Shop Talk

Some Production Plating Problems & How They Were Solved—Part 5

Collected and edited by Dr. Samuel Heiman Updated by Dr. James H. Lindsay, AESF Fellow

1. Chisholm's Laws

Dear Dr. Heiman:

The other day I read an article in the newspaper under the headline "Dust Cover on Fuel Line Left By Error in Gemini 6." It began as follows: "In the day of efficiency experts and electronic wizardry, a two-cent plastic dust cover can turn the most devout statistician right back to *Murphy's Law*, which says that as long as a mistake can be made, sooner or later it will be made." In your article in the October 1965 issue of *Plating*, you attributed this law to Chisholm. Would you please clarify this point? *A. J. Clark, Collegeville, Pa. 19426*

Dear Mr. Clark:

Francis P. Chisholm's now-famous laws are published in a chapter in R. A. Baker's book entitled, "A Stress Analysis of a Strapless Evening Gown and Other Essays for a Scientific Age" (Prentice-Hall, Inc., 1963). The chapter is headed, "The Chisholm Effect: Basic Laws of Frustration, Mishap and Delay." The complete statement of these laws and their several corollaries are:

First Law: If anything can go wrong, it will.

Corollary #1: If anything just can't go wrong, it will anyway.

Second Law: When things are going well, something will go wrong.

- Corollary #1: When things just can't get any worse, they will.
- Corollary #2: Any time things appear to be going better, you have overlooked something.

Third Law: Purposes, as understood by the purposer, will be judged otherwise by others.

- Corollary #1: If you explain so clearly that nobody can misunderstand, somebody will.
- Corollary #2: If you do something which you are sure will meet with everybody's approval, somebody won't like it.

Corollary #3: Procedures devised to implement the purpose won't quite work. (Refers back to the First Law.)

Your editor is aware of the fact that Murphy's Law was cited not only in the above incident but also as a factor in the Great Northeast Blackout of November 1965 [to say nothing of the one in August of 2003]. However, I have been unable to find any basic documentation on either Murphy or his Law. Perhaps one of our readers can help us on this point.

S. Heiman

2. Barrel Zinc Plating: Random, White Blotchy Areas

After several months of very successful operation of a bright barrel zinc tank, dull areas began to appear at various positions on a steel rod part. Both the bath analysis and cyanide-to-zinc metal ratio were in order and the bath was too new for inorganic contamination to be a factor.

It was at first believed that poor precleaning was responsible for the trouble, but a concentrated effort to improve cleaning did not affect an improvement. The acid dip after the soak clean was changed on the assumption that there might be some scale on the part that could not be removed by either tumble clean or soak clean.

An observation was made by one of the men at the tank that a dark grease-like substance was present on the surface of the zinc solution. It was thought that this was excess grease put on the moving parts of the barrel by the maintenance men. After steps were taken to prevent excessive greasing, the brown grease-like substance still continued to appear. It was then thought that possibly this was a formation of some sort of fatty soap. The cylinder was removed and completely cleaned and all of the brown substance was "skimmed" from the top of the solution. After this was done, the dull areas disappeared.

It is assumed that the parts were rotating through this brown film and this soil was being deposited on random areas of the part which thus prevented proper bright plate deposition. Grease on the surface of a barrel zinc plating solution is an indication of poor cleaning. Although this often does not appear to affect the brightness of the zinc

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deposit, in this instance, it resulted in random, white blotchy deposits which caused rejection of the parts.

3. Equipment: The Case of the Reluctant Pump

We were moving the Plating Department several miles to another building while still maintaining production. The move was to proceed on a weekend.

With the tank truck backed into position, we started to pump out the first of five 3000-gallon nickel tanks. Soon a solid stream of beautiful green solution was issuing from the three-inch hose into the tank top. For several minutes it continued, but as we watched, the flow slowly diminished to a slight trickle. The intake was moved to prevent clinging to an anode bag or the bottom, reprimed, and restarted. Full pumping resumed at once - for a few minutes. Again the flow lessened and lessened to a trickle. The entire system was flushed with a high-pressure water hose to a clear solid flow. Pumping was started again with a rush, only to die again.

Words were exchanged with the Maintenance Department on their "overhauled" pump which resulted in the pump being torn down and reassembled. It pumped better than ever for even a shorter length of time. Time was fleeting and our work was dragging. Taking masterful charge, I ordered, "Switch the hoses from one end of the pump to the other."

"Why?" asked the maintenance man.

"Never mind," I said, "just do it."

After all, I had tried everything else. Grumbling, he did so, and restarted the pump, which proceeded to pump a solid green stream for the next 18 hours, stopping only to change tank trucks.

Much later, after everyone was gone, I found that the inner lining of the original intake hose was partially loose. As suction increased it slowly collapsed, throttling the flow like a diaphragm valve.

Sagittarius

4. Cadmium Plating: Poor Solderability

The trouble was poor solderability on a cadmium-plated part supplied to us by a vendor. Since this difficulty was holding up our production, I was sent to the vendor's plating shop to determine the cause.

I found that the solderability of freshly plated parts was also poor, so storage conditions and shelf life were not involved. Using a rosin flux, the solder did not wet the cadmium plate which behaved as though its surface was greasy.

The metal was a smooth cold-rolled steel. The work was clean after the cleaning and pickling; the latter consisted of a 5-min immersion in a 10 vol% hydrochloric acid bath. The cadmium plate itself had a good, clean, bright appearance and had the required thickness of 0.2 mil (5.1 μ m).

A fresh ¼% nitric acid bright dip was made up and tried, but this had no effect. Attention was turned to the acid pickle. The vendor said that the cold rolled steel which he processed was not rusty or scaled and, therefore, did not require the greater pickling action provided by stronger acid. Nevertheless, I recommended that the strength of the pickle be increased to 50% to keep it in line with standard practice. After this change was made, the cadmium plate soldered readily.

On another occasion, I had to check another vendor whose cadmium-plated parts also had soldering problems. Here again, the solutions were in good condition, there was no fault to be found with the cycle and the cadmium plate looked good. The hydrochloric acid pickle analyzed at 90 vol% of carboy acid but the dwell time was only 8 sec. Based on our previous experience (described above), I decided to experiment with the effect of pickling time on solderability. First of all, with no pickling at all, and only a pumice scrub or a cyanide dip after the cleaner, the solderability was very poor. However, after pickling for a few minutes, the solderability was excellent and continued to improve somewhat up to 7-min pickling time. In view of the overall considerations in the operation of this plating machine, it was decided to specify a pickling time of 2¹/₄ min. No further trouble with soldering was experienced.

It appears as though the plated metal "knows" and is influenced by what is done to the basis metal. Roughening or etching of the steel seems to be essential for good solderability of the plate. Failure to recognize this factor could well be a cause of the variability which is experienced in the solderability of plated coatings. I have not had an opportunity to study the mechanism of this phenomenon and would welcome discussion from readers.

Edwin F. Ottens, Philco Corporation, Philadelphia, PA 19134

5. Color Anodizing: Maintaining Uniformity Of Olive Drab Color

The problem was to maintain the same shade of olive drab color on a tubular aluminum furniture part from lot to lot and from day to day. Variations in the olive drab color obtained resulted in a high percentage of rejects in both in-house rework and that returned by the customer.

Our first reaction was to consider that the customer's quality control people were color blind. Instead, the use of the Dvorine Color Blind Test disclosed that one of our production men was color blind for the colors involved. He was assigned to clear anodized work only.

It was known that the required shade of olive drab could be consistently obtained by "hard anodizing" the part and sealing it in a dichromate bath. This process, however, was uneconomical and could not be used. Some improvement was obtained by closer control of all of the anodizing conditions as well as those of the nickel acetate seal. These were fixed to give the desired shade when using a fresh olive drab dye bath.

It was then noticed that as the dye bath was used, the color changed from the desired "greenish" olive drab to a "brownish" cast. Two steps were taken. First, since it was difficult to get one specific shade continuously, we obtained from the customer two swatches of the limits of the shades which he would accept so that all intermediate shades would thus be acceptable. These standards were then used by both his Quality Control people as well as ours.

Secondly, we learned from the supplier of the dye bath that the color was really a mixture of three dyes and the change in shade from the green to the brown cast was because of the greater absorption of the blue component than of the other two during the dyeing process. Consequently, he recommended a small addition of the blue dye component, which he supplied, to restore the green cast whenever the color assumed the brownish cast.

At this point, good work was obtained but trouble still occurred sporadically. This was found to happen invariably on the second shift. While one could charitably ascribe this to greater difficulty in matching colors at night, recourse had to be taken to the timehonored method of solving a problem of this nature. Whenever the shade went off range during the second shift, the tank was dumped and a fresh bath was made up.

> Howard G. Lasser, U. S. Army Research and Development Laboratories, Ft. Belvoir, Va. 22060

6. 400 Series Stainless Steel: Improvement in Corrosion Resistance

The problem involved how to prevent or retard the corrosion of 420 stainless steel retaining rings used in a mechanism that was immersed in water for an extended period of time.

420 stainless steel is a martensitic stainless steel which is hardenable by heat treatment. It contains 12-14% Cr, 1.00% Mn, 1.00% Si and 0.30% C. It has good strength and ductility and is widely used for cutlery.

The corrosion test consisted of immersing the parts in deionized water at room temperature for 340 hr. This test was used because the actuator maintenance cycle lasted about this period of time.

The part was a retaining ring used in a reactor control shim rod actuator. This reactor was water moderated and the corrosion from the snap rings was contaminating the deionized moderating water system. The parts had been passivated, removing iron contaminants embedded in the surface of the stainless steel.

Prior attempts to obtain a more corrosion resistant stainless steel retaining ring were unsuccessful. Therefore, methods of improving the corrosion resistance of the 420 stainless steel retaining rings were investigated and tested.

Electroplating a corrosion resistant finish such as nickel or chromium on the retaining rings was considered but this idea was discarded because of possible hydrogen embrittlement.

One of the factors affecting the corrosion of 400 series stainless steel is surface finish. The retaining rings should have a good finish and be highly polished. Since it is impractical to polish retaining rings manually, an electropolishing process was used to obtain the

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This important reference book published by AESF was written by an expert in the field of surface finishing. Your surface finishing library should include this:

The Properties of Electrodeposited Metals and Alloys

(Second Edition) W.H. Safranek, CEF (550 pages/1986, hardcover) Order Number 20-105 Members/\$72.00; Non-members/\$82.00

This edition completely updates and expands an earlier, exceptional finishing reference book—a "must" for shop owners, managers, design engineers and

researchers. The introductory chapter summarizes material presented in the book, and serves to emphasize the importance of appreciating and relating properties and structures to coating selection and application. Properties and structure of individual electrodeposited metals and alloys are covered—from aluminum electrodeposition to zinc plating.

Two chapters address copper and its alloys and composites; three cover nickel, its alloys and composites. Chapters on both electrodeposited and electroless cobalt give information on magnetic properties. Cadmium, chromium, gold, iron, platinum-group metals, rhenium, silver, tin, zinc and their alloys, as well as nickel and cobalt alloy processes, are covered.

The book draws from more than 1500 sources for its detailed information and provides valuable comments and caveats. Improve electrodeposit properties on specific products ... find help in specifying the most appropriate coatings ... learn about new aspects of electrodeposition—all from this volume.

Call the AESF Bookstore or Go On-line 1-800/334-2052 www.aesf.org (secure site) desired results. The electropolishing bath used was the citric acid-sulfuric acid type, but there is no reason to believe that any other standard electropolishing bath for stainless steel could not have been used. This solved the problem.

The merit of electropolishing is shown by the fact that the unpolished retaining rings had general pitting and corrosion after the corrosion test, whereas the electropolished parts had only a few isolated pits. This is shown in the accompanying figure.



We did not investigate the corrosion mechanism. However, other ways by which electropolishing improves the corrosion resistance are likely to involve (1) the formation of a heavier oxide film on the surface than the "natural" oxide and (2) the removal of the surface layer which originally had stresses and inclusions (insoluble in dilute nitric acid) from previous forming operations.

J. M. Messingschlager, General Electric Co. Cincinnati, Ohio 45215

7. Hard Anodizing: Pitting

Pits appeared in hard anodized spool-type pistons. Since the pistons had to have a 15 to 20 μ -in. finish, the pitting caused the parts to be scrapped. The scrap on one lot ran up to 40%.

The pistons were made of 606l-T6 aluminum. After the final grinding operation, the parts were cleaned in a conventional vapor degreaser and an alkaline soak cleaner and then hard anodized. Efforts which did *not* solve the problem were:

- 1. Complete and thorough analysis of all processing solutions. No chloride was found in the hard anodizing electrolyte.
- 2. Metallurgical study of the aluminum for possible stress corrosion or intergranular corrosion.
- 3. Visual examination immediately after grinding for signs of imperfections in the surface.

We found that corrosion of the aluminum occurred somewhere between the final grinding operation and the hard anodizing process. The corrosion was difficult to see with the naked eye, but was readily seen under a low-power microscope.

The problem was solved by applying a chromate conversion coating to the aluminum immediately after the final grinding operation. This prevented corrosion of the aluminum from any source whatsoever in the time interval before the anodizing process. Aluminum is an active metal and is prone to corrosion from many sources such as condensation and residual chemicals on the surface.

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The preceding article is based on material compiled and contributed by Dr. Samuel Heiman, as part of the Plating Topics series that ran in this journal. It dealt with everyday production plating problems in the mid-1960s, many of which are still encountered. Much has changed ... but not that much. The reader may benefit both from the information here and the historical perspective as well. In some cases here, words were altered for context.

