ASK DR. GALV

WHAT CONSTITUTES HIGHLY REACTIVE STEEL AND HOW DO I GO ABOUT PREDICTING A COATING THICKNESS THAT WILL RESULT FROM GALVANIZING?

Most normal (killed) steel has a coating growth rate that tapers off the longer you leave the product in the zinc bath. When galvanizing reactive steels, the coating growth rate is linear: the longer you leave it in the bath the more zinc the product picks up. Reactive steels are those with a silicon level above 0.30 weight % or in the Sandelin range as explained below, and phosphorous contents above 0.04 weight %. The results of galvanizing reactive steel are usually a thicker coating, a duller surface appearance and a less ductile coating.

Numerous studies have been done on galvanizing reactive steels, most notably by Dr. Sandelin. Dr. Sandelin's studies led to the creation of the Sandelin Curve (figure 1). The curve shows that in the lower ranges of Si (0-0.05%), normal zinc coating thickness is obtained. However, a dramatic increase in zinc thickness will be unavoidable in the range of Si (0.05 - 0.15%). But then there appears a saddle in the curve from 0.15 - 0.35% Si, where once again normal galvanizing coating thickness will occur.
Dr. Sandelin drafted the following formula based on his studies relating the levels of silicon and phosphorous to coating thickness. [Si + 2.5*(P) = position on Sandelin curve]. Take for example steels with the following chemistry:
Steel #1: Si = 0.17%; P = 0.01%.
Steel #2: Si = 0.17%; P = 0.08%

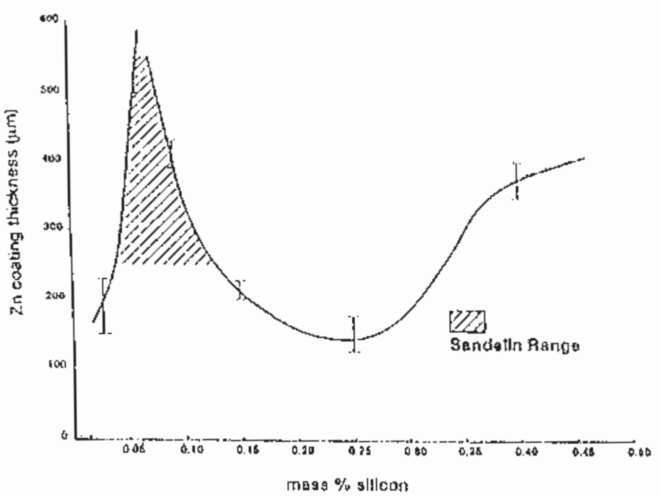

Figure 1: Sandelin Curve

At first glance you will notice that the given Si levels correlate to a position on the Sandelin curve that is located in the "saddle," which gives a normal galvanizing thickness. But without taking into account the phosphorous level of 0.01 and 0.08 you may be misled about the outcome of the galvanized coating. Using the formula for Steel #1, we get: 0.17 + 2.5*(0.01) = 0.195. Now, if the phosphorous level is increased to 0.08 this drastically changes the position on the curve. The formula used on Steel #2 yields: 0.17 + 2.5*(0.08) = 0.37. This steel is now positioned on the upper slope of the saddle and very likely will pick up an excessive amount of zinc.

But remember that the given chemical components are usually within a range of +/- 0.05%. If we incorporate this plus / minus variance we will find that Steel #1 can have portions of the steel falling below 0.15 on the Sandelin curve resulting in a high growth rate. In Steel #2 we see that 0.37 can become 0.42, basically off the chart on increasing Fe-Zn alloy layer buildup.

So what are you to do if the steel to be galvanized falls just on the edges of what is considered optimal for galvanizing? There are several remedies for subduing the growth rate in high reactive steels. Several companies are in the process of making alloys that will minimize the increased growth rate and are claiming they bring about a bright spangle finish as well. Nickel, as a minor alloying element, is often used to retard the formation of the Fe-Zn alloy layer. Nickel is considered only effective on steels in the range of 0.03% - 0.25% Si.

Blasting of the product prior to galvanizing can also retard the excessive growth rate obtained in reactive steels. Now you're probably saying, "Dr. Galv, I thought blasting was a method used to help pick-up more zinc?" You are correct. Blasting normal steel creates a rough profile and when the Fe-Zn layers form, they push up and against each other forming thicker coatings. However, the reactive steels form the Fe-Zn intermetallics in the form of columns. Therefore, with a rough surface profile the columns collide and interfere, slowing down the excessive growth rate.

By simply manipulating the galvanizing kettle's temperature and the product's time in the zinc bath, often the galvanizer can get around the negative factors associated with reactive steel. Lower galvanizing temperatures and minimal time in the kettle will result in a more desirable coating thickness.

ILZRO produced a report, available through the AGA, that summarizes in table format the reactivity classification for steels. This report is a good quick reference guide for steel reactivity and coating appearance in relation to silicon and phosphorous content contained in the steel. Call us if you'd like a copy.