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Chromium Plating— Additional Tips for Good Service Performance

Troubleshooting and correcting decorative hexavalent chrome plating processes are usually quite straightforward. Ratio, temperature, and continuous electrical contact by themselves, or in some combination, are typically involved with any corrective action. What makes this interesting is the fact that we can only provide operating parameters or ranges. There is no specific guide for determining fixed values that work in all baths. In fact, once determined, the set operating parameters may be found to enclose a rather tight window. For example, a temperature range of 105–110°F may suit one bath, while 110–120°F may do well for another. A ratio of 125:1 in one bath may result in chaos in another, rather than 175:1 for best plating conditions. Setting the individually best suited operating parameters becomes a "dial-in" procedure, facilitated by observation, documented corrective action, and regular analysis. Some of the items I look for are:

- **Chromic acid determination by titration versus Baume measurement**. Chromic acid measurement by Baume will always yield a greater value than the titration analysis. That's obvious, because the Baume hydrometer measures specific gravity of the solution that is predominantly chromic acid. But it includes sulfate, trivalent chromium, and total metallic contaminants. Over the years, I have noted that when this gap, or difference, in chromic acid is up to 7–10 oz/gal, the contaminant levels are usually tolerable, allowing for acceptable chrome plating. Good, comprehensive lab analysis provides quantitative values to fill in the gap (*e.g.,* percent trivalent chromium, metallic contaminants). Knowing the complete analysis will help with another service tip.
- **Chloride level**. This ion is in a sense an out of control catalyst. It's in Group VII of the periodic table of the elements, but that is where the similarities with fluoride end in chrome plating. Thorough rinsing is essential between the nickel exit rinses and the chrome bath. A quick way to check the chrome bath for harmful levels of chloride is to dip a brass panel in the solution for 10 seconds. If the brass is etched, the chloride level is at a harmful concentration (*e.g.,* over 20 ppm). The normal corrective action is to dummy electrolyze the bath, using the high anode to cathode ratio and current density explained in standard troubleshooting texts and bulletins. I have not yet met anyone who has added silver sulfate to precipitate chloride in a chrome bath.
- **Hull Cell tip #1**. This test gives a reasonable determination of the bath's ratio. Observe the gassing pattern as it runs along the surface of the panel from high- to low-current density. If the gassing pulsates or continually pushes forward and recedes in a cyclic action, the ratio is probably off. A sufficient ratio for the bath will form a continuous, extended gassing pattern that does not recede.
- **Hull Cell tip #2**. Adequate or sufficiently satisfactory plating characteristics (throw and LCD coverage) in many baths are indicated by 60–80 percent coverage. The best coverage I obtained was 85 percent in a new bath. The tricky item when plating the hull cell is developing and maintaining temperature control, such as using water bath jacketing the porcelain hull cell. The high hull cell amperage will quickly heat the solution, giving a false result, unless the solution temperature is consistently maintained.
- **Sufficient catalyst**. This refers to sulfate and proprietary fluoride. Observe the low current density residue on rinsed and wet parts before entering the dryer. Is a rainbow colored pattern visible? This condition may also be seen in the same LCD area on a rinsed, wet hull cell panel. Wipe your finger horizontally across the wet panel deposit before it is blown dried. Is the rainbow pattern missing where you have wiped the panel? If the answer to either or both questions is "yes," it is practically certain there is a low catalyst level in the bath.
- **Metallic contaminants**. Check for and remove dropped parts. Monitor post nickel rinsing for sufficient action. The usual metallic contaminants, such as copper, iron, nickel, and zinc can not be removed by dummy electrolyzing. Instead, they become "resistors," detrimentally affecting chromium throw and coverage. Increasing the chromic acid concentration helps. Diluting or dumping the bath is no longer a viable purification option. Instead, porous pots and ion exchange are more widely used to remove these metallic contaminants.
- **Deposit on anodes**. The anodes should be covered with a chocolate brown col-

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by human intervention;
2. Humans must learn to act as stewards for this threatened world.[9]

He goes on to observe: "Such views, however well intentioned, are rooted in the old sin of pride and exaggerated self-importance. We are one among millions of species, stewards of nothing. By what argument could we, arising just a geological microsecond ago, become responsible for the affairs of a world 4.5 billion years old, teeming with life that has been evolving and diversifying for at least three-quarters of that immense span? Nature does not exist for us, had no idea we were coming, and doesn't give a damn about us. This assertion of ultimate importance could be countered if we, despite our late arrival, now held power over the planet's future. But we don't, despite popular misconception of our might. We are virtually powerless over the earth at our planet's own geological time scale. All the megatonnage in all our nuclear arsenals yields but one ten-thousandth the power of the 10 km asteroid that might have triggered the Cretaceous mass extinction. Yet the earth survived that larger shock and, in wiping out dinosaurs, paved a road for the evolution of large mammals, including humans. We can surely destroy ourselves, and take many other species with us, but we can barely dent bacterial diversity and will surely not remove many million species of insects and mites. On geological scales, our planet will take good care of itself and let time clear the impact of any human malfeasance."[9]

Our arrogance also is evident when we talk about future generations. H.W. Lewis uses radioactive wastes as an example. He notes that standards established by EPA for the repository to hold this waste require that it remain intact for 10,000 years, by which time the radioactive materials will be relatively innocuous. "EPA requires that the waste be stored in such a way that future people, presumed to be ignorant savages, will not be able to hurt themselves if they accidentally dig the stuff up. The arrogance deserves emphasis. We assume that we know much more than the people of the past, and it is even true, certainly as far as science and technology are concerned. To assume that we are also more competent than the people of the future means that we have selected ourselves as the highest manifestation of the human race, the peak of human development for all time. An engaging thought, just a bit pompous." He concludes by pointing out that the risk from radioactive waste buried according to EPA standards is ridiculously low, at least a factor of a million lower than any other risk discussed in his book Technological Risk. "The risk is as negligible as it is possible to imagine, yet the clamor about the subject has paralyzed the decision-making authorities, and there is still no consensus solution."[10]

Summary

No question we humans should do everything we can to prevent degradation to the environment wherever possible. However, any bad things we might do are trivial by comparison with the power of nature. As one of my favorite authors, Gabor Levy observes: "It is arrogant to forget that we will never be able to stop California from sliding north, or the lava flowing in Hawaii. The Caribbean will keep spawning tornadoes, and winters will always follow summers."[11] *P&SF*

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Think Tank

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ored, soft, friable deposit or film. New anodes are electrolyzed to develop this film. Orange-red deposits or crust indicate contaminants, such as chloride.

- **Bath temperature**. Reference is given to confidence in knowing what the temperature actually is. Where is the temperature probe located? Twelve inches down in a 45-inch deep tank is not good enough or, in itself, accurate. Is there sufficient solution movement? The bath contains 20 or more oz/gal of chromic acid. This contributes to a layering effect, with different temperature zones, unless the solution is sufficiently agitated. Thermostatic control is only as good as it's calibration and stick free operation.
- **Electrical contact**. Hexavalent chromium is acutely sensitive to any current interruption. Make sure all contacts are kept cleaned and are live. This is especially critical in return type automatic machines. One station may be dead, resulting in whitewash and haze. This usually occurs in the entry station. For this reason, I prefer a separate rectifier with low current connected to the entry station.
- **Rectifier**. The rectifier should be at least three-phase. Adequate filters should minimize AC ripple to be no more than 0.5%. A service technician, or the electrical department, should routinely check for the level of AC ripple with an oscilloscope.
- **Time delay**. This is in reference to the time required from exiting the nickel bath to chrome bath entry. The nickel deposit will readily form an oxide, resulting in passivation, causing chrome plating rejects. Automatic, computer run lines should have sufficient times programmed into the cycle, preventing any problems during transfer to the chrome tank. Manual lines must keep racks moving along. The last station before chrome entry may be a pre-dip, consisting of the dilute chrome bath, effectively activating the nickel deposit. In a few instances, an overhead hoist may be running many stations, resulting in a hard-to-overcome time delay. If this happens, and tank space is available, I have found cathodic electrocleaning the nickel plated parts to be most helpful prior to chrome plating. Do not use the electrocleaner in the surface preparation step, but rather a separate electrocleaner, just for this application.
- **Nickel Deposit**. Maintain the bath and operating parameters to plate sufficient coverage of nickel. This includes optimum levels of the organic brightening and leveling additives. Excessive amounts of these agents in the nickel deposit will speed unwanted passivation.
- **Racks**. These should be maintained in top operating condition. Loose or broken prongs and contacts will affect chrome deposit coverage, as will excessive buildup of nickel deposits on tips. *P&SF*