Autodeposition: Tough Coatings and No VOCs

Thomas C. Jones, Technical Manager, Parker + Amchem (Madison Heights, MI)

The metals finishing industry is undergoing major changes. The primary reasons for these changes are increasingly stringent environmental regulations; rising costs for material, labor, and waste handling; increasing quality requirements; and the need to paint preassembled workpieces, which are often composites of metal and heat-sensitive plastics.

To overcome these challenges, more and more finishers are turning to autodeposition, a waterborne process that depends on chemical reactions to achieve deposition. To date, the process has been used to coat over 1 billion ft² (93 million m²) of metal. There are currently 20 autodeposition lines operating in North America.

Autodeposition features no heavy metals or solvents, low-temperature cure, and high-corrosion resistance. It uses a mildly acidic paint bath, made with Parker + Amchem's Autophoretic coating chemicals, that solubilizes positively charged metal ions from the workpiece's surface. The ions react with negatively charged paint particles dispersed in the coating bath to form a deposit on the workpiece surface.

Coating thickness is time and temperature related. The coating continues to grow as long as ionic species are being produced at the coating/metal interface. Initially, deposition is rapid, but it slows down as the film begins to build. As long as the part is in the bath, the process will continue; however, the rate of deposition will decline. Film thicknesses are typically controlled from 0.5-1.0 mil.

Unlike conventional systems, the autodeposition process does not include phosphate conversion coating stages and associated rinse cycles. The equipment used for other stages (cleaning, rinsing, painting) is the same as that used for other immersion finishes. In fact, several companies have built autodeposition lines by converting stages previously used in other systems like phosphating and plating.

The physical and corrosion-resistance properties of autodeposited coatings depend on the chemical nature of the organic resin used to make the paint particles. Autophoretic 800 Series coatings are formed from products based on a polyvinylidene chloride latex resin. The low-cured (220°F [104°C]) films are flexible and hard, and provide excellent corrosion resistance. The process is totally free of solvents or heavy metals. The 700 Series, based on acrylic chemistry, offers resistance to a variety of solvents at high temperatures. This process uses a small amount of coalescing solvent
(1.6 lb/gal [0.19 kg/L] VOC) and chromium in the final sealing rinse. It also cures at a higher temperature (350°F [177°C]) than the 800 Series. The deposition mechanism and chemical control of the two systems are identical.

**Benefits**

**Waste treatment reduction.** Since the 800 Series does not contain VOCs (volatile organic compounds), it is not necessary to scrub or otherwise control emissions. Elimination of phosphate pretreatment eliminates the need to precipitate and landfill potentially hazardous metals like zinc and nickel. Discarded paint solids can be flocculated, filtered, and treated as nonhazardous waste. Further, you can treat overflow from alkaline cleaners and associated rinses using standard methods. The minimization of waste also reduces treatment and disposal costs.

**Cost savings.** Comparative analyses with conventional paint systems show that autodeposition systems occupy 30–35% less floor space, while providing a finish capable of withstanding rugged conditions. The savings result from the elimination of phosphate pretreatment and rinses, as well as reduced oven length because of lower cure temperature requirements. This means a lower capital investment because you do not have to buy equipment for these stages. Moreover, because of the process’s simplicity, you can convert existing systems at relatively low cost. A new system, requiring less space and equipment, will also cost less. The low-temperature cure also saves energy.

Further cost-saving areas include rack stripping and maintenance. Once a rack is coated, the metal is protected from further reaction and coating deposition, preventing additional coating formation. Fewer stages mean reduced maintenance of both equipment and chemical process baths. Autodeposition requires no electrodes, rectifiers, or other potentially troublesome equipment.

**Versatility.** Many automotive components combine organic materials with steel. The higher cure temperatures required for conventional solvent paints can destroy these materials. Solvent-free, low-cure autodeposited films eliminate this problem and easily coat plastic/metal components. Examples of successfully coated parts include fully assembled leaf springs and seat components with plastic handle covers and nylon connections.

Autodeposition also enables painting of severely recessed or blocked areas that are difficult to coat by other methods. Wherever liquid wets the surface, a protective coating is produced. This deposition mechanism avoids problems with electrical shielding, which limits application of electrophoretic coatings. In electrocoating, the electric field weakens as it enters a recessed area (because of the Faraday cage effect), resulting in gradually diminishing film builds. Electrostatic spray and powder paint systems suffer from the same electrical shielding effect.

**GM’s Success Story**

One company reaping the benefits of autodeposition is General Motors’ Harrison Radiator Plant 3 in Buffalo, NY. Recognizing that their century-old facility needed updating, Harrison engineers and officers from United Autoworkers Local 634 formed a task force to research, select, and install a new finishing system.

What sold Harrison on autodeposition? “We were interested in a modernization that centered on improved productivity, worker safety, and better environmental performance,” says Raymond McGinty, senior manufacturing engineer. Autodeposition provides these and more. For example, attributable to the new system, Harrison was recently awarded a new steel blower case for various models for 1992. Housings for eight models now go through the plant. This number will increase with the in-

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**TYPICAL PROCESS SEQUENCE**

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>DURATION (MINUTES)</th>
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<tbody>
<tr>
<td>SPRAY ALKALINE CLEAN</td>
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<tr>
<td>DIP ALKALINE CLEAN</td>
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<tr>
<td>DIP AND OR SPRAY WATER RINSE</td>
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<td>DEIONIZED WATER RINSE</td>
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<tr>
<td>DIP AUTODEPOSITION BATH</td>
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</tr>
<tr>
<td>DIP WATER RINSE</td>
<td>1</td>
</tr>
<tr>
<td>DIP REACTION RINSE</td>
<td>1</td>
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<tr>
<td>CURE (CONVENTIONAL)</td>
<td>20-30</td>
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</tbody>
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Harrison Radiator’s autodeposition line.
Blower housing coated using autodeposition.

increased plant capacity. Harrison currently turns out nearly 7000 blower air inlets per day. As the third shift, once required for clean-up, comes on line for production, the paint line will be capable of running 24 hours per day, five days per week—a 50% capacity increase over the previous system.

Harrison has also significantly reduced non-value-added time. "With the new system," says McGinty, "we've cut nonproductive time per part from 1 hour 26 minutes to 13 minutes."

According to McGinty, benefits began with the decision to have plant people install the line. "Aside from saving on the upfront cost of putting in the equipment," he says, "it will save down the road because our people are more familiar with it. If we have problems, they'll be able to handle them better."

Operational advantages are already substantial a few months after start-up. "By eliminating paint cleanup," explains McGinty, "we did away with one of the dirtiest, nonproductive jobs." John Benoit, assistant superintendent of Manufacturing Engineering, adds: "Much of the cleaning was aimed at stamping out fire hazards. The autodeposition system eliminates this risk."

Harrison is saving money and energy, as well. Steam consumption to heat the new system's insulated tanks is one-third of that used to heat the old stripping tank. Moreover, the company estimates they're saving $150,000 in heating costs. The more efficient infrared oven also uses much less electricity than the previous one.

While it's too early for exact comparisons, figures indicate that the reject rate is also decreasing. "If a part has a scratch," says McGinty, "we just hang it and repaint it. The system paints that mark only—nothing else."

In addition to using less plant space, the shorter conveyor line also simplifies materials handling. The old system required transferring parts from the press room all the way to the back of the plant and then back. But, as McGinty points out, "that was not in line with synchronous manufacturing. With the new process, we've moved the entire paint area next to the press room. We go directly from stamping, and within five minutes we're in the wash area."

Finally, the autodeposition equipment facilitates preventive maintenance because parts are easier to remove and replace when necessary. Instead of weekly routines, Harrison now performs monthly checks and perhaps filter and dryer changes. Further, because the plant workers installed the system, they're better troubleshooters. Harrison estimates annual total savings on operations could add up to $600,000.

An Eight-step Process

Harrison's operation begins with a prespray to remove most of the oil and dirt from the part. Next, the system applies an alkaline spray at 150–170°F (65–77°C). If the spray misses any area on the part, it is cleaned in an alkaline immersion step at 150–170°F.

Step three applies a plant water rinse at ambient to 120°F (49°C) to remove the alkaline cleaner. The part then moves through a deionized water rinse for 60 seconds. Next, the system applies the organic coating for 120 seconds at 70°F (21°C). A 60-second water rinse at ambient temperature removes excess material. To tighten the paint bond, step seven is a 60-second reaction rinse. The last step is a four-minute cure in an infrared oven.

The system moves at the same speed as the old one—25 fpm (7.6 m/min). Its overhead conveyor is 1600 ft (487 m) long. One cycle takes 64 minutes. The old system's conveyor was 4500 ft (1372 m) long, with one cycle taking three hours.

Plant officials agree that the savings in time and costs have positioned Harrison Radiator for the future. "We're competitive head-to-head," says Wayne Bank, plant manager. "That gives us confidence to go after other business within the division and outside it. We're going to be more aggressive in looking for other opportunities."

Future Developments

With autodeposition, it's possible to produce high-performance coatings on zinc without compromising quality. This requires modifying the paint bath chemistry and paying close attention to the cleaner formulation to prevent excessive substrate dissolution. Efforts are under way to develop the process for commercialization. Also under investigation are barrel coating techniques for bulk coating small workpieces such as fasteners.

Pilot trials have uncovered many prospective topcoats for use over Autophoretic-primed parts. Examples include water-reducible alkyds and acrylics and low-cure urethanes. Since any primer-topcoat system has critical capability requirements, it is necessary to thoroughly evaluate topcoat candidates for application and performance prior to production trial.
FINISHING West '90

Plans are well under way for the FINISHING West '90 Conference and Exposition, September 25–27 (Anaheim, CA). Sponsored by SME and AFP/SME, the conference will explore advancements in painting and coating technologies. Specifically, attendees will learn about developments in liquid and powder coatings, surface preparation, robotic finishing, computer design applications, environmental regulations, compliance, and waste management. Session titles and times are as follows:

TUESDAY
September 25

8:00–11:30 am
Hazardous Waste and Environmental Considerations

Topics:
- "Dilemma: How Precise are Paint VOC Measurements?"
- "EPA Compliance with Modular Regenerative Oxidation for Low Solvent Paint Finishing Processes"
- "Market Study of Paint Spray Booth Solvent Emission Control Systems"
- "Waste Minimization & Resource Recycling in Paint Booth Operations"
- "Water Wash Spray Booth Design and Considerations"

11:30 am–1:00 pm
Group Luncheon

Keynote Speaker: "Regulatory Compliance in a Nutshell,"
Bill Milner, air quality engineer, South Coast Air Quality Management District (El Monte, CA)

1:00–5:00 pm
Hazardous Waste and Environmental Considerations (cont.)

Topics:
- "Effects from Treatment of Paint in Water-Wash Spray Booths on Waste Classification and Management"
- "Designing Environmental Compliance into a World Class Finishing Operation"
- "What Does Solvent Recovery Have to Do With Land Bans?"
- "High Performance Aluminum Pretreatment Virtually Eliminates Hazardous Waste Generation"
- "Recent Developments in Air Quality Regulations"
- "Environmental Regulations and Waste Management Alternatives for Compliance"
- "Pollution Abatement of Metal Finishing Wastes"

THURSDAY
September 27

8:00–11:30 am
Paint Systems: Processing

Topics:
- "Optimize Your Finishing Line Through Laboratory Analysis and SPC"
- "Plastics Finishing at Mazda Motor Manufacturing, USA"
- "Planning and Implementing Statistical Process Control on a Powder Paint Line for Aluminum Alloy Wheels"
- "Powder Coating: Doing It Right the First Time"
- "Coating Removal"
- "Sandroid Robot Blasts US Navy Ships"

The FINISHING West exposition offers the chance to see the latest finishing and coating systems in action. Suppliers will present new applications and methods for finishing fabricated metal products and computer, transportation, and electronic equipment. To date, the following companies have reserved exposition space: Adjust-A-Rak, Air Technologies, Bessam-Aire/Accu-Spray, Calgon Vestal Laboratories, Cardinal Industrial Coatings, C-E Air Preheater, Dinamec, Elektro-Physik, FAR-BOIL Powder Coating, Frederick Gumm Chemical Co., Hankison, Division of Hansen Inc., Koch Membrane Systems, Might Hook Div., Nalco Chemical Co., Nordson, Paint-O-Matic, Special Plastic Systems, Swen Sonic Corp., Jervis B. Webb Co., and XYTEK Products. For more information, contact Beth Magewick at SME, ext. 341.