Coating Processes

The original use of a metallic coating was to enhance the appearance the part it was covering. Such was the use of silver, gold, nickel, chromium and copper. Then it was learned that certain coatings also protected the base metals from atmospheric corrosion; some better than others and by different means. All steel fasteners have some type of protective coating on them, if even it is only a thin coating of oil to protect the bare steel in shipping or in transition to be coated in another process. Today there are a variety of coatings that will enhance the part's appearance improve its corrosion resistance or control the torque-tension resistance during assembly.

ZINC

This is a metal that provides a sacrificial barrier between the substrate (bare metal part) and atmospheric corrosion. In other words, it will corrode first, thereby protecting the steel part. It is applied to fasteners in several ways: hot dip, mechanical deposition, electroplated or by chemical conversion.

HOT DIP GALVANIZING

During this process, parts are dragged through a bath of molten zinc. Since the temperatures are over 800˚ F for the molten zinc it would greatly affect the tempering temperature of a grade 8 fastener more than a grade 5; therefore this process is limited to structural A325, A307 and transmission tower bolts, as well as a variety of pipe and iron flanges. Coating thicknesses are very thick: from 10 to 30 times that of an electroplated zinc fastener. Averaging over 0.005 inches, its corrosion protection is extremely good in outdoor use by virtue of its heavy thickness.

MECHANICAL ZINC GALVANIZING

This is another process that produces a heavy coating but without high temperatures. Because it is a mechanical process using slurry of zinc metal flakes being impinged onto the parts by glass or metal beads, there is nothing in the process to promote hydrogen embrittlement. Thickness can be controlled and varies from 0.0003" to 0.005". The resultant finish will be a dull matte or hammer tone metallic zinc.

CHEMICAL CONVERSIONS

These are actually called phosphate coatings. Dissolved metal ions of zinc, iron and manganese are chemically bonded to the surface of the steel. Typically, thin conversion coatings are used on office furniture, etc., as it is an excellent base coat for paint.
When used with fasteners, higher thicknesses will determine the corrosion resistance of the coating. Heavy zinc phosphate coatings in the range of 1,000 to 3,000 mg./sq ft. will provide salt spray corrosion test results from 96 to 400 hours. This depends upon the type of sealer used, such as wax or oil.

ELECTRODEPOSITED ZINC

Typically, electroplated zinc ranges in thickness from 0.00015 to 0.0003", the median being 0.0002". Salt spray tests will show some form of corrosion product on unprotected zinc within 24 hours. Depending upon the porosity of the deposit, this could be red rust.
This is why many zinc coatings receiving a supplementary chromate dip, which acts as a sealer to counter any porosity and enhance the corrosion resistance. Therefore, white zinc corrosion product will first appear after 36 hours.
The chromic acid dip can have additives that provide color as well as a thicker film. Naturally, the thicker film provides the greater resistance to corrosion. There is trivalent and hexavalent chromium. The latter is thicker but found to have harmful effects on the environment and public health and is being discontinued for use. With a colored conversion coating, the red rust resistance is pushed up to 96 hours.
To comply with the EPA and RoHS (Restriction of Use of Hazardous Substances) requirements, trivalent chromium has been replacing the hexavalent chromium for all plated parts. The color of the trivalent parts is not as iridescent s the hexavalent chromium. It more of a muted yellow color, but still offers similar corrosion protection

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Nut Thickness

Many specifications require that the nuts thickness should be the same as the fastener. This is unnecessary. For one thing it will increase thread fit problem. Electroplating creates a Christmas tree effect at the thread crests. This is a combination of the current density of the electrolyte and the geometry of the part. The crest being closest to the anode, or metal source.

The nut will have similar problems, only the plating will build up at the outside of the first thread. Since plating baths have relatively low "throwing powers" the inside threads will receive little plate. But remember, they mate with their male counterparts which will provide sufficient protection when tightened. Consider hot dipped nuts. They are all tapped after coating and have essentially bare threads.

HYDROGEN EMBRITTLEMENT

This is a delayed fracture phenomena that occurs due to the absorption of hydrogen ions from the metal finishing process. This can be induced from the ion exchange during the electrolysis, cleaning process or chromic acid dip process. Some will contend that some hydrogen absorption can come from the bolt manufacturing process.

In any event, strides have been made to assure parts are free from hydrogen embrittlement. For one, zinc plating was changed from cyanide electrolyte to an alkaline or acid bath, which is far more efficient and therefore produces less hydrogen at the cathode, part. The metal deposits also have less porosity.

It has been standard practice to bake plated parts whose hardness exceeds Rockwell 38 in hardness. Baking is done at 400˚ F ± 25˚F for four hours. This method has shown to provide some relief but is not an absolute.

If baking a part that is specified to receive a chromate conversion coating, bake the parts first. Otherwise the coating will become useless as it will degrade over 25 ˚F. bake first, then apply the coating.

Organic coatings

These dip-and–spin coatings were being developed in the 1980's they could not control the thickness very well then. Now thicknesses are being appplied in layers with different metallic particles, such as zinc and aluminum. Top coatings over the metallic rich coatings have further enhanced the corrosion resistance. Salt sprays tests range from a low 500hours to well over 1,000hoursdepending upon the layers and treatments. The organic coatings have had a tremendous application with automotive OEM (Original Equipment Manufacturer) and military parts. Some finding many MRO applications.

There are many other types of alloyed coatings available, such as zinc-nickel, zinc and tin, even electroless nickel. They all have their unique functions, and some, a unique cost. Be sure of the process before you generically ask for a plated product.