GalvInfoNote	Selecting Coating Thickness (Weight or Mass) for Galvanized Steel Sheet Products
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Introduction

The proper selection of coating thickness to meet a galvanized steel sheet user's needs requires knowledge of the corrosiveness of the environment in which the product will be used. The thickness of the zinc coating largely determines its ultimate life, but it is not used directly to specify the amount of coating. GalvInfoNote 1.1 explains why galvanized sheet coatings are specified, not as thickness, but as coating weight (inch-pound system) or coating mass (SI system).

Effect of Atmospheric Conditions

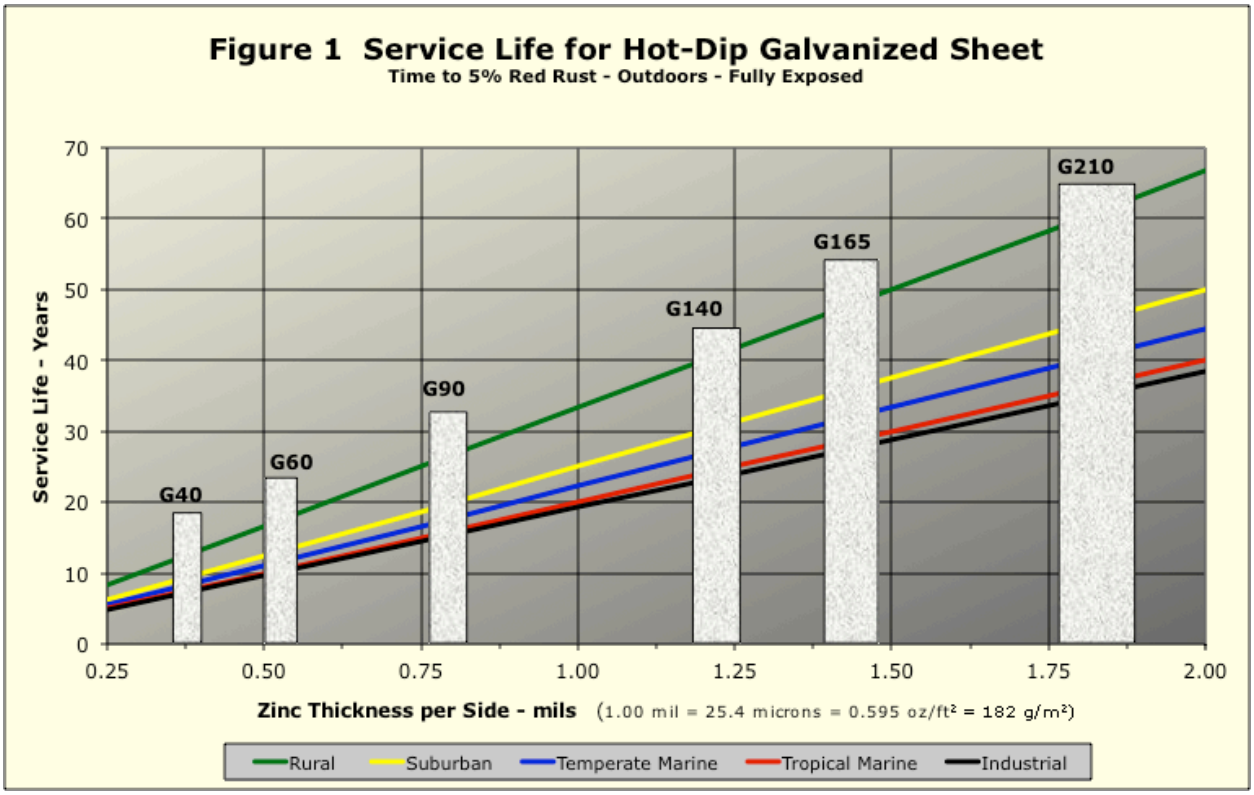
The corrosion rate of a zinc coating varies widely depending upon many environmental factors. For example, "time of wetness" is an important issue that affects corrosion rate, i.e., outdoor applications in the dry Southwest United States are very different from locations that experience high annual rainfall or extended foggy periods. Also, the presence of impurities such as sulfates, chlorides, and nitrates can dramatically affect the rate of corrosion. Other variables, including the amount of oxygen present in the electrolyte, and the temperature of the environment are important determinants for predicting product life.

In 2003, the American Galvanizers Association (AGA) published an updated service life chart for batch-galvanized articles that have zinc coatings up to 6+ mils thick. The chart also applies to continuous galvanized sheet, although the life expectancy of their thinner coatings is hard to read on the AGA graph (www.galvanizeit.org). The original AGA data was obtained by the GalvInfo Center, which allowed Figure 1 below to be generated. Essentially it is a magnified version of the lower left hand corner of the AGA chart.

The life expectancy lines shown by this chart reflect calculated outdoor corrosion rates produced using the **Zinc Coating Life Predictor (ZCLP)**. This software was developed by Gregory Zhang of Teck Metals Ltd., and can be found at www.galvinfo.com in the **GalvInfo Library** – **Additional Information** section. It is applicable to all zinc-coated steel; that is, coatings composed of zinc or zinc/iron. It does not apply to zinc/aluminum or aluminum/zinc coatings. It performs calculations based on statistical models, neural network technology and an extensive worldwide corrosion database. The environmental input data obtained by the AGA was from the World Wide Web. The calculated corrosion rates used to generate the service life chart in Figure 1 are averages for six different North American cities in each of the five climate categories. Keep in mind that the corrosion rates shown are **estimates based on models** using data from environmental databases. **The life expectancy lines are not based on actual measured zinc consumption rates.**

Six common ASTM A653 coating weight "bars" have been overlaid on the chart. For each bar, the left edge is an assumed one-half[·] of the minimum allowed triple spot test coating thickness, and the right edge is one-half the maximum TST thickness that would typically be produced. The middle of a bar width is therefore a good estimate of the service life of the coating designation in a given environment, e.g., G90 will last 20 years before 5% red rust in an average suburban locale. To determine the corrosion rate for a specific locale, the documented actual environmental data for the ZCLP can be looked up and input onto the software.

[·] ASTM TST coating weight specifications allow one side to be as low as 40% of the total specified minimum. Figure 1 uses a 50/50 split as the minimum, since this is by far the most typical coating distribution produced on modern coating lines.



Product Life Considerations

The performance requirements, i.e., the desired product life, will be a factor in determining the required coating weight [mass] needed for a given application. For example, consider an application such as a metal building roof where the desire is for no red rust being visible for many years. In this case, the time to failure might be defined as the time for the onset of red rust (the time for the zinc coating to be consumed in a large enough area for rusting of the steel to be observed). This application requires a thick zinc coating. Another example is an application in which the time to failure is defined as the time when perforation of the steel sheet is observed. In this case, failure is affected by the thickness of the steel sheet (and the corrosion rate of the steel) as well as the thickness of the zinc coating.

Once the desired product life is determined, it is important to match the desired life with corrosion rate information for any specific application. By combining the rate of corrosion (zinc coating thickness loss/year) for a specific application with the desired life in years, one can then readily determine the zinc coating weight [mass] to specify.

Designation System for Ordering a Specific Coating Weight [Mass]

For galvanized steel sheet products, the coating weight [mass], and hence the thickness, is defined by the designator system in ASTM Specification A653/A653M. The inch-pound coating weight designators (as A653) range from designations **G30** (0.30 oz/ft^2 of sheet) to **G235** (2.35 oz/ft^2 of sheet), with many intermediate coating weights between these two. The equivalent SI coating mass designators (as A653M) are **Z90** (90 g/m^2 of sheet) to **Z700** (700 g/m^2 of sheet). This is almost an eight-fold difference in weight [mass] of zinc. These coating designations are total-both-sides, meaning that the coating weight [mass] on one side of the sheet is nominally one-half of the indicated value. Refer to GalvInfoNote 1.1 for more details on coating designations.

For many outdoor applications of bare (unpainted) galvanized sheet, the most common coating weight [mass] in use today is **G90 [Z275]**. This product is also specified for indoor applications where there is the potential for considerable amount of dampness due to condensation, etc. For other indoor applications where the environment is relatively dry, a **G40 [Z120]** or **G60 [Z180]** coating weight [mass] are usually sufficient. Outdoor applications such as corrugated steel pipe (CSP) for drainage applications require very heavy coatings. The most common coating weight [mass] for CSP is **G200 [Z610]**.

Effect of Coating Weight [Mass] on Product Life

Although the corrosion rate can vary considerably depending on the environmental factors, as Figure 1 shows, **the life of a zinc coating is a linear function of coating weight [mass]** for any specific environment. This means that to achieve twice the life for any specific application, twice the coating weight [mass] is required.

Examples –

- A G60 coating weight will exhibit approximately twice the life of a G30 coating weight
- A G90 coating weight will exhibit about 50% longer life than a G60 coating weight

Additional information on this topic is contained in Appendix X4 of ASTM Specification A653/A653M.

Corrosion Rate Data

In addition to The Coating Life Predictor that is available at www.galvinfo.com, the following two reference books are excellent sources for additional and more detailed information on the corrosion behaviour of zinc-coated steel sheet products. These publications go beyond the information available using **The Coating Life Predictor** in that they contain information on corrosion rates in various aqueous solutions, as well as in organic and inorganic solutions, and in soils.

1. Corrosion and Electrochemistry of Zinc, X. Gregory Zhang, Published by Plenum Press, 1996.
2. Corrosion Resistance of Zinc and Zinc Alloys, Frank C. Porter, Published by Marcel Dekker, Inc., 1994

These publications document that corrosion can range from very low rates – in the order of less than 0.01 mil*/year [0.254 μm/yr] – to much higher rates. If the rate of corrosion were, for example, 0.05 mil/year [1.25 μm/year], the life of a G90 coating would be approximately 16 to 17 years, since a G90 coating is approximately 0.83 mil [21 μm] thick on each side of the coated steel sheet. In some environments, the rate of corrosion is so high that galvanized steel is not the preferred product. Generally, such applications are those that have either very acidic or very basic environments.

Another source of zinc corrosion rate data can be found in ASM Metals Handbook Vol. 13B Corrosion: Materials, 2005, pp. 402-417,available at: http://asmcommunity.asminternational.org/portal/site/www/

It should be emphasized that much of the zinc corrosion data given in the above references was generated in the 1950–1970 era, while the data used to generate Figure 1 on page 2 is more recent, after aggressive pollutants such as sulfur dioxide declined from their higher levels of the mid 20th century. The service life of galvanize in, say, urban industrial areas is now longer than it was 30 to 50 years ago. On the other hand, corrosion rates in marine environments are not so much changed, since the rate of zinc loss is governed more by the amount of deposited sea salt than airborne pollutants.

*(1 mil=0.001 in)

Contact the GalvInfo Center

The correct selection of coating thickness is but one of the many factors that need to be considered when using galvanized sheet products. Others include the steel thickness, the steel strength, the steel formability, the surface treatment applied to the galvanized coating, etc. To assist you with these many considerations, please contact the GalvInfo Center by either phone or e-mail.

Toll-free phone: 1.888.880.8802

E-mail: info@galvinfo.com

Note: Additional information on: corrosion rates in various environments, ASTM coating designations, and galvanized steel specifications can be found in GalvInfoNotes 3.1, 2.5, and 1.5, respectively.