Electrostatic Application of Water-Borne Paints

Spraying water-borne paint electrostatically has been improved by equipment innovations...

By MICHAEL J. DIANA
Binks Manufacturing Co.
Franklin Park, Illinois

Solvent-borne paint has been sprayed electrostatically for a long time. But with the development of water-borne paints, problems have surfaced with this coating method. Several years ago the automotive industry tried to paint cars electrostatically using water-borne paint, and the results were catastrophic.

The major problem, beside the pumps and spray gun needle packing, among others, was the paint itself. After solving formulation deficiencies such as poor adhesion, insufficient hiding, and temperature and humidity sensitivity, water-borne paint still could not be sprayed electrostatically. By its very nature, it was too conductive. The solvent-borne paints, which were readily sprayed electrostatically, had a conductivity of 20 megohms to 0.05 megohm, compared to water-borne's 0.01 megohm or less.

Electrostatic equipment used to spray water-borne paint often shorted out because of electricity feeding back from the spray device through the fluid line to ground.

Rerouting the Fluid Line. The first attempt at resolving the shorting-out problem was to change the fluid line routing, which was normally grounded near the spray devices. After isolating the fluid supply from an earth ground using an isolation stand, the water-borne paint could be sprayed electrostatically (Figure 1). The fluid supply was now charged at the same voltage as the spray device (60,000 to 120,000v). For safety, a cage surrounded the pressure vessel. This method worked well and is still used for applying single colors. In situ-
1. TYPICAL ELECTROSTATIC installation for water-borne coatings

Pressure Tank or Material Pump
Electrostatically Charged to 00,000 to 120,000 VDC

Plant Air

Oil and Water Extractor & Air Control

Atomizing Air
Fluid Hose
Spray Gun

Cylinder Air
Solenoid Valve

Stand-Off Valve

Power Supply
Isolation Cage

Nylon Air Hose

Isolation Stand

High Voltage Cable

2. TYPICAL INSTALLATION with three isolation stands for faster color changes.

JULY, 1992
Spray Painting

ations where rapid color change is required, it is not a practical application method.

**Blocked-Charge Design.** The next innovation involved increasing the number of isolation stands and incorporating air and solvent valves to purge out the last color sprayed. This method decreased color change time but had some drawbacks. As shown in Figure 2, the three containers on isolation stands are electrostatically charged simultaneously. This arrangement makes it harder to maintain isolation and adds capacitance to the system, which increases the chance of an electrical discharge.

Once one reservoir is filled with paint, it is isolated from ground via a solvent and air purge, which flushes the voltage blocks. This sequence occurs during the purge and fill cycles. Once this cycle is complete, the device waits for a signal to spray.

For added safety, a pneumatic ground leg is attached to each reservoir. While the device is spraying, the ground leg is energized. While one reservoir is spraying, another prepares for the next color to be sprayed. This simultaneous action provides the system with the ability to purge in 10 seconds. In the event of an electrostatic power supply overload, the pneumatic ground legs for both reservoirs are de-energized, eliminating all chance of a high-capacitance discharge.

This blocked-charge design uses three flow meters for loading and dispensing paint. The flow meter measures the volume of paint required in the selected reservoir. Once the required volume is met, the color valve closes. An air bubble is inserted behind the paint and then the air valve is closed. This air bubble is followed by a water push. The water pushes the paint to the selected reservoir, replenishing it. This technique for refilling the reservoirs allows for minimal paint loss between the color changer and the voltage block.

To monitor and control fluid flow, a fiber optic flow meter is located between the reservoirs and the spray apparatus. The flow meter, an I/P (amps to pressure) transducer, an air-piloted fluid regulator and a computer with PID (proportional integral) control the paint volume output. The selected color is sprayed at a preselected flow rate.

**Transfer Efficiency.** When water-borne paint is directly charged, as with an isolation stand or a voltage block, the transfer efficiency is 50 to 65 pct for spray guns and about 90 pct for rotary atomizers. With an indirect charge, the transfer efficiency for spray guns is 30 to 40 pct and 70 to 80 pct for rotary atomizers. Because water-borne paint is lower in solids than solvent-borne paint, more paint is needed to achieve the proper film build. This makes transfer efficiency more important. An increase in transfer efficiency means less paint is needed to meet paint standards, thus saving money.

With regulations already passed in some states and soon to come in others, a minimum of 55 to 60 pct transfer efficiency must be achieved by all paint facilities, or heavy fines will be imposed. Clean air regulations are an-
other concern. Overspray no longer will be allowed to go out the stacks. Plants also face the problem of paint sludge disposal. Much of this material is classified as hazardous waste and is expensive to dispose of.

Transfer efficiency determines how much sludge a facility will have to deal with. The higher the transfer efficiency, the lower the disposal costs. At present, blocked charge is the only process able to meet automotive industry standards.

**Continuing Developments.** As time went on, several more approaches were tried to overcome water-borne paint isolation problems. One was a grounded paint container that employed a metering orifice to break the coating into droplets that then fell into an isolated electrostatically charged tank (Figure 3). To improve this process, a vibratory device was added. This provided better control of droplet size, which lessened the chance of shorting out to ground.

Next, the orifice was replaced with a spray nozzle. This atomized the coating differently. All of these methods had similar problems. When paint accumulated on the walls of the nonconductive tube the electrostatics shorted out to ground. It was hard to continuously maintain the droplet size with different coating formulations. Also, these methods aerated the paint, which caused additional difficulties.

Color changes were still too time consuming. Many other approaches along these lines were tried with minimal success in meeting automotive finishing standards.

**Indirect Charging.** A more recent development has been the use of an external probe (Figure 4). Using a non-electrostatic spray gun and placing a probe near the emerging atomized droplets, the paint is electrostatically charged. A charging ring around a rotary atomizer has the same effect as the probe. The atomized droplets are charged while passing through the electrostatic field.
These two methods are known as space or indirect charging, which does work and is being used with some success at automotive plants in the U.S. and abroad. The main disadvantage of these approaches is the lower transfer efficiency achieved by indirect charging.

**Voltage-Block Technology.** Advancements in water-borne paint formulation, computer technology, plas-1ics and controls have made possible the development of the voltage-block method. A voltage block interrupts electrical flow between the spray device and the grounded paint supply so that water-borne paint can be sprayed electrostatically.

One form of voltage block is created using a peristaltic pump and adding multiple rollers and coils of tubing. The theory is that the rollers squeeze the coating material into slugs, interrupting the electrical path and forming a voltage block. At present there is little information available on this method.

**Block-Charging Method.** A different approach is block charging. A block charge is a form of voltage block accomplished by inserting an isolator between the grounded material supply and the electrostatically charged paint. In this design paint is loaded from a color changer to the spray guns. Once loaded with the coating material, the color changer purges through a plastic manifold and valve, isolating the paint and grounded color changer. The paint then can be electrostatically charged.

This first method worked, but the hose length and inner diameter limited the volume of material that could be sprayed. Also color changing took too long to be practical. To resolve some of these problems, a reservoir and a flow meter were added (Figure 5). The design is no longer dependent on hose size and length, and the paint volume loaded into the reservoir is controllable. Because of the addition of a reservoir, which increases the system's capacitance, a pneumatic ground leg...
has been added to discharge the system when not spraying. If a high-voltage overload occurs, the leg eliminates all chance of a high-capacitance discharge.

The voltage block shown in Figure 6 is the most advanced blocked charge design. This design uses two reservoirs with a measured volume of paint to spray a specific job.

Because of recent breakthroughs in spraying water-borne paints electrostatically, it is now not only possible, but desirable. Current state-of-the-art water-borne paint applications methods consist of old approaches enhanced by new methods developed with today's technology.

Reprinted with permission, 1994, Society of Automotive Engineers, Inc.

More Information?
To obtain more information on products or processes mentioned in this article, circle corresponding numbers on the Reader Service Card.
Electrostatic application of water-borne coatings ........................ Circle 287
To request an additional copy of this article, write on company letterhead to "Reprints," c/o PRODUCTS FINISHING, 6600 Clough Pike, Cincinnati, OH 45244.

EPI Electrochemical Products, Inc.
17000 W. Lincoln Avenue
New Berlin, WI 53151-2781
Phone 1-414-786-9330
FAX 414-786-9403

Next Month in PF—
Plating Pollution Control

JULY, 1992