Industrial Paint Application Technology: An Overview

Photos courtesy of Tnemec.

by Cynthia Challener,
JCT CoatingsTech, Contributing Writer

Paint application technology depends on the type of coating and the nature of the substrate. The major types of coatings—liquid, powder, UV-curable—are all applied using different methods. Choice of technique can also be determined by the specific application. Architectural coatings are applied differently than industrial and automotive finishes. Liquid coatings can be applied with brushes, using spray technology, or via continuous methods such as roll, curtain, and air knife technology. The application of powder coatings is typically done via electrostatic spray technology. UV-cured coatings, which can be solvent-free, water-based formulations, or powder materials, can be applied in a variety of ways. No matter what the coating type or the application methodology, transfer efficiency and uniformity remain the critical parameters that continue to be addressed by research and development efforts.

Spray systems are one of the most prevalent technologies for applying paint to various substrates. There are three major types of spray systems—those that are air driven, those that are airless, and those that rely on electrostatic interactions to attract the coating to the surface. Liquid paint sprayed via air spray or high volume low pressure (HVLP) techniques can be found in automotive, refinish, wood, and general industrial applications. Airless systems are typically used by painting contractors for residential repair, new construction, maintenance, and institutional applications. Both liquid and powder coatings can be applied using electro-

static techniques. Manual and automatic electrostatic systems are used by the metal finishing, custom coating, and OEM markets including automotive, appliance, lawn and garden, and general metals.

The key issue for manufacturers of paint application equipment is the need to meet customer demands for increased efficiencies in the paint application process. "Suppliers need to bring to the market products that allow users of paint application equipment to do more with less time, effort, or expense," says Larry Robertson, general manager with Azimuth Spray Systems, LLC, www.spraysystemsonline.com, a business to business e-commerce site for professional paint application equipment. "Process technology innovations typically provide greater transfer efficiency, through-put, or flexibility for our customers," notes Vince Dattilo, manager, applications technology and development centers with PPG Industries.

Advancements in paint application technology tend to be improvements on existing techniques. "In general," says Mr. Robertson, "most new products on the market today are refinements of existing proven products. Incremental engineering and design changes are providing additional value in small steps." These changes also impact the coatings manufacturers as well. "With each new applications process innovation, there is a ripple effect resulting in the need to adjust, change, or otherwise reformulate coatings to work within the new applications process," explains Mr. Dattilo. Mr. Robertson adds that the ability to access information and complete transactions on the Internet has made it easier for suppliers to communicate with their customers.

As a coating formulator, PPG has found that many developments in paint application technology are driven by a specific industry. As an example, the automotive industry has focused on the advancement of the "metallic bell," atomizer for spray applications over the past several years, according to Mr. Dattilo. Overall, though, he sees a consolidation of application processes and atomizers. "We are closer today to an ideal applications process than we were 10 years ago, and many atomizers and process configurations are beginning to look and perform in a similar fashion," he continues. At the same time, many customers are looking for customized solutions for their coatings applications needs. "A challenge for coatings suppliers like PPG is keeping many generations of coatings products active where the combination of coatings and processes becomes more varied," Mr. Dattilo adds. John Ashworth, manager of paint products for ABB, also notes that the efficiency of the paint application process can be greatly improved with the addition of smart automation, such as robotics.

In the future, Mr. Dattilo expects to see a continued evolution of the bell atomizer and the eventual stabilization of its change for both liquid and powder coating applications. Issues do still need to be addressed with regard as to how to achieve direct charge in waterborne coatings, or charging/handling of powder coatings. The other area that Mr. Dattilo would like to see addressed is the use of real-time data in the application process. Currently there are systems that capture and process data for later analysis. "Unfortunately, we do not yet see the ability to capture real-time data, make an analysis of that data, and then provide suggestions through a direct connection to process variables that will manage the process," he says. "When the process and coatings are in harmony, the outcome is very high first-time-through capability," Mr. Dattilo explains.

LIQUID COATINGS

The major methods for applying liquid paints for industrial applications include spraying (both traditional and electrostastic) for substrates with complex shapes and roll or web, curtain and knife techniques (continuous operations) for less complicated parts. With spray techniques, the transfer efficiency and uniformity of the coating that is applied remain the critical aspects of the coating process. For continuous processes, line speed is also an issue.

Transfer efficiency relates to the percentage of paint sprayed that actually adheres to the substrate. The current standard is 65% or better, according to Professor Raymond Fernando of California Polytechnic State University (San Luis Obispo). The need for improved transfer efficiency originates both from increasing environmental regulations, especially for volatile organic compounds (VOC) and waste minimization, and the obvious desire to keep costs low by using only as much coating as necessary.

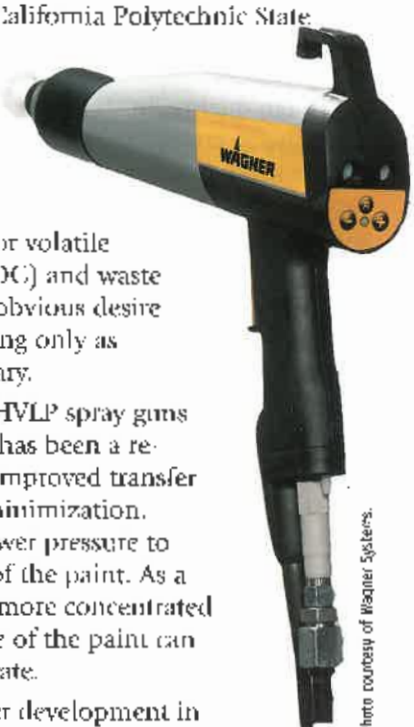

Photo courtesy of Wagner Systems.

The introduction of HVLP spray guns within the last 10 years has been a response to the need for improved transfer efficiencies and waste minimization. These spray guns use lower pressure to spray a higher volume of the paint. As a result, the spray area is more concentrated and a greater percentage of the paint can be applied to the substrate.

In California, another development in the monitoring of spray applications has

been driven by the California Air Resources Board, says Prof. Fernando. Shops with spray operations are testing monitoring devices that utilize laser technology to determine when overspray is occurring. An alarm is triggered if the spray exceeds boundaries marked by laser beams, and the operator is given information so that the spray system can be adjusted.

Spray technology is ideal for many industrial applications where parts are three-dimensional and have many nooks and crannies that are difficult to reach. The automotive industry is one such example, where most of the parts have irregular shapes. In these cases, robots have found great utility as the technology for control of fine movement has rapidly advanced.

ITW Ransburg developed the liquid electrostatic paint application technique and manufactures this type of hand-held and automatic equipment. Products include automatic guns, bells and disks, plus fluid handling equipment. The company recently introduced its high-speed Turbodisk applicator for the aluminum extrusion market. Ransburg's Evolver automatic robot gun and RMA-202 robotic bell atomizer are also new to the market. "These products provide excellent transfer efficiency and atomization with fine particles producing beautiful class-A finishes," says Judith Lietzke, marketing manager with ITW Ransburg. The company also recently introduced a new product called the I-R-O-C (Ransburg Integrated Operating Controls).

ABB is another company offering a full line of products for painting and coating, ranging from robots, atomizers, and process equipment to peripheral devices, such as controls and process system devices. "In today's environmentally sensitive market, paint application technology is driven by customer needs for a consistent, high quality finish part, to minimize energy consumption, remove people from a hazardous environment, and eliminate emissions and waste, all while improving finish quality," says Mr. Ashworth.

The company is most widely known for its Flexline robotic paint applicators. IRB 5400 is a family of paint robots offering accurate painting, high uptime, low paint consumption, short cycle times, and effective integration of paint application equipment, according to Mr. Ashworth. "ABB's unique Integrated Process System (IPS) features closed-loop regulation and high-speed control for paint and airflow adjustment which minimizes overspray and ensures a consistent, uniform film build," he adds.

Photo courtesy of Graco.

ITW Finishing Systems, which offers the Binks and Devilbiss brands of paint application equipment, has recently developed a new method for reducing the mottling associated with wood finishing materials applied through spray equipment. The new internal jet impingement technology has been utilized in an HVLP spray gun for various wood finishing materials including nongrain raising, toners, wiping stains, and topcoats. The technology involves preatomization and uniform pattern coverage and provides reduced mottling and haloing and improved color consistency. Lower atomization pressures are required and less material is consumed as well. "Savings both in time, material, and reject rate could be significant for the wood finishing industry and result in other savings downstream," says Chuck Scott, marketing manager with ITW Finishing Systems. Further studies are being conducted with other materials. The company is also in the process of developing several other new products that will increase the transfer efficiency or improve process capability for a variety of single and two-component applications.

Plural component sprays are another area under investigation by many companies. The application of highly reactive multi-component coatings has been a challenge for the industry because they often react immediately upon being mixed. These coatings are desirable because they perform well in very aggressive and harsh environments. The advent of plural component spray guns, which have two or more nozzles that spray the different components alongside one another, has made the use of these reactive coatings a possibility. The components mix dynamically and get deposited on the surface. Chemical companies such as Bayer have active programs in this area. The U.S. Naval Research Lab is also investigating plural component sprays for use in the application of highly reactive coatings to ship hulls.

While this area remains largely developmental, there are some commercial products. Graco's Industrial/Automotive Equipment Division (IAED) introduced the Xtreme Mix plural component airless spray package in October 2003. The new sprayer is designed for spraying plural-component, protective coating materials used by shipyards, railcar manufacturers, and rebuilders, as well as industrial contractors who paint bridges, water towers, and other structures requiring tough coatings, according to Mark Sheahan, vice president and treasurer with Graco. IAED also introduced the Reactor E-XP plural component proportioner and Fusion spray gun. These products apply high performance coatings and other fast-set

materials, as well as foam insulation and polyurea in residential, commercial, and industrial construction markets.

While spray application is widespread in the industrial setting, Prof. Fernando believes there is much to be learned about the technology behind paint spraying. "There is still much to be understood with regard to the fluid properties of paints," he notes. Studies need to be done on how spray patterns form and what impact droplet size has on them, according to Prof. Fernando. "We also need to learn more about the properties of coating components and what impact each component can have on atomization of the paint. Currently we can use the same application equipment under identical conditions but get completely different atomization properties from different coatings. If we can determine what impact the different components have, we can then optimize the sprayability," he continues. And of course improvements still need to be made in transfer efficiency.

Leading Suppliers of Paint Application Technology

Company	*Technology*
ABB	Electrostatic liquid spray equipment including robotics
Dürr/Behr	Full integrator
Eisenman	Full integrator
Fanuc	Liquid spray equipment
Global Finishing Solutions	Electrostatic and traditional liquid spray equipment
Graco	Liquid spray equipment
Haden	Full integrator
ITW Gema	Electrostatic powder spray equipment
ITW Industrial Finishing (DeVilbiss, Binks)	Liquid spray equipment
ITW Ransburg	Electrostatic liquid spray equipment
Nordson	Electrostatic powder spray equipment
Sames	Liquid spray equipment
Spraymation	Liquid spray equipment
Wagner Systems	Electrostatic powder spray equipment
Companies to Watch	
C.A. Technologies	Liquid spray equipment
Diversified Finishing Equipment	Custom liquid and powder finishing systems
Parker Ionics	Powder application equipment
Titan Tool, Inc	Innovative airless pumps and accessories

From an equipment manufacturer's perspective, the key issues in spray coating are controlling and measuring the application of the coatings, according to Ms. Lietzke. She adds that controlling coating parameters such as air, temperature, and viscosity using closed loop controls is also important. "As paint application technology providers, we must provide solutions for our customers," she says. "We also need to constantly work to improve quality of finish. In addition, first-time-through production and cost reduction remain a key focus of our development efforts. The overall goal is to bring break through technology to the market."

Improvements in continuous coating operations typically relate to increasing the line speed of the process. In coil coating (or roll coating), the coating is applied to a roll of metal sheets that moves through a web of the coating. Once the sheets are coated, parts are fabricated from them. Garage doors and other flat parts are examples of products coated with this method. The thickness of the coating is related to the line speed of the process.

If a part has embossed or textured markings, however, the coil coating process will not maintain the surface markings, but provides a flat coating with thicker areas where the substrate is embossed. In order to retain the design on a part, the air knife coating process is often employed. In this coating operation, a coating roll picks up the coating. Directly above it is a second roll, and the substrate moves in between the two pads. The air knife, which is a thin stream of high velocity air, removes the excess coating from the embossed areas. As a result, the part has the same thickness of coating over its entire surface and maintains the embossed design.

For discontinuous substrates, curtain coating provides a better system for applying paint than roll coating.

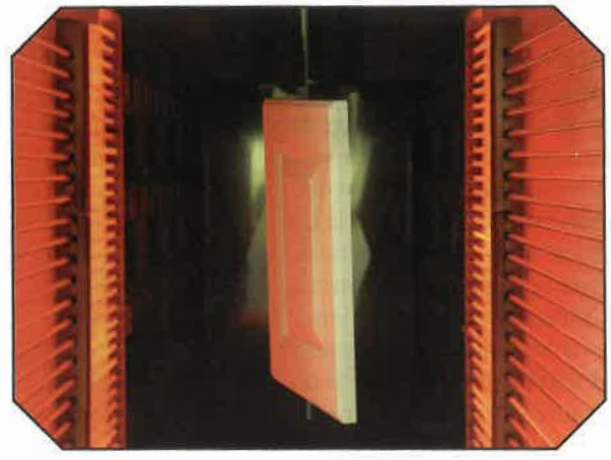

Photo courtesy of ITW BGK Finishing.

Photo courtesy of ITW Gema

The coating cascades through an approximately six foot wide slot. The part to be coated moves on a conveyor belt at anywhere from 200 ft/min to 1000 ft/min. The coating gets deposited on the surface in a thin layer. The line speed is limited at the lower end because the curtain must be maintained. As with coil coating, the thickness of the coating can be maintained by adjusting the line speed. However, there is an upper limit to the speed for curtain coating, as parts will not be coated properly if the line speed is too high.

POWDER COATINGS

Powder coatings are applied to metal surfaces using electrostatic attraction of the paint particles to the metal surface. For nonconductive surfaces such as wood, plastic, and composites, a "prep-coat" is often applied that provides the necessary conductivity. In other cases, moisture in the wood or conductive additives added to a molded part can serve as the source of conductivity. Electrostatic spray provides significantly enhanced transfer efficiency over airspray without electrostatic attraction. The powder application equipment market was flat in 2003 with respect to 2002, according to industry experts. Some companies, however, do expect significant growth in 2004.

"The key issue in powder coating application technology today is just that . . . application," says Carl Kyrk, director of marketing, development & product planning—North America with Wagner Systems, Inc. "Applying powder to the work piece and not into the powder collection system is the key to a future when spraying-to-waste will become the norm. Our goal at Wagner is to develop technological advances that further increase transfer efficiency to the point where powder reclamation becomes passé, thereby increasing productivity. Productivity is the North American advantage. Plants all over North America have line speeds that make other global markets envious. In order to keep manufacturing on our shores, we need to continue to make these types of advances," he continues.

ITW Gema, which manufactures electrostatic powder coating spray equipment, is another company focused on improving the transfer efficiency of powder coating application processes. The company has recently introduced two new products to the market—the EasySystem automated OptiSystem spray guns and controls. "The biggest advantage of these products is their efficiency," says Jeff Hale, marketing manager with ITW Gema. "These products apply powder efficiently and effectively and provide uniform coatings as well," he adds.

One of the newest technologies to be introduced to the market is the Pulse Power powder coating system developed by Parker Ionics and IONTECH. The pulse power system can significantly improve transfer efficiency, particularly on complex parts with "Faraday Cage" areas. Customers have been able to reduce powder consumption by up to 35%, while others have been able to eliminate a touch-up operator. Other benefits include smoother finishes with reduced orange peel and back ionization. Very thick coatings can be applied using the pulse power system, and metallic powder coatings react the same as standard powders. "Pulse power represents a new and clearly different approach to overcoming the 'Faraday Cage' issue," says Mr. Robertson.

Besides transfer efficiency and the desire for uniform coatings, the main issue for application of powder coatings has revolved around the need for faster color changes. "The buzz in the industry is about color change," adds Mr. Hale. "Color flexibility is a big challenge. We need to develop application equipment that allows our customers to get as much product through their process as fast as possible with as much flexibility as possible."

According to Harry Lader, an independent coatings consultant, a full color change can take 15 to 20 minutes and requires two operators to manage it. For companies making 60 to 80 color changes per day, that kind of time and investment of resources is unacceptable. This need, combined with the increased cost effectiveness of powder coatings and improved recycling ability, has resulted in a shift to "spray-to-waste" techniques where the guns and lines are blown out after each color is used to clear them for the next. Mr. Lader also says that booths have been designed with low airflow around the parts being sprayed to help improve

transfer efficiency. Technology has also been developed to minimize the amount of powder that adheres to the walls of the booth, resulting in more powder getting on to the part as well decreased cleaning times.

Wagner Systems, Inc. manufactures a complete range of powder coating application equipment, from manual to fully automated systems. The company's new DuraTech powder spray booth features a transparent roof for a much brighter coating environment and is constructed of U.L. self-extinguishing, flame-rated, durable polymers that also reduce powder deposition on the walls. ITW Gema has also introduced two new recovery booths to the market. Both the Magic Cylinder and Vortech booths have been designed for the extreme color change environment.

Production of the powder coatings themselves is also affecting the application of paints. Paint manufacturers have improved the particle size distribution of powder coatings by removing more of the undesirable fines. The narrower distribution has resulted in reduced waste and greater transfer efficiency. Issues such as chargeability of particles and particle shape are areas that Mr. Lader expects will be investigated in the near future.

Lean manufacturing may also be an issue for the powder coatings application market in the future, according to Mr. Hale. Various companies take different approaches—Six Sigma, Total Quality Management, just-in-time manufacturing—but the overall goal is process improvement. "Before the economic downturn, companies were investing in lean manufacturing programs. These were dropped when cost savings became the major focus. I expect that once the market improves we will see the industry focusing its attention again on lean manufacturing as a way to achieve significant process improvements and address demand flow manufacturing issues," Mr. Hale explains.

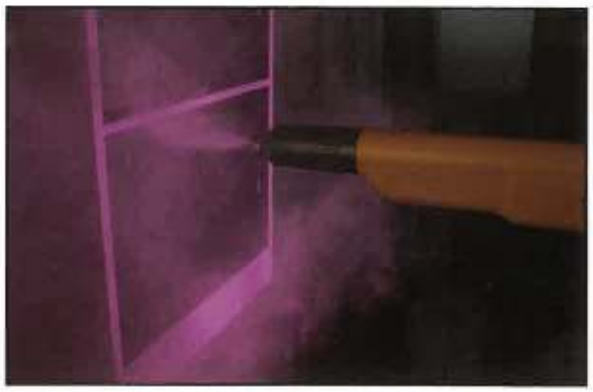

Photo courtesy of ITW Gema.

CURING

Many types of coatings can be cured using infrared technology. Infrared is absorbed by the coating, heating the substrate and the coating, resulting in a quick curing cycle. A major advantage of infrared curing over traditional curing with convection ovens is direct heat transfer—no heat is lost to the surrounding air. Benefits are seen in shortened cycle times, increased productivity, and reduced floor space and energy consumption.

A variety of conveyors, such as chain-on-edge, flat-line, and overhead styles are used to assist in the application of coatings through the curing process. These conveyors are compatible with both liquid and powder application equipment and can be used with infrared, convection, or combination ovens.

ITW BGK Finishing Systems designs, fabricates, and installs electric infrared curing systems with capabilities for curing a full range of coatings including liquid, powder, Teflon, wax, UV, and adhesives. ITW BGK offers focused solutions to a wide range of industrial curing and material handling needs. "We specialize in providing custom conveying and curing systems that fit a specific company's needs, thus ensuring that the customer's process is as efficient as possible" says a company spokeswoman. "Our system advantages include reduced energy consumption, floor space, increased productivity, and premier finished product quality," she adds. The company also offers turnkey system capabilities, process verification, installation, start-up, and training. Recently ITW BGK introduced a new patented IR Smart Lab Oven designed to test coatings and processes using infrared technology.

Photo courtesy of Wagner Systems.