Durable Industrial Finishing Company

DIFCO

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Finishing: What is it?

- Finishing is the bonding of one metal/coating to another for the purpose of corrosion protection, decorative appeal, hardness, electrical conductivity, reflectivity, and/or wear resistance
- In a nut shell, finishing modifies the surface properties of the base metal to make it more suitable for its intended use

Typical Properties Achieved Through Metal Finishing

- Corrosion resistance
- Appearance
- Abrasion resistance
- Value (silver/gold, etc)
- Solderability
- Rubber Bonding
- Electrical Resistance
- Reflectivity
- Diffusion Barrier
- Lubricity
- High Temp. Resistance

Finishing Alternatives for Fasteners – Black Oxide

- **Hot black Oxide is a conversion coating for steel that offers no dimensional change while imparting corrosion resistance to steel. This coating does not peel and is a true black when used with a good rust preventative.**

Finishing Alternatives for Fasteners – Black Oxide

Features of Black Oxide

- **No dimensional change**
- **Does not affect conductivity**
- **Increased corrosion resistance**
- **Reduced light glare**
- **Provides anti-galling properties**
- **Base for organic coatings, improved adhesion**

- **No regulatory concerns (RoHS), cheap, low level of protection**

Electroplating Alternatives for Fasteners – Phosphate Coatings (Mn, Zn)

The manganese phosphate coatings (type M) are available in black and dark gray color. They are used as corrosion protection agents, anti-galling agents, and as a lubricant. These coatings have the highest hardness and superior corrosion resistances among all general phosphate coatings. The treatment time often varies from five to fifteen minutes. Some of its features and applications are:

Finishing Alternatives for Fasteners – Phosphate Coatings (Mn, Zn)

- These coatings are applied by immersion to bearings, bushings, fasteners and other common industrial products.
- The coatings are used for sliding products like transmission systems, motor vehicle components in brake and clutch assemblies, engine components, leaf or coil springs

Finishing Alternatives for Fasteners – Phosphate Coatings (Mn, Zn)

Zinc Phosphate Coatings – Type Z:

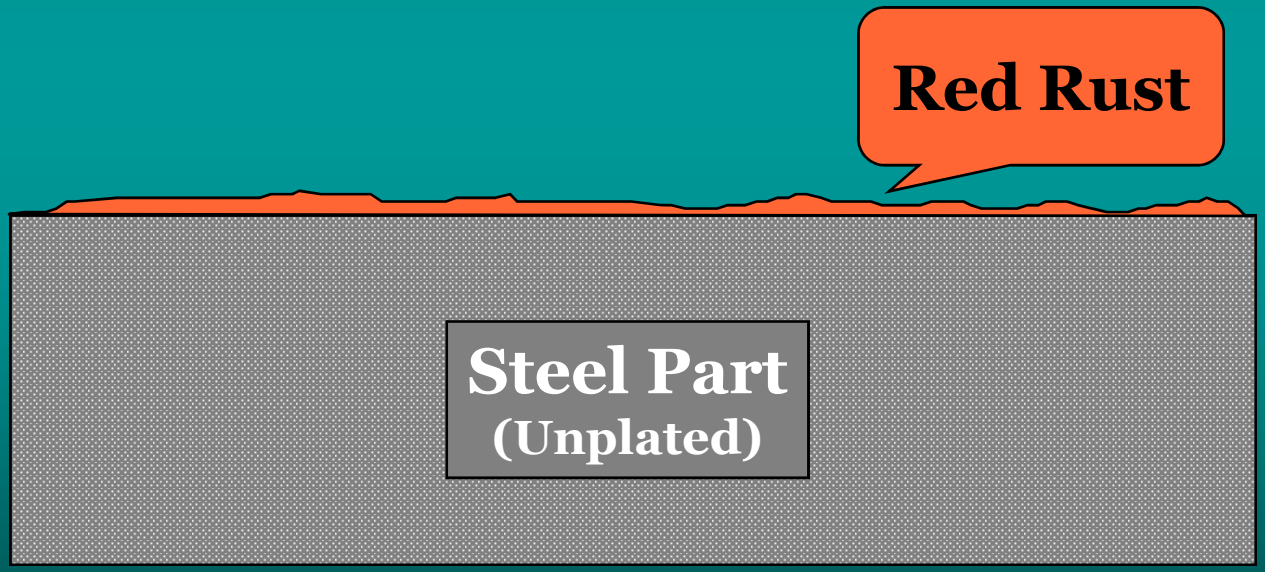
- Zinc phosphate coating is mainly used as rust proofing. These coatings are usually applied by spraying or immersion. The zinc phosphate coatings are available in black and dark gray colors, and lighter in comparison to manganese phosphate coatings.

Finishing Alternatives for Fasteners – Phosphate Coatings (Mn, Zn)

- Offer 12-72 hours to red rust with oil
- Self-limiting, reactive coatings typically 5 – 8 microns
- They do run the risk of hydrogen embrittlement
- Phosphate coating provides strong adhesion and corrosion protection, and also improves the friction properties of sliding components.
- Some of the threaded parts are treated with phosphate coatings, which improves their anti-galling and rust inhibiting characteristics
- No regulatory concerns (RoHS) unless chrome seals are used

What happens to steel?

- Steel is the cheapest structural material available for countless uses
- However, steel is not very resistant to corrosion (red rust)



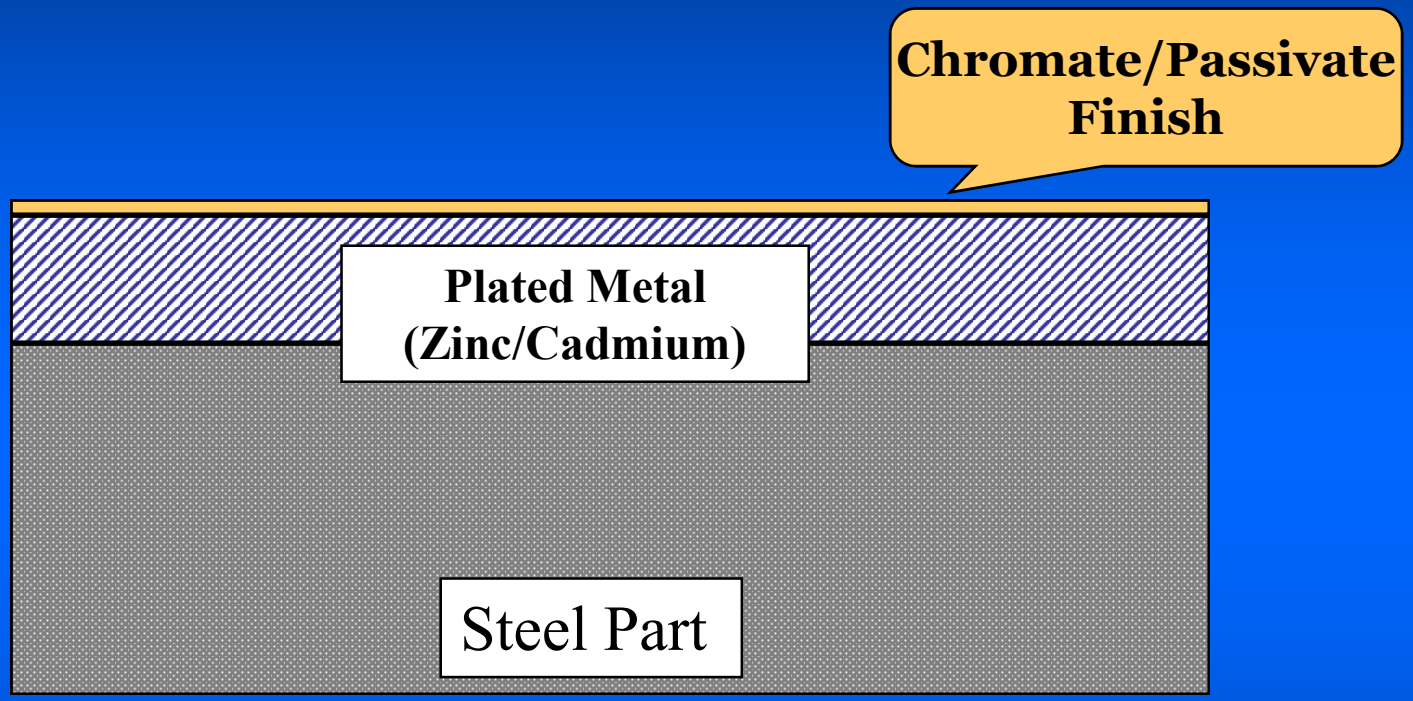
Rust damages (pits) the surface of the base metal

What happens to zinc/cadmium?

- Zinc/cadmium metal will corrode (white corrosion) if not protected by a chromate finish
- As the zinc/cadmium corrodes, it fails to protect the base metal and red rust of the base metal occurs

Rust damages (pits) the surface of the base metal

ZINC/CADMIUM PLATED PART

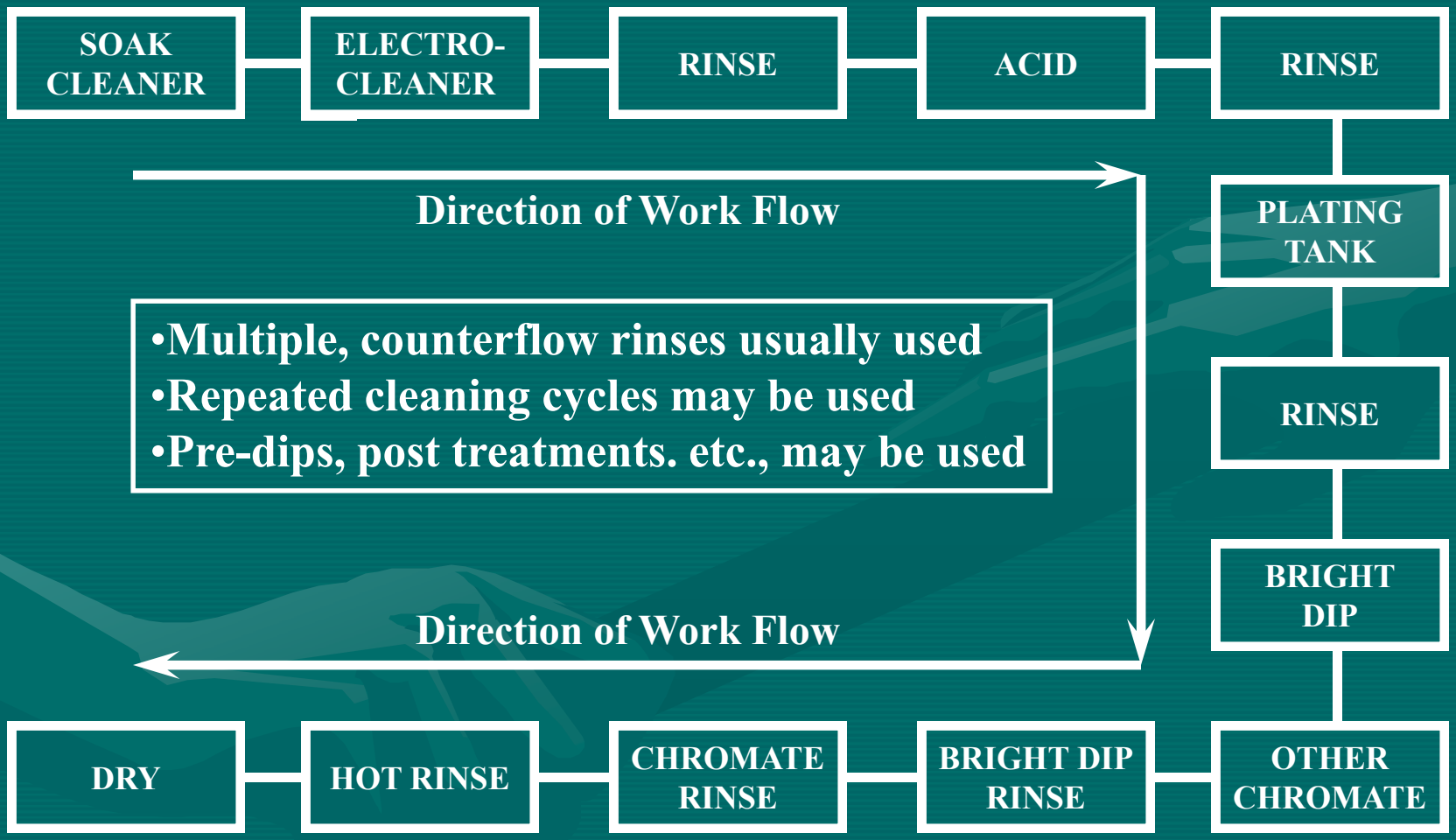


- The part is protected from corrosion by the cadmium plating
- The zinc/cadmium plating is protected from corrosion by the chromate/passivate finish

CRITICAL STEPS IN PLATING/COATING

- **Loading (position, number of parts)**
- **Amperage when applicable (amount of current for the number of parts)**
- **Cleaning (strength, temperature, time)**
- **Pickling/Acid (strength, temperature, time)**
- **Rinsing (time, flow of water, cleanliness)**
- **Plating/Coating process**
- ***Chromates/Passivates (strength, pH, temperature, time, age of chromate)***
- ***Post-dips (strength, age, temperature, pH)***

Typical Zinc/Cadmium Plating Cycle



Advantages of Cadmium plating

THE MANY BENEFITS OF CADMIUM PLATING

- Unparalleled resistance to corrosive marine / sea-shore environments.
- Natural lubricity which provides anti-galling and low friction properties.
- Low electrical resistance and exceptional conductivity.
- Favorable galvanic compatibility with aluminum.
- Good bonding surface for adhesives.
- Can be used with a wide range of base metals.
- But there are toxicity/poison issues

Topcoats / Seals

- There are a variety of topcoats / seals available. Silicated dips, polymers/lacquers, cross-linking polymers, lubricating seals (torque-n-tension compounds)
- Silicated dips offer some self-healing help and increase corrosion protection. These are very thin and will not cause dimensional problems with fasteners

Topcoats / Seals (cont.)

- Polymers / lacquers offer enhanced corrosion protection as well as scratch resistance
- Polymers / lacquers can pose some conductivity issues
- Polymer / lacquer films can be thick and may cause fit/dimensional issues in fasteners, especially in threaded areas
- Lubricating seals (torque-n-tension) offer enhanced corrosion protection, some self-healing help, and lubricity, changing torque values of the surface (automotive fastener requirements). These seals can be expensive to apply.

Finishing Alternatives for Fasteners

- Zinc alloy plating (ZnNi, ZnFe)
- Mechanical Zinc Plating
- Zinc Flake Coatings (Dip Spin Coatings)
- Xylan/Teflon/Etc. Coatings
- Thermal Diffusion Zinc

Developments in Metal Finishing – Zinc Nickel

Significant growth of zinc nickel coatings for critical parts: chassis, brakes, fluid tubes, fasteners, brackets, etc.

- Application of advanced, customized sealers on top of highly productive Cr(III) passivates to improve performance for zinc and zinc nickel
- Combination of zinc/zinc nickel plus capable topcoats to meet highest requirements

Developments in Metal Finishing – Zinc Nickel

ADVANTAGES OF ZINC-NICKEL PLATING

- Offers outstanding corrosion resistance, even in high-salt and low-thickness environments.

- Environmentally friendly in comparison to Cadmium plating.

- Corrosion protection equivalent or greater than Cadmium capabilities.

- Corrosion can extend beyond 2,000 hours to red rust with high performance chromates and thickness.

Developments in Metal Finishing – Zinc Nickel

ADVANTAGES OF ZINC-NICKEL PLATING (cont.)

- Finishes can be coated in black or yellow.

- Coating is 10 to 15 percent nickel, the remainder being zinc for longer lasting protection.

- All chromate finishes are RoHS and REACH compliant.

- Far less chance of hydrogen embrittlement than zinc plating (still require baking)

Developments in Metal Finishing – Mechanical Zinc

Mechanical zinc plating is accomplished by tumbling small parts in a drum with zinc and proprietary chemicals. Small iron and steel parts usually limited in size to about 8-9 inches (200-300 mm) and weighing less than one pound (0.5 kg) are cleaned and flash copper coated before loading into a plating barrel. The barrel is then loaded with proprietary chemicals, glass beads and zinc powder and tumbled. During tumbling, the glass beads peen zinc powder onto the part.

Developments in Metal Finishing – Mechanical Zinc

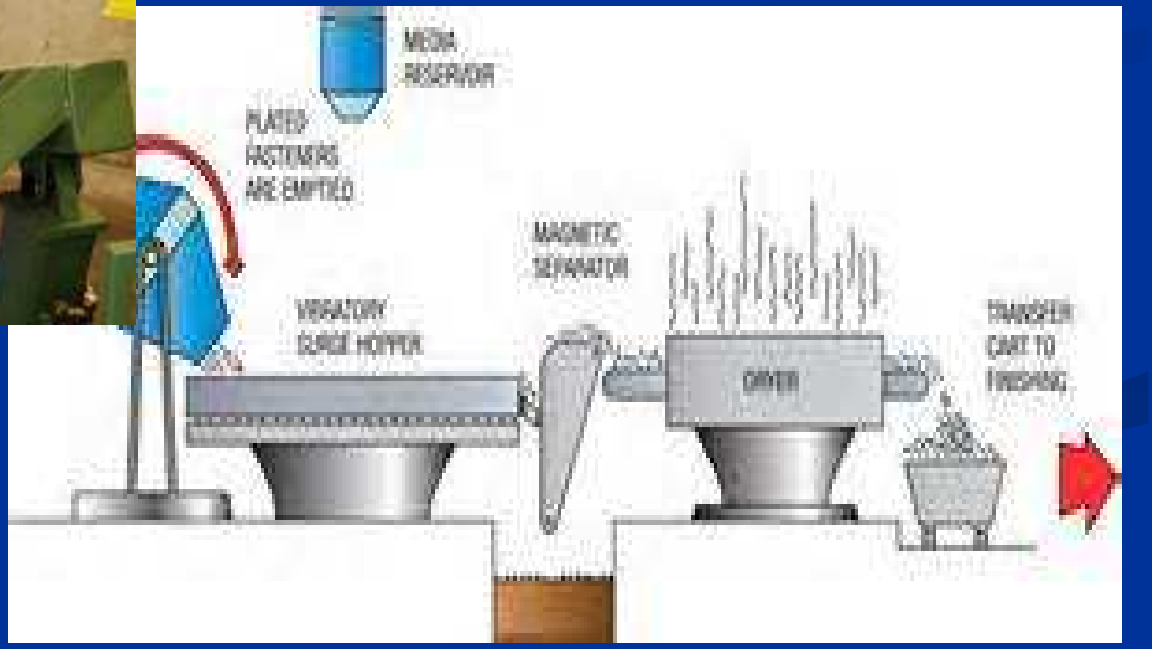
Once finished, the parts are dried and packaged, or post-treated with a passivation film, dried, and packaged. As mentioned, mechanical plating can only be applied to small parts limited to the capacity of the drum. Furthermore, the materials must be simple in design to ensure peening to all surfaces. Mechanical zinc plating is most commonly used on high-strength fasteners and other small parts not suitable for hot-dip galvanizing.

Developments in Metal Finishing – Mechanical Zinc

- Size limitations
- Few applicators
- 72 hours FWC/300 hours FRR salt spray
- No hydrogen embrittlement
- Lodging of the process beads (not normally an issue with fasteners

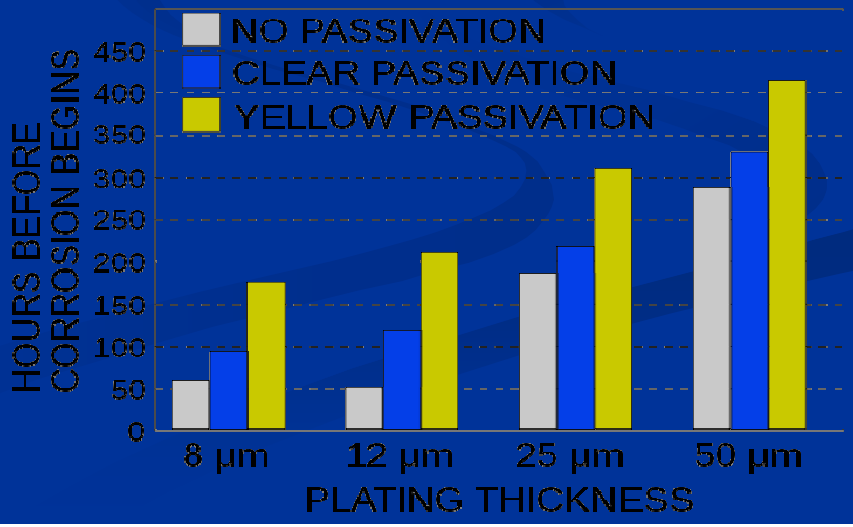
Electroplating Alternatives for Fasteners

- Mechanical Zinc Plating



Electroplating Alternatives for Fasteners

- Mechanical Zinc Plating



Developments in Metal Finishing – Hot Dip Galvanizing

Hot-dip galvanizing (HDG) is the process of coating fabricated steel by immersing it in a bath of molten zinc. There are three fundamental steps in the hot-dip galvanizing process; surface preparation, galvanizing, and inspection. After surface preparation, the steel is dipped in the molten (830 F) bath of at least 98% zinc. The steel is lowered into the kettle at an angle that allows air to escape from tubular shapes or other pockets, and the zinc to flow into, over, and through the entire piece.

Developments in Metal Finishing – Hot Dip Galvanizing

Hot-dip galvanizing (HDG) coatings are thick and typically require threads to be chased after coating. Coatings can also be rough and sharp (drips). Though not normally measured by salt spray, HDG coatings can give up to 600 hours protection to FRR.

Developments in Metal Finishing – Zinc-Flake Coating

- Geomet/Dacromet (not available in US)
  - Dorken
  - Magni
  - Atotech
  - others

Finishing Alternatives for Fasteners – Zinc Flake

- Mechanical damage resistance
- Adhesion
- Self repairing
- Thin dry Hydrogen Embrittlement free film
- Bimetallic corrosion resistant
- Heat resistant, conductive and paintable
- Water based products are highly solvent resistant
- 24 g/m2 with topcoat 1500+ hours no RR

Finishing Alternatives for Fasteners – Zinc Flake

- Equipment intensive
- Dip-spin coatings and rack coatings
- Possible size limitations (dip-spin applications)
- Licensed products

Electroplating Alternatives for Fasteners

- Zinc Flake Coatings

Finishing Alternatives for Fasteners – Thermal Diffusion Zinc

- Applies a uniform zinc powder that thermally diffuses to the base metal (ferrous) at high temperature and pressure/vacuum
- Harder than normal zinc – high wear resistance
- Good elasticity and ductility (good for springs, etc.)
- Can coat over damaged surfaces evenly
- SS protection to FRR to 2000+ hours
- Popular in deep mining (ocean oil drilling) ops
- Equipment intensive/few coaters/size limitations

Future Finishing Directions

- Chrome free products (no hex or tri chromium)
  - Hydrogen embrittlement free products
    - Increased salt spray protection
  - Reduced process costs (especially in automotive markets)

THANK YOU!

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