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Choosing a Chromate Alternative

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Chromates – what are they used for and why?

Chromates (salts containing hexavalent chromium in the chemistry Metal-CrO_3) have the unusual property of affording corrosion protection even when scratched or damaged. They do this by going into solution in the corrosive environment, migrating to the exposed bare metal surface, and forming complexes to inhibit further corrosion. In addition, chromates often form good bonding layers, improving the bond between a paint system and a surface, which also helps to improve corrosion resistance. Consequently chromates are widely used as corrosion inhibitors and passivates in the aircraft and defense industries, and are used wherever corrosion is a serious concern, especially where damage to the surface coating is quite likely.

Chromates are also used for chromic acid anodizing (CAA) and etching. CAA is used to create a good bonding surface (because of its roughness and porosity) and as an anodized for components with liquid entrapment areas where acids can be trapped and sulfuric or other acids cause etching.

Examples include

- Chromate conversion coatings for metal surfaces
    - Aluminum alloys are typically chromate converted to resist chloride attack in marine environments
    - Sacrificial corrosion resistant coatings on steels (such as Cd, Zn, Al) are frequently chromate converted to supplement the corrosion resistance of the sacrificial coating. This type of chromate treatment is often termed a “sealer”.
    - Phosphate passivation coatings on steels are typically chromate sealed
    - Anodized layers on Al alloys are usually chromate passivated
    - Mg alloys used in aircraft gearboxes
- Primers and paints
    - Al alloy surfaces are commonly chromated for corrosion resistance and to enhance paint adhesion. Chromate conversion is the most common treatment prior to painting aircraft.
    - Aircraft primers usually contain chromates so that if scratched they will continue to protect the surface. Corrosion is the biggest problem with aircraft frames and skins.
- Anodizing
    - Chromic acid anodizing and sealing

Typical applications of chromates

- Galvanized steel sheet
- Galvanized fasteners (bolts)
- Painted steels used in corrosive service
- Aircraft skins and structural members made of aluminum alloys
- Magnesium alloy components such as gearbox housings used in aircraft
- Cadmium plated aircraft landing gear
- Electrical connectors and cabinets
- Castings and extrusions

Alternatives to Chromates

There are so many uses of chromates that there are numerous alternatives, depending on the application and the substrate, its service conditions, and other factors. You should consult the ASETSDefense database at http://db.asetsdefense.org for detailed data and information on approvals and implementations.

Passivation and sealing

There are various trivalent chrome passivates on the market. For Al alloys the US Navy has developed TriChrome Pretreat (TCP), which is a trivalent chrome passivate with Zr inhibitor. For Zn and Zn alloy coatings there are many passivates based on Co inhibitors and some non-Co ones.

There are also passivates that are Cr-free, based on permanganates, molybdates, rare earths such as Ce and Pr, and other inhibitors.

In addition there is another class of conversion coating alternatives based on paint adhesion promoters, such as sol-gel coatings based on Boegel, which is used by Boeing, and other adhesion systems such as Prekote, which is used on some USAF aircraft.

CAA alternatives

Most users of anodizing have gone over to sulfuric or thin film sulfuric acid anodizing (SAA, TFSAA). Boeing uses boric-sulfuric (BSAA), while Airbus uses tartaric-sulfuric acid anodizing.

For specialized applications there is also a class of high voltage anodizing methods based on Plasma Electrolytic Oxidation (PEO), also sometimes called Micro-Arc Oxidation (MAO), the best known of which are Tagnite (in the US) for Mg alloys, and Keronite (from the UK) for Al alloys, although there are others.

Chromated primers

Paint systems have now been developed based on non-Cr primers, such as rare earth systems from Deft Finishes and Mg-rich primers from Akzo-Nobel.

There are even some experimental aircraft fuel tank coatings based on nano-particle filled polymers.

Metallic-Ceramic coatings for GTEs

There are now a number of low-Cr and Cr-free metallic-ceramics on the market, including coatings from Indestructible Paint in the UK, Praxair in the US (owners of SermeTel), and Ceral in Germany. There is some test data available for these, but it is limited. However, several of these systems have been approved and are used on aircraft.