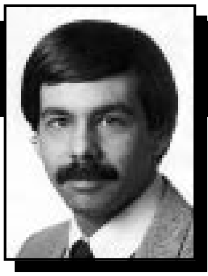

Finishers' Think Tank

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Sustainable Metal Finishing

At a recent meeting of the American Institute for Pollution Prevention, I was privileged to meet Joseph Ling, a retired vice president of technology at 3M Corporation. He and I talked in detail about the integration of environmental concerns and sustainable growth. Developed countries have the technology and the work ethic to move industrial society along the road to enhanced standards of living, as well as to develop methods of manufacturing that will improve the environment as it exists today ... while not compromising the needs of future generations.

Aside from the rhetoric that goes along with a rather new idea, a concept came out of the discussions that I refer to as *good plating practice*: "Produce the highest quality of product possible, while consuming the least amount of materials possible with a minimal impact on personnel and the environment during operation."

Design for Sustainability

A process that integrates all environmental, economic, social, human and ecological concerns, resulting in maximum benefits with minimum use of natural resources, embraces the concept of *design for sustainability*. This is clearly good business and plating practice. By employing this concept, as well as total quality management (TQM) and ISO techniques and concepts, design for sustainability can be an achievable and affordable practice.

The main factor in this type of endeavor is the inclusion of all resources available to our industry—educators, product designers and fabricators—as well as the metal finishers, themselves. A major component of design for sustainability is the effort to include input during the design phase from all who are affected by the product, as well as those who may be able to anticipate a future problem.

One of the "problem areas" concerns waste that is produced from a manufacturing process. When those involved with the waste product—the recycler or post-production waste processor—are included at an early phase of the process, some of the imperatives may be addressed. Waste streams might be configured, for example, so that they are beneficial to the manufacturer.

Turning a Liability Into an Asset

Let's use the example of a producer of a steel product that is plated with copper, nickel and chromium. The waste treatment system adequately pre-treats the effluent to yield a compliant discharge, but the sludge produced contains bits and pieces of all the process systems. It has some iron from cleaners and pickles, some copper from the copper solution, and some nickel and chromium from the associated process systems. As a result, the waste sludge must be sent to a facility that reclaims the metals as a virtually useless copper-nickel-chromium-iron alloy, which has no real economic value.

If thought had been given to the configuration of the waste stream, the copper could be replaced or segregated and the resultant waste materials could become a valuable asset to any manufacturing process that deals with ferro-nickel-chromium materials, as in the manufacture of stainless steels. The isolated copper could also be used in a process that requires fairly pure copper input. The waste stream, therefore, becomes an asset, rather than a liability.

Obviously, there are many factors on different levels that need to be considered. The inclusion of non-traditional participants in the structuring of a manufacturing process system, however, will become more common as we continue to travel the road to sustainable development in metal finishing.

To paraphrase a comparison Joseph Ling made between sustainable development and riding a bicycle: *If you pedal, you move forward; if you stop pedaling, you don't. Coasting will only carry you so far—but if you're going to coast, the only way to go is to coast downhill.*

Importance of Pre-dips

Q. We are running various substrate materials in a system that deposits bright nickel for decorative purposes. We sometimes experience surface problems in the interface prior to the nickel, such as a slight particle roughness or, at its worst, an adhesion problem. How can we correct these problems and make the system more reliable?

A. Whether or not you are plating over copper, brass, or a ferrous substrate with nickel, you should prepare the surface 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 between the preparation cycle and the plating bath, pre-dips are very important—they can make the difference between success and failure in a plating operation.

Pre-dip solutions should include the following properties:

- They must be amenable to drag-in to the nickel solution. The acid used should be non-contaminating to the nickel bath and, because the 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.
- They should be clean and uninhibited. Good grades of mineral acids should be used.
- They should be inexpensive and replaced often (or purified to remain clean). This last station before the plating tank can be used to collect errant material, and prevent it from entering the plating tank.
- 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 can form on the surface of steel during the preplate process, a pre-dip should be used. A simple formulation should be 2 percent sulfuric acid. If the pretreatment is excessive, or if there is a great deal of flash rust on the surface, 1–2 percent of hydrochloric acid should be included.

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 increasing the integrity of the deposit, and also prevent the drag-in of iron to the nickel bath.

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. It also will condition the surface by neutralizing the surface if the copper was plated from an alkaline plating bath, and will leave a slightly acidic film.

Sulfuric acid at 1–2 percent is usually enough to activate and remove any slight surface oxidation prior to the nickel plating sequence. Because chlorides are more soluble than sulfates, a small addition of either sodium chloride or hydrochloric acid will help remove the oxidation.

Because you are dissolving copper as copper, the oxide and the copper will exist in the ionic form, and the bath will need to be replaced often to prevent the drag-in of copper into the nickel bath. Also, the copper in the pre-dip solution may immersion-deposit onto the surface of the parts if the concentration is allowed to get too high. Following these simple steps should help achieve better finishing results.

Cyanide Pre-dips

Q. Is it necessary to use a sodium cyanide dip before cyanide cadmium plating on steel? When we don't pre-dip, we run into problems with blistering and adhesion.

A. Boy, do I love cyanide in a preparation process! It saves us from ourselves and opens the window to pretreatment parameters ... but the answer to your question is "No." When plating cadmium onto steel, you are depositing from a process solution that is very forgiving, in terms of cleaning and deoxidizing. High-cyanide concentrations in this type of plating solution usually allow for amazing forgiveness in processing questionably clean parts. Cyanide also has the ability to do a bit of deoxidizing of the parts—light scale and flash-rusting will be removed. If you are having a problem plating over simple steel parts with this kind of a solution, however, the reliability of your preparation cycle should be examined.

Pre-dips may be used to address some specific problems associated with processing of steel parts. Sometimes, when operating in a hard-water area, the pre-dip will remove some films and surface-precipitated materials. Hard water is characterized by containing concentrations of calcium, magnesium and iron. Calcium is especially a problem because it forms insoluble species with many different materials, both organic and inorganic. These films can be handled by a cyanide pre-dip, and the surface may be prepared for further processing, but if proper attention is paid to the preparation processing, it should not be necessary.

A good, solid preparation cycle is recommended to remove soils, scales and oxidation prior to plating. The following cycles will be adequate to prepare steel parts for further plating of mild steel parts, without major scale on the surface.

Remember to add the quality of the incoming water to the equation when addressing preparation problems and products. In hard-water areas, cleaners should have water softeners built into the cleaner system; otherwise, an external water softener may be needed.

A sample pretreatment system for steel is: Soak clean in a mildly alkaline cleaner to remove any greases and oils; electroclean with a highly alkaline electrocleaner; and then acid pickle with a mineral acid to remove rust and light scales (rinse well between each step).

If there is a great deal of rust or heavy welding scale, run the following cycle: Soak clean with a mildly alkaline cleaner; electroclean with a highly alkaline electrocleaner; electrolytically pickle with a mineral acid, parts cathodic; electroclean with a highly alkaline electrocleaner; and then mild acid dip with a mineral acid (rinse well before processing).

There is no substitute for a good preparation cycle—a dip that hides problems with an inadequate preparation cycle will only be temporary. Another problem with a cyanide dip is that it must be waste-treated before discharge. Iron cyanide complexes, which will form by the deoxidation of the parts, create havoc with conventional waste treatment systems, and special processing cycles must be used to destroy the iron complexes.

Finally, if the preparation cycle is inadequate, use of a pre-dip will not work for all degrees of problems. Results will be unpredictable and product quality inconsistent, which is unacceptable in our industry today. ❑