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What is Black Oxide?

Black oxide is the conversion coating formed by a chemical reaction with the iron in metal to form an integral protective surface.... contrasted to an applied coating which bonds to the metal but does not react chemically. A black oxide conversion coating is applied to ferrous alloys when a blend of caustic, oxidizers and additives react with the iron to form magnetite (Fe_3O_4), the black oxide of iron. Black oxide coatings are offered under a variety of trade names including Black Magic , Black Pentrate®, Black Passivation, Gun Bluing and others. Black oxide will not affect the part dimension, hardness, temper or surface properties..... a polished surface retains its gloss and a dull surface finish will retain its matte finish. Black oxide will not chip, peel, flake or rub off. Hot black oxide is a conventional hot (285 F°) process which produces a true black oxide iron magnetite. All the benefits of black oxide are available from the "hot" oxidizing process.

A black oxide coating can be formed in either a hot or cold solution. The "cold" black oxide process, applied at room temperature or slightly elevated temperatures, are not true oxides, but soft deposits that offer less corrosion and abrasion resistance than the "hot" oxide process. The cold black oxides oftentimes display color variations on the same part or part-to-part. The "cold" process does not meet automotive or military specifications for black oxide coatings. Premier Finishing only employs the "hot" black oxide process.

How is the process performed?

There are five basic steps for the black oxide conversion coating. They are clean; rinse; black oxide (parts are immersed in an alkaline salt solution operated at approximately 285 degrees F.); rinse; and supplemental coating. If rust or scale is on the part, additional steps such as acid pickling or alkaline de-scaling may have to be added before black oxide. Black oxide cannot be produced over plated parts (zinc, chromium, cadmium, phosphate). This plating must be stripped prior to the black oxide process.

The supplementary coating (after-finish) will dictate the final appearance and function of the part. When a print or drawing specifies "Black Oxide" without any specific after-finish, it is interpreted as black oxide and oil. The after-finish is usually determined by the part configuration, application and the end-user. If a "dry-to-touch" finish is needed, it is important to specify either oil spin dry-to-touch, wax or lacquer. The oil after-finish will generally be a glossy finish, whereas the wax will be more of a matte finish. A lacquer (or acrylic) coating is a hard, dry coating.

What are the advantages and benefits of black oxide coating?

Dimensional Stability – Black oxide adds no more than 5 to 10 millionths of an inch to the dimension of a part (it also penetrates to an approximate depth of 5 to 10 millionths). For all intents and purposes, the as-formed dimensions do not change (as they do when plated or painted).

Anti-galling – Where break-in of mating parts is necessary, the anti-galling surface lets the outer lubricating layer be sacrificed during the initial contact and abrasion while work-hardened surfaces are formed. The black oxide itself has a hardness of 5.5 on the Moh's scale.

Improved Lubricity

Oil or wax post-treatments not only protect against corrosion, but will add lubricity in mating parts.

Decorative Finish – The resulting lustrous black finish adds visual appeal and a "quality" image at a very low cost. Harder parts (40 Rockwell and above) tend to have a glossier finish. Softer parts tend to have a matte finish.

Corrosion Protection – Depending on the post-treatment applied, black oxide coating can give corrosion resistance equivalent to 400 humidity hours exposure. Other applications are designed to provide extended shelf life for stored parts prior to their use or to prepare them for further surface treatment (painting).

Reduced Light Glare – Moving machine parts, hand tools and surgical instruments coated with black oxide reflect less light and reduce eye fatigue when used under bright lights.

Cost Competitive - It is very difficult to achieve the same protection, appearance and performance qualities from other finishing processes for the same low cost as black oxide

Where is black oxide regularly used?

Black oxide conversion coatings are widely used in the machine tool, automotive, appliance and general forming industries. Screw machine parts, forgings and stampings are commonly black oxide coated.

Applicable "Hot" Black Oxide Specifications

SAE Aerospace AMS 2485K
Mil C-13924D-Class 1*
Ford Motor ESF-M6P3-A
General Motors GM-4347-M
Toyota TSH7603G
Steelcase ES 1-02-02

*Premier Finishing does not comply with the Chromic acid step (3.4.2)