosion of the coating) may occur if the coil or sheets get wet and have no way of drying. Instead of forming white rust, the first appearance change is the formation of an adherent oxide that is most often dark grey-to-black in appearance. The corrosion product has this dark appearance because it does not form as a loose powder, but is a thin, often adherent continuous film. The dark grey-to-black color is associated with light-absorbing characteristics of the thin film of corrosion product. If the sheet stays wet for long periods and large amounts of corrosion product form, the stain may begin to exhibit some of the same flocculent white corrosion product to that is observed on storage-stained galvanized sheet.

Why is Galvanized Sheet Susceptible to Dark Staining?

Perhaps, the primary reason that this dark grey-to-black corrosion is seen somewhat more than perhaps expected on galvanized sheet is because galvanized product is often shipped "*dry – no oil and no surface passivation (chem. treat)*" to the customer. That is, there is no rust-inhibitive oil applied at the exit end of the galvanizing line. Nor is the surface passivation treatment, a clear chromate treatment that is typically applied onto galvanized sheet to minimize white rust, applied to the galvanized sheet surface.

The reasons for shipping without any type of corrosion-inhibiting surface film are:

1. Surface passivation treatments may interfere with obtaining good paint adhesion. Since galvanneal is intended to be painted, most customers do not want to be concerned about the possible adverse effect of a surface passivation film on paint adhesion.
2. Also, since galvanneal sheet is most often painted, many customers do not want to be concerned about getting rid of the rust-inhibiting oils present on the surface. Excellent cleaning methods are required to get rid of all the oils, especially since the galvanneal surface is somewhat rough and porous. If the oil is not totally removed, paint blistering can be experienced during the paint-curing cycle if the paint is thermally cured. Alternatively, if the paint is an air-dry paint, the presence of any oils beneath the paint and the galvanneal surface can lead to premature separation of the paint during service.
3. Passivation treatments interfere with the spot welding of galvanized and galvanneal steel parts. The presence of the chromium causes a severe drop-off in the life of the welding tips and degrades the quality of the welds.

Recommendations

1. The susceptibility of galvanneal sheet to exhibit a dark grey-to-black surface discoloration is caused by either the intrusion of water during shipping or storage, or condensation of moisture onto the sheet surfaces that might occur if the coil is subjected to varying temperatures during transit and storage. For example, when a coil stored at 70°F in a steel manufacturer's warehouse is shipped to a customer during the wintertime, there is a high potential for condensation to occur within the coil. If, at the customer's site, the coil is then allowed to sit for a period of time before use and no attempt is made to remove the condensation, black stains may form. Thus, extreme care is needed to prevent the corrosion reaction that produces dark surface stains. Care must be exercised when shipping, especially

during wintertime. Packaging is important. The storage conditions at the customer's plant are important. Also, inventory control is important to assure that any specific coil is not allowed to remain unused for a long time. Refer to GalvInfoNote #7 for more information on protecting against storage stain.

2. Whenever possible, especially for critical paint-adhesion applications, the customer should utilize good cleaning practices such as a staged alkaline cleaning unit and then order the product "oiled". The presence of rust-inhibitive oil will dramatically extend the shelf life of galvanized sheet, and help to prevent storage staining.
3. In some instances, cooperative work among the steel producer, the surface treatment supplier, and a paint company has allowed the customer to paint over the surface passivation film that the steel producer applies on the exit end of the hot-dip coating line. When this is feasible, the tendency for dark storage stains to develop is reduced very dramatically.
4. If dark stains are present on a galvanized sheet, it does not necessarily mean that paint adhesion is "poor" for all applications. Typically, the dark stain corrosion product is formed as a thin adherent film onto the surface of the galvanized coating. It is recommended that paint trials be done to determine if the dark stain does indeed adversely affect paint adhesion. If not, it may then be possible to use the stained galvanized product.

If this salvage method is tried, it is important to assure that the dark stained oxide on the surface of the galvanized sheet is adherent to the unaffected galvanized coating, and that the paint has sufficient hiding power to prevent "show through". If the amount of storage stain is severe and the dark corrosion product is no longer adherent to the unaffected galvanized coating, it is often better to not apply the product for a painted application unless the coil is subjected to aggressive cleaning.

Summary

The dark stains that are at times visible on galvanized sheet are caused by the same wet-storage conditions that cause white rust on galvanized surfaces. Since galvanized sheet is often shipped "dry, no oil, no surface passivation", it is very important to control the shipping and storage of galvanized sheet. Often, if storage stains are present and the stain is a thin, adherent film, the product can still be used for the intended application. Paint adhesion tests should be conducted to assure that the mechanical adhesion of the paint is not adversely affected over the stained areas.

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