China Fastener World no.57/2019

Stainless Steel Fasteners

by Laurence Claus

In the United States, if I were to survey a number of average individuals regarding their knowledge of Stainless Steel, I would likely receive very similar answers. It is likely that they would tell me that these materials do not rust, are attractive in appearance, and are not magnetic. If I were to press them further and ask how they intersected with Stainless Steel on an everyday basis, I would be likely to hear a common response that their large kitchen appliances are made of Stainless Steel. In fact, the trend for the last couple of years in United States kitchen design is to showcase a suite of gleaming Stainless Steel appliances (refrigerator, range, and dishwasher). In addition to the appliances, they might tell you that the sink, pots and pans, and silverware are all made of Stainless Steel.

The fact of the matter is, the average American encounters many things, including fasteners, which are made of Stainless Steel. As I explained in an earlier volume of this magazine, in my article, "The Basics of Stainless Steel", there are five different categories of Stainless Steel. These different varieties, although all being classified as stainless steel and sharing some common traits, are, generally speaking, quite different in performance, behavior, and properties. This makes it important to realize that not all Stainless Steel fasteners are the same, and like any other fastener, require the designer to make intentional and educated choices depending on the design criteria they are trying to fulfill.

In review, Stainless Steels fall into one of five different varieties. They are:

Austenitic Stainless Steels:

When the average person is asked about Stainless Steel, this is the variety they most likely associate their answer to. Austenitic Stainless Steel provides excellent corrosion protection, is non-magnetic, and the most commonly used variety in everyday kitchen appliances and implements. In the United States, these are designated with 200 and 300 series numbers to distinguish them from other varieties. In Europe they are designated with the letter "A" and a number, such as A2 or A4.

Ferritic Stainless Steels:

Ferritic Stainless Steel is much less commonly used than Austenitic Stainless Steel. It has only moderate corrosion protection but is less expensive and easier to form. In the United States it is designated with a 400 series number. (Note: One must be very cautious here, Ferritic Stainless Steels share their 400 series designation number with Martensitic Stainless Steels, so that you cannot determine which variety you are working with unless you either know or look it up in a reference book.)

Martensitic Stainless Steel:

Also much less common than Austenitic Stainless Steel is Martensitic Stainless Steel. This has the poorest corrosion protection of the different Stainless Steel varieties, but can be strengthened and forms easily. Like the Ferritic Stainless Steels, it goes by a 400 series number.

Precipitation Hardening Stainless Steel:

These are Stainless Steels that can be strengthened through solution hardening. They approach the Austenitic Stainless Steels in their corrosion protection qualities. Unfortunately, these materials have reputations for being very difficult to form.

Duplex Stainless Steel:

The final variety of Stainless Steels is Duplex Stainless Steel. These are an approximate 50/50 mix of Austenitic and Ferritic Stainless Steel. Although they possess improvements in certain properties or physical qualities over both Austenitic and Ferritic Stainless Steel, on the whole, they do not rise to the same level of performance as Austenitic Stainless Steels.

Selecting the Right Stainless Steel:

With so many variations of these five varieties of Stainless Steel available, how does one choose one over the other? The answer to this question, of course, simply depends on what properties and characteristics are most needed by the application.

Corrosion Protection:

As this is the primary property that leads a designer to seek out Stainless Steel, it is probably appropriate to start the conversation with this topic. Stainless Steel achieves its corrosion protection in its ability to form a protective chromium oxide on its surface. This chromium oxide is a passive film that is resistant to further oxidation or other forms of chemical attack.

The designer must evaluate what kind of environment and corrosive conditions the fasteners are going to be exposed to. If the exposure conditions are extreme, like constant wet, turbulent water, or industrial harsh (such as mildly acidic) conditions, the designer must choose an Austenitic or Precipitation Hardening variety. If the exposure conditions are moderate the choices are Austenitic or, perhaps, Ferritic Stainless Steel. If the exposure conditions are mild then Ferritic or Martensitic Stainless Steel may be an appropriate choice.

Although there are specialty metals which exhibit far superior corrosion and oxidation protection, the best corrosion protection from materials commonly considered Stainless Steel and most often used for fasteners are 316, 304, 302HQ, 17-4PH, and 13-8Mo. The use of these materials, however, does not preclude a designer from choosing a Ferritic Stainless Steel, such as 430, or a Martensitic Stainless Steel, such as 410, when the severity of the environment is only moderate or mild. In fact, many designers may choose one of these grades of Stainless Steel to take advantage of other properties while still outperforming the corrosion protection of a carbon steel part with a protective plating or coating.

Some common applications where Stainless Steel fasteners are used include applications where fasteners are exposed to periodic wet conditions, such as any fastener used on a product exposed to the elements or construction fasteners. Many construction fasteners used on roofs, exterior cladding or siding, and to mount solar panels are made of Stainless Steel. One unique construction application is as a deck screw for cedar decking. The Stainless Steel fasteners not only resist corrosion in the outdoor environment but do not react with the Tannin in the cedar wood which causes staining (a common problem when using galvanized steel screws).

Strength:

One of the more serious disadvantages of the Austenitic and Ferritic Stainless Steels is that they cannot be strengthened through heat treatment. This means that the only strengthening opportunity is through work hardening. If strength is a strong design criterion then a heat treatable Martensitic Stainless Steel or Precipitation Hardening Stainless Steel must be chosen.

Formability (Ability to Cold Head):

Once again, the variation in formability between the different varieties of Stainless Steel can be extreme. As a general rule, the Martensitic and Ferritic Stainless Steels are relatively easy to cold head. In fact, many a seasoned cold header operator will tell you that there is little difference in forming 410 (Martensitic) or 430 (Ferritic) Stainless Steels from an alloy steel. However, their tune quickly changes when speaking about Austenitic and Precipitation Hardening Stainless Steels, such as 304, 316, and 17-4PH. In fact, they might have many a story about difficulty in forming parts made of these materials.

Occasionally when a manufacturer has a particularly challenging part to form from Austenitic Stainless Steel they may attempt to add some additional heat, usually by drawing the wire through an induction coil right before going into the machine. Additionally, sufficient and effective wire coating is extremely important. Stainless Steel is prone to galling. If the wire coating is not sufficiently effective to prevent galling, the tools will break down very quickly. For this reason, much of the Stainless Steel wire that you will see in a cold heading plant is copper coated. The copper provides an exceptional lubricating surface and is certainly favored by almost any header operator that has ever tried it on Stainless Steel material.

Cost:

The final factor we will look at here is cost. Stainless Steel commands a significant premium when compared with carbon and alloy steel. Austenitic Stainless Steel is more costly than Ferritic or Martensitic Stainless Steel. It is for this reason that a designer might chose a Ferritic or Martensitic Stainless Steel over an Austenitic Stainless Steel. They have decided that they need a Stainless Steel for their application, as it provides superior performance to a plated or coated Carbon Steel part, but they do not need as much performance as they would get from an Austenitic Stainless Steel. It is similar in theory why a resident of Kansas (a very flat state) may not choose to purchase a car with All Wheel Drive. The added cost of All Wheel Drive is simply not worth paying for as they do not need the added performance.

Summary:

There are many factors that a designer must consider when choosing the right Stainless Steel variety for their project or application. Stainless Steels are very versatile and often perform at extremely high levels, which make them attractive to users. The primary advantage is corrosion protection but there are other advantages to Stainless Steel as well. Understanding and having knowledge of all these things is very important to avoid costly blunders and procure the best fastener for the intended job.