Finishers' Think Tank

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Have a problem on the finishing line? To send your question, use the convenient, postpaid form on our Readers' Service Card, or send a letter to: "Finishers' Think Tank," 12644 Research Pkwy., Orlando, FL 32826-3298.

High- & Mid-Phosphorus EN We are trying to qualify our • electroless nickel (EN) plating line to process parts for a major aerospace manufacturer. The panels we process for corrosion resistance are failing after 150-170 hr in neutral salt spray (ASTM B117) testing—200 hr is required for qualification. The specification does not call out for a high-phosphorus coating, but we feel it would give us better results. What is the difference between high- and midphos EN, and is one more beneficial than the other?

A. Electroless nickel phosphorus is a marvelous, amorphous metal deposit that is applied for its functional properties of hardness and corrosion and wear-resistance. In this case, we will consider the corrosion mechanism itself, and evaluate the ultimate corrosion resistance of the deposit. EN phosphorus protects the surface of the parts by providing a shield to the base metal. The ultimate corrosion resistance of the coating is affected by both the nature of the coating and the pre-plate preparation.

To be resistant to corrosion for the first few hundred hours of testing, the coating must completely cover the base metal, including base metal porosity and imperfections. The substrate, therefore, needs to be chemically clean and deoxidized, and the surface free from defects. A treatment cycle must be developed and properly implemented so that the surface will successfully accept the EN coating. Even in the mid-phosphorus range, EN is fairly impervious to neutral salt spray. This test reveals the quality of coverage attained on the substrate, and in doing so, serves as a measure of effectiveness for the preplating and processing sequences.

The use of a high-phosphorus (>10 percent) content probably will not yield a better result, and will also fail with premature corrosion in <250 hr of the test. Results, therefore, will emulate the results obtained with the mid-phosphorus content bath.

A high-phos EN coating at the appropriate thickness, however, will demonstrate corrosion resistance over a longer time in the salt spray cabinet, with hours in excess of 1,000. The high-phos systems will yield a coating with high reliability and—with proper pretreatment—a high degree of reproducibility.

Because this question concerns an aerospace application, it is important to note that when EN is baked, all bets are off—the coating loses its corrosion-resistant nature. Baking at elevated temperatures will precipitate nickel phosphide and cause the coating to change from amorphous to crystalline in structure, thereby diminishing the resistance to corrosion tests.

Water-based Lacquer Systems We use a water-reduced lacquer coating over brass in a dip-and-spin operation for small parts. The lacquer builds up with particles and causes premature failure in salt spray. Filtration removes the particles, but also reduces the viscosity of the coating solution, rendering it unusable. Is there any other way to remove these particles?

A. For an answer to this problem, I consulted Kirt Johansen of Stanley Hardware, New Britain, CT. It appears that, if filtration is damaging the efficacy and viscosity of the water-based lacquer systems, then the filtration is not being carried out properly. Water-reduced lacquers are delicate organic/water blends that may be damaged if handled improperly. Filtration systems require the correct combination of filter, media, pumps and pressure to be effective.

Temperature

High temperatures may result if incorrect or insufficient filter media are used, and if higher-than-necessary pressures are employed. High temperatures will reduce the viscosity of the system, or corrupt the organic structure of the coating so that it becomes unusable. Parallel filter mechanisms may be employed to reduce the overall filter pressure and, consequently, temperature.

Pumping

A diaphragm or piston pump should be used to move lacquer solutions. Centrifugal pumps at high temperatures will cause a shearing action on the organic materials. These shearing factors will break apart the molecular structures, which are holding the organic materials in solution.

Centrifugal pumps will also cause higher temperatures to form as a result of the turbulence in the volute areas of the pump. Last, and most important, the coating should be applied as a final step in the finishing operation, and as such, the parts entering into the lacquer should be free of particulate.

Quality imperatives of the 1990s warrant that problems should be prevented, rather than fixed. Coatings over brass should be continous and free of particles, so that the protection is complete. The short life-cycle of your current coatings technique (three–four weeks) shows that your quality declines to a point of unacceptability, which means your parts will be only intermittently reliable. Nickel Plating Pre-dips We nickel-plate parts made from various base metals, and occasionally have adhesion problems. The distance from the acid pickel and the nickel process is long, and the parts are exposed to atmospheric conditions for several min prior to nickel plating. Is there a way to prevent this problem?

A. Whether you are plating over copper, brass of a ferrous substrate with nickel, the surface should be prepared by removing the surface oxidation prior to nickel plating. This can be achieved by the use of a pre-dip, which is usually a mild acid with enough activity to remove the flash rust and mild oxidation. On process systems that have a great deal of time passing from the preparation cycle to the plating bath, pre-dips are very important they can make the difference between success and failure.

Pre-dip solutions should have the following properties:

- They must be amenable to drag-in to the nickel solution. Because pre-dips are either rinsed with a single rinse or not rinsed at all, it is important that the drag-in does not contaminate the nickel bath.
- Pre-dip acids should be clean and uninhibited—high-grade mineral acids work well.
- Pre-dips also serve to collect errant material and prevent it from entering the plating tank, so they should be cheap and replaced often, or purified to remain clean.
- They should be effective at room temperature.

Sample Pre-dips

For Steel or Iron Parts Direct Plating of Nickel over Steel—To remove flash rust that will form on the surface of steel during the pre-plate process, a pre-dip should be used. A simple formulation should be two percent sulfuric acid. If the pretreatment is excessive or if there is a great deal of flash rust on the surface, one to two percent hydrochloric acid should be included.

Woods Nickel—Woods nickel or modified Woods nickel can be used as a pre-dip with current. The electrified Woods nickel will remove flash rust as a chloride and deposit a thin coating of an active nickel on the surface. This will increase adhesion by improving the integrity of the deposit, and also will prevent drag-in of iron to the nickel bath.

Sample Pre-dips

For Nickel over Copper Alloys Whether plating over a copper substrate or over a copper deposit, an acid pre-dip should be used prior to nickel plating. This will remove any oxides that form over the copper surface, or will condition (neutralize) the surface if the copper was plated from an alkaline plating bath, and leave a slightly acidic film.

Sulfuric acid at one to two percent is usually enough to activate and remove any slight surface oxidation prior to plating. Chlorides are more soluble than sulfates, so a small addition of either sodium chloride or hydrochloric acid will help to remove oxidation. Because you are dissolving copper as copper, the oxide and the copper will exist in ionic form in the bath and will have to be replaced often to prevent drag-in of copper into the nickel bath. The copper in the predip solution may also immersiondeposit onto the surface of the parts, if the concentration is allowed to get too high.

Shop Talk from Marty ... Energy & the Environment: A Winning Combination For Sustainable Development I have talked in the past about sustainable development of the metal finishing industry, as well as of other North American industries that are under attack by offshore competition that does not experience the same level of regulatory and societal restraints.

We need to approach our production imperatives with conservation of our industry assets, and implementation of ingenious techniques to become—and remain—world-class competitors. One of the areas of weakness in our industry is the use and application of energy resources. Even though our industry is a heavy consumer of energy—both heat and electric—we do not get the same attention as other industrial segments. Because of the fragmented nature of metal finishing, energy professionals and energy providers, as well as government agencies, do not see the industry as a major beneficiary of a national comprehensive energy strategy.

I view energy as any other commodity we purchase to process our work, and the conservation of these commodities is essential to competitiveness of operations. Environmental issues are closely associated with energy issues. Both are caused by the consumption of incoming commodities and the discharge of unused assets. If environmental discharges are considered wasteful discharges of valuable assets, then the same is also true with misuse of energy. We have the advantage, however, of linking environmental and energy issues, by combining the discharge of both to eliminate waste from environmental discharges and incorporate the appropriate, intelligent use of energy.

We may employ wasted energy to reduce discharges, such as the employment of evaporators for solution conservation and recovery. We may use energy in the form of electricity to recover and purify metal waste streams. If we are able to combine innovative techniques of wasteful energy practices with recovery of our metal-laden effluent, the cost implication is significant.

An example I often use is the employment of steam boilers to provide heat to process tanks. Although a common piece of equipment in a plating shop, boilers are—at the most—65 percent efficient, with 35 percent of the energy conversion going up the stack and into the atmosphere, unused. I have yet to see a shop that has taken advantage of that energy, or is in a position to recuperate that energy loss. A simple flue gas-to-air heat exchanger would help by giving a stream of hot air for use in increasing the amount of evaporation in an evaporator. It takes 8,000 BTU/gal to evaporate wateryour choice is to use expensive, purchased energy, or to use what was "wasted" energy. If engineered properly, the evaporator can also be used as a quasi-scrubber to clean up the flue gas prior to discharge, *i.e.*, using one waste stream to clean another.

More examples of energy applications will follow in future columns. \Box