Corrosion Protection of Carbon and Stainless Steel Track

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Introduction
Bishop-Wisecarver employs several types of surface treatment processes to enhance the corrosion resistance of carbon steel and stainless steel Track.

These processes are identified below with a brief outline of their characteristics and attributes.

Electroless Nickel (EN) Plating
Electroless nickel deposits are routinely used in many industries and are approved for use in agriculture, food processing, and medical applications. The EN plated coating generally has a uniform thickness and will coat the entire part's shape. This process offers distinct advantages when plating irregularly shaped objects that include, holes, recesses, internal surfaces, or threads. The thickness of the coating depends on the time that the part is in the plating bath. The characteristics of EN plating are:

- Uniformity of the deposits, even on complex shapes.
- EN Deposits are not porous and thus provide a better barrier for corrosion protection, much superior to that of electroplated nickel and hard chromium coatings.
- Deposit thickness: Coating thickness is usually specified as .0001"/.0003" Greater thicknesses can be applied to increase corrosion resistance, but this may adversely affect its spalling resistance under load.
- The deposits only generate about 1/5th as much hydrogen absorption as electrolytic nickel and about 1/10th as much hard chromium.
- Deposits can be plated with zero stress.
- Deposits have inherent lubricity and non-galling characteristics, unlike electrolytic nickel.
- Deposits have good wetability for oils.
- The as-plated microhardness of EN plating is 450 - 600 VPN (45 to 55 HRC). The hardness of these deposits can be increased to 1000-1100 VPN (70 HRC) by a suitable heat-treatment for 1 hr at 400°C.
- USDA approved coating

Physical Properties
- Melting Point : - 890°C
- Density: - 7.85-7.95 grams per cubic cm.
- Coefficient of friction :- EN vs. STEEL 0.3
- Coefficient of Thermal Expansion :- 0.13 microns /°c

Armoloy Coating
Armoloy coating is frequently referred to as Thin Dense Chromium (TDC). It is comprised of a 99%+ chromium layer that permeates the surface of the part being plated. Armoloy coatings
have been available for many years, are USDA approved, and also approved for use in food processing and medical environments. The characteristics of Armoloy coating are:

- Increased Wear resistance – Coating Hardness of 70-72 HRC.
- Deposits have inherent lubricity.
- Good corrosion resistance.
- Deposit thickness: Coating thickness is usually specified as .0001"/.0003".
- Deposit will not peel, crack, or flake.
- Can withstand temperatures from -400F to 1800F (-240C to 982C).

**Black Oxide Finish**

Black oxide is a conversion coating that is commonly applied to steel. It is formed by a chemical reaction when steel parts are immersed in a hot (285F) alkaline aqueous salt solution. The reaction between the steel and the hot oxide bath produces magnetite ($\text{Fe}_3\text{O}_4$) on the surface of the part. The characteristics of black oxide coating are:

- Decorative black color. Shiny, glossy or matte finishes can be obtained. The color is stable at increased temperatures.
- Only minor dimensional changes occur. The thickness of black oxide coating generally does not exceed $3 \times 10^{-5}$ inch (0.75 µm), half of which is added to the part dimension and the other half penetrates the part depth.
- There is strong adhesion between the coating and the substrate. The black oxide coating will not peel from the surface.
- There is only a slight improvement of corrosion protection. Black oxide coatings provide some minor corrosion protection for non exposed parts (not good in corrosive environments).
- Good lubrication characteristics. Black oxide coatings improve the anti-galling properties of the Track. In addition, a subsequent oil/wax finish will decrease the coefficient of friction of the black oxide coated parts even further and adds to the general corrosion resistance.
- Low light reflection.
- No hydrogen embrittlement. Since Hydrogen is not evolved in the chemical process of black oxide coating, there is no hydrogen diffusion into the metal.
- Cost effectiveness. Black oxide coating is less expensive than many other types of coatings.

**Passivation of Type 420 Stainless Steels Tracks**

Passivation of stainless steel is a simple, cost effective, non-electrolytic process that enhances the corrosion resistance of stainless steel track. The passivation process should be applied after fabrication and thorough cleaning. Tracks are passivated by immersion in a 20% (by volume) nitric acid bath. Nitric acid is a potent oxidizing agent, and readily forms a tight, coherent oxide film on the track surface. The characteristics of passivation are:

- Passivation significantly enhances the corrosion resistance of stainless steel track and should be used whenever track will be subjected to highly corrosive environments and whenever application aesthetics are important to the end user.
- The passivation process removes "free iron" contamination that is left behind on the surface of the stainless steel, during fabrication. If not removed, these contaminants will act as potential corrosion sites, which will deteriorate the life and appearance of the track.
- The passivation process facilitates the formation of a thin, transparent oxide film, which protects the stainless steel from selective oxidation (corrosion). This protective oxide film is extremely thin, about 100,000 times thinner than a human hair (4 x $10^{-8}$ in).
Electropolishing of Stainless Steel Track
Electropolishing is an electrochemical process used to polish a metal surface by removing microscopic amounts of metal from the work piece. Electropolishing is accomplished by creating an electrochemical cell in which the track to be polished serves as the anode. A cathode is formed to duplicate the geometry of the track, and the anode and cathode are submerged in a heated electrolyte bath. When a DC current is applied, an electrical charge dissolves metal ions from the anode (track) surface. For stainless steels, the electrolyte is usually a mixed solution of glycolic acid, phosphoric acid, and sulfuric acid. The characteristics of Electropolishing are:

- Electropolishing conditions the surface of the track, rendering it free from contaminants that could act as corrosion cells. A track that has been electropolished requires no subsequent passivation.
- Electropolishing maximizes the corrosion resistance of the stainless steel by electrochemically milling the surface material to eliminate contaminants.
- Electropolishing deburrs any sharp edges on the part as it polishes the surface.

Summary
The types of finishing processes discussed in this document are all cost effective if applied correctly to achieve the desired level of corrosion resistance or surface coating properties. It is not uncommon to apply electroless nickel or Armoloy plating to stainless steel track to further enhance the corrosion resistance beyond that of stainless steel.

Please contact our Applications Engineers to discuss how Bishop-Wisecarver’s surface treatment options may work for carbon or stainless steel track in your application.