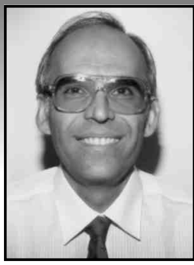

Finishers' Think Tank

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Hard Chrome . . . Hard Facts

Hard chromium plating, also referred to as functional plating, is from a chemical reference, a relatively simple plating solution. Control, maintenance, and troubleshooting, however, all contribute to a complex and challenging metal finishing process. The bath consists of: chromic acid, sulfuric acid, fluoride or non-fluoride type catalysts, and a "pinch" of trivalent chromium.

Accompanying the roaring '20s was the debut of hard chromium plating. This technological break-through offers many finishing benefits, such as:

- Improved wear resistance
- Enhanced lubricity and sliding properties (abrasion resistance)
- Buildup of desired thickness layers
- Excellent deposit hardness
- Better corrosion protection
- Salvaging worn industrial parts

The focus of this article is to highlight some of the important parameters, maintenance, trouble-shooting, operating tips, and safety.

Bath Types

There are three types of operating baths: conventional, mixed catalyst, and non-fluoride. A working formula-tion for each bath is given in Table 1.

The mixed catalyst system offers a larger operating range with respect to ratio of chromic acid to sulfate. However, the non-fluoride catalyzed bath is a big technological advance in hard chrome plating, offering these exceptional benefits: higher rate of deposit (faster buildup), improved corrosion resistance, and improved wear properties. The efficiency of this bath is approximately double that of the mixed catalyst bath. Another benefit of the non-fluoride bath is the elimination of etching exposed steel.

Table 1

Bath Type	Chromic Acid, oz/gal	Sulfate, oz/gal	Ratio
Conventional	20-60	0.20-0.60	100:1
Mixed Catalyst	20-50	0.08-0.13	150-200:1
Non-fluoride	30-35	0.30-0.35	100:1

Table 2

Bath Type	Cathode CD, ASF	Temp, °F	Anode/Cathode
Conventional	35-370	115-145	1:1 to 3:1
Mixed Catalyst	140-580	125-140	1:1 to 3:1
Non-fluoride	140-870	125-140	1:1 to 3:1

Shake, Rattle & Plate

The critical operating parameters are summarized in Table 2. Agitation is optional, preferred when making additions. Conventional and non-fluoride solutions use lead with six-percent antimony alloyed anodes. The mixed catalyst uses lead with seven-percent tin alloyed.

Run Buddy, Run

Let's review the "octane rating" or plating speed of these baths, as given in units of thousandths of an inch per hour (Table 3).

Comparisons at 130°F. Data from test work under controlled operating conditions. The non-fluoride bath offers a deposition rate of chrome that is over three times faster than the conventional system. By comparison, the mixed catalyst bath provides up to twice the deposition rate of chrome versus conventional.

Turn on The Juice

Chrome plating is very sensitive to AC ripple. As a rule, the lower the AC value, the better the system will plate chromium. Getting down to one percent and lower, AC ripple is a good maintenance check using an oscilloscope. Using a three-phase rectifier is preferred. AC especially affects the lower plating current densities, resulting in white wash, reduced coverage, and poor adhesion. For most practical applications, at least a 6-volt rectifier is recom-mended, with 9 to 12 volts offering a wider range for many chrome plating applications.

Positive is a Plus

The suggested anodes as described are composed of specific alloy combina-tions. This maximizes corrosion resistance, sufficiently stiffens the material of construction, and helps to control preferred reactions at the anode during plating. Two important oxidation products formed at the anode are oxygen and trivalent chromium. Trivalent chromium is very critical to maintain desired operating efficiency of the bath. Approximately 1-2 percent trivalent chromium in the bath relative to the hexavalent chromium concentration is preferred (or a maximum of 0.5 oz/gal). Keeping a 1:1 or 1.5:1 ratio of anode to cathode in the bath helps. A visual check of the anodes should confirm a "chocolate brown to black syrupy" film on them, as related to sufficient trivalent chromium concen-tration. This should not be confused with the formation of a yellow-colored sludgy coating on the anodes, when the bath is not used. Remember to clean the anodes when plating resumes after a period of non-use. This prevents anode resistance, which severely hampers a process having a relatively low plating efficiency to begin with.

Table 3

Current Density, ASF	Conventional	Mixed Catalyst	Non-fluoride
390	0.80	1.27	2.50
435	1.40	2.11	4.22
580	2.06	2.88	5.70
725	2.78	3.71	7.20

Don't Reject It—Reclaim It!

Hard chrome is a great "fixer upper." Worn, pitted, corroded parts are reclaimed and overhauled to provide excellent service and field life endurance. Among parts that are given a second life and beyond are: pistons and rods, crankshafts, transmission parts, drill bits, tools, molding dyes, military hardware, and gravure printing cylinders. The overhauling procedure not only recycles good parts, but does so at considerable savings. For example, a 6 X 7 ft shaft with 3-in. diameter may cost between $1,200 and $3,500 new, or as an even replacement for a worn part. Complete handling from start to finish by the hard chrome plater may cost approximately $500. That's more than a 75-percent savings compared to a new part!

Doctor, Doctor! Help on the Way

Usually the problems that occur are related to chromic acid/sulfate ratio, trivalent chromium level, metallic contaminants, temperature, contact, and electrical. Some items of concern and their likely causes are:

Roughness—Low temp, bath chemistry imbalance, solids in bath, parts not properly polished, high current
Pitting—Hydrogen gas trapped in surface
Milky deposit—Break contact, AC ripple, high temp, low current, bath chem imbalance, chloride contamination
Peeling/blistering—Poor surface prep, break contact
Bare zones—Poor surface prep, bath chem imbalance, high temp, excess trivalent chrome, entrapped gas
No plating—Electrical (rectifier, connections), bath chem imbalance, chloride contamination

Routine chemical analysis (chromic acid by titration & Baume, sulfate catalyst, appropriate additional catalyst, and trivalent chromium) should be conducted. Equipment maintenance (rectifier, bussing, connections, etc.), racks, and process tank are normally scheduled when a particular tank is not being used or during similar plant events. The last experience anyone wants is an unscheduled shutdown.

Doing It Better

Following are some beneficial items meant to keep the system on track.

- Lower concentrations of chromic acid, while maintaining correct ratio to sulfate, favor brighter deposits. Duller deposits are obtained from higher bath concentrations of chromic acid.
- Higher bath temperature, chromic acid concentration, and current densities result in smoother deposits, better throwing power, and faster deposition rate.
- Keep the solution at operating temperature during idle periods to maintain good balance for mixed catalyst baths.
- High sulfate reduces throwing power. Low sulfate reduces plating speed and could contribute to nodular deposits.
- Selected current density depends on bath temperature, shape of part, desired plating speed.
- Only use stop-off lacquers and similar compounds that are recommended for use in chromic acid solutions.

Time Marches On

With use, the bath gradually builds up metallic and organic impurities. Metals such as aluminum, copper, iron, and zinc become "internal resistors," reducing overall efficiency of the plating bath. This includes conductivity and deposit quality. A good way to determine where the "gray line" of contamination lies is to compare the chromic acid by titration to the chromic acid by Baume. If the Baume reading (higher of the two) differs by more than 2 oz/gal vs. the titration value, the gray line has been identified. Quick fixes have consisted of adding more chromic acid or diluting the bath to sufficiently lower the gray line. More effective purifications include ion exchange and electrodialysis (sometimes referred to as the porous pot). In the ion exchange method, metal contaminants are transferred via a dynamic process through cation-selective membranes. The porous pot is a type of filter. It is electrically powered, driving metal contaminants through pores in the unit, effectively segregating them from the plating solution.

Cleaning the Air

Shops conform and meet federal EPA and regional government regulations. The Common Sense Initiative has been very helpful in keeping compliance sensible, yet earth-conscious. Perhaps the easiest and simplest approach to effectively contain emissions is by using fume suppressants. These additives lower the chrome plating solution's surface tension. They may also form thin, stable surface foam, eliminating, by EPA testing, over 98 percent of previous chrome mist emissions. Related process benefits include:

- Help to comply with OSHA regulations.
- Reduced solutions loss due to mist and drag-out save on chemical consumption.
- Less chance of chrome contamination of adjacent process baths.
- Minimized corrosion of process equipment and the physical plant.
- Lower cost to heat the bath.
- Extended service life of mechanical ventilation equipment.

Hard chrome plating—in many respects, nothing, as yet, does it better. The metal finishing industry hasn't just "lived" with the related problems of hard chrome, but has continually strived to improve it. The benefits include better efficiency, more utility, safer handling, and a strong market demand. P&SF

Think Tank Trivia

- Alkaline electroless nickel deposit over zincated aluminum provides an evenly distributed deposit with uniform thickness over all wetted surfaces. The alkaline EN is also a substitute for the cyanide copper strike.
- Chloride zinc exhibits excellent throwing power, while cyanide zinc deposits have better coverage.
- Powder coating has continued to grow in popularity. Method of application, variety of colors, and easier related waste treatment contribute to its growing use.