Low-VOC Coatings Meet a Wide Range of Needs

New resin technologies have made many kinds of low-VOC coatings acceptable for a variety of applications . . .

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HILL REFRIGERATION uses a high-solids polyester on its commercial refrigeration units.

FOCUS: Low-VOC Liquid Coatings

How to reduce Volatile Organic Compounds (VOCs) is on the minds of most finishers these days. Fortunately, there are acceptable, low-VOC alternatives for almost every aspect of metal, plastic and wood finishing. The potential solutions range from high-solids coating systems to new, highly effective water-borne coating systems.

Today, low-VOC coatings are available in high-bake, low-bake and air-dry formulas and in one- and two-component systems. Implementing these new coating systems frequently results in not only reduced VOC levels, but also in unexpected benefits, including improved quality and operation efficiency.

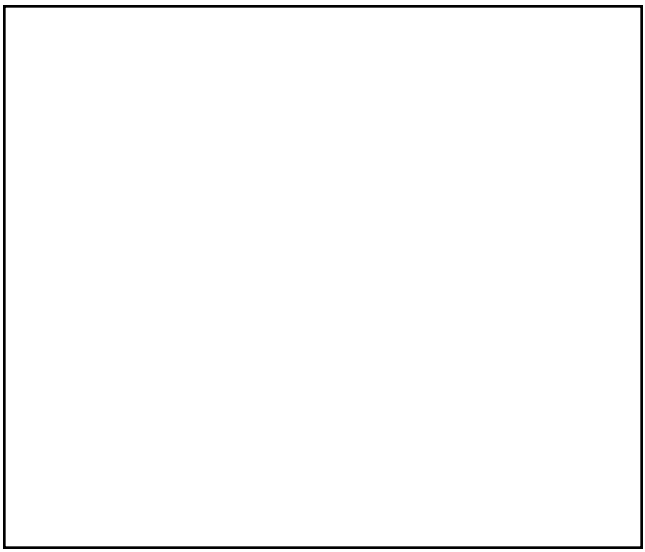
High-Solids Coatings. In conventional coating systems, solvents play an important role in coating performance. By changing the blend of solvents used in a coating, chemists can change the coating's performance and application characteristics significantly. A high-solids coating, however, is one containing fewer solvents. As a result, the role of the solvents in coating performance is diminished. Paint formulators look primarily to changes in resin structure to enhance performance properties, so polymer development plays a significant role in the advancement of high-solids coatings.

Polymer development for high-solids coatings is especially challenging because of the low molecular weights of most of these resin systems (500 to 2,000 range for high solids, compared to 20,000 for conventional resins.) These "lightweight" structures must provide the backbone of the coating system.

Using many different resins, including alkyds, acrylics, urethanes, epoxies, and polyesters, as well as low-viscosity cross-linkers and other modifiers, chemists are creating new and better high-solids coatings that meet the requirements of metal, wood and plastics finishing markets. Alkyds, acrylics, and urethanes are especially popular.

Alkyds. High-solids alkyd coatings are now available that offer excellent flow and dry quickly with no sagging, pinholing or solvent-popping. Earlier efforts at producing fast-drying high-solids coatings resulted in air entrapment, which caused these problems because the surface of the paint film dried while underneath the coating was still wet. A defect-free finish is especially important when a high-gloss coating is being used, since imperfections tend to be readily apparent in these finishes.

Acrylics. New resin developments also have resulted in new air-dry high-solids acrylic coatings that are far more forgiving and user-friendly than previous coatings of this type. The new high-solids acrylic coatings offer good flow, good hardness and durability and excellent color and gloss retention. Some of these coatings may be catalyzed for increased chemical and abrasion resistance, improved hardness, sharper gloss, and excellent color and gloss retention. The addition of the catalyst may slow drying times, however.



KUHLMAN CORPORATION uses a low-VOC, high-solids alkyd topcoat system on transformers.

Urethanes. For high-performance applications, two-component urethane coatings are increasing in use because of their outstanding film properties and low-temperature curing mechanisms. These coatings are made by combining a solvent-borne polyol with a polyisocyanate to create an extremely durable, highly cross-linked paint film.

High-solids urethane coatings are excellent for coating many types of metal, plastic and wood substrates. They are frequently used in the finishing of agricultural equipment, off-road vehicles, and by other demanding industries. These coatings also offer excellent resistance to most lubricants and cutting oils, enabling them to meet the requirements of the machine tool industry. Most often, urethane coatings offer VOC levels in the range of 2.8 to 3.5 lbs/gal.

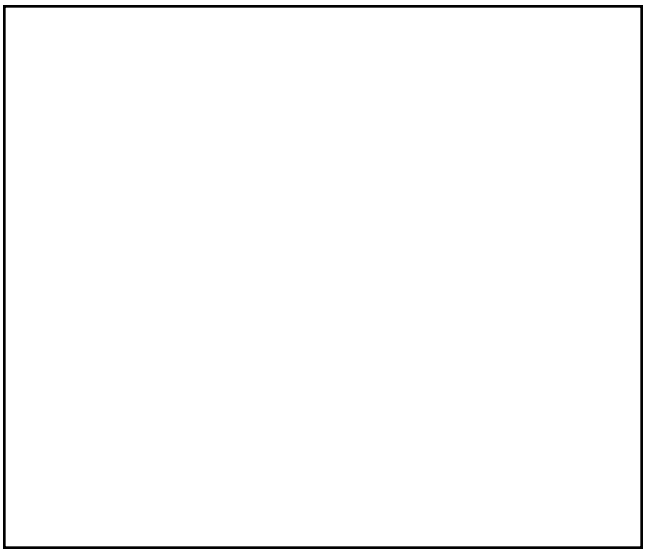
Many manufacturers, such as Grove Worldwide, a Pennsylvania-based manufacturer of mobile hydraulic cranes and self-propelled aerial work platforms, adopt high-solids urethane coating systems to achieve the dual goals of improved performance and lower VOC levels. In the process, unexpected benefits are frequently achieved.

Grove, for example, has found that the high-solids polyurethane coating now used offers excellent corrosion protection and an outstanding appearance, including excellent impact and abrasion resistance, and gloss retention. The coating also has cut oven dry times in half, from 60 to 30 min, resulting in increased efficiencies in the coating operation.

Recently, low-odor two-component coatings have been developed that are easy to apply and offer outstanding physical properties. These developments have been made possible through the use of aromatic solvents not typically used in conventional coatings.

Polyesters. High-solids polyester

baking enamels are high-performance, low-VOC coatings frequently used for exterior and demanding interior metal finishing applications. These coatings offer excellent color and gloss retention, excellent hardness and mar resistance and good one-coat hiding. Typically, they do not require heat or special equipment for application.



HILL REFRIGERATION uses high-solids, low-VOC polyester coatings to protect commercial refrigeration units.

Depending on their specific formulation, these coatings may provide an excellent low-VOC alternative for manufacturers of metal office furniture or for the aluminum extrusion market. Major office furniture manufacturers, such as Steelcase, have found high-solids polyester coatings to meet their needs quite acceptably. Other manufacturers, such as Hill Refrigeration in Trenton, New Jersey, which makes commercial refrigeration equipment subject to severe humidity and abrasion, have found the high-solids, low-VOC polyester coatings to provide excellent adhesion and durability while offering superior color and gloss retention.

In the future, look for the traditional lines between alkyd, acrylic, urethane and polyester high-solids coatings to blur. The development of resins with interpenetrating polymer networks (IPNs) will be the cause. IPNs contain multiple polymers that could have two or more curing mechanisms operating simultaneously. For example, a urethane-acrylic-epoxy IPN could feature simultaneous curing of the urethane with the acrylic and the urethane with the epoxy.

In use. In the past, obstacles to adopting high-solids, low-VOC coatings included higher cost per gallon and difficulty with application. These objections are no longer valid. For example, one manufacturer of small and medium power transformers, Kuhlman Corporation of Crystal Springs, Mississippi, found that a low-

APPLE COMPUTER has a water-borne coating applied to its product for a durable finish.

VOC, high-solids alkyd topcoat system not only meets its strict performance criteria, the system also provides significant cost advantages. The topcoat is a high-solids, high-gloss, air-dry enamel that meets VOC regulations of 3.5 lbs/gal. The coating provides a one-coat finish of up to 1.5 mils and dries to touch in just one hour.

Kuhlman had set a goal to improve quality as well as reduce VOCs. Its performance guidelines required excellent adhesion characteristics, excellent corrosion resistance, fast air drying properties to maintain production schedules, the ability to be applied in temperatures over 100F and above 80 pct relative humidity, compatibility with existing spray equipment and good consistency from batch-to-batch.

According to Mike Beasley, factory superintendent for Kuhlman, the high-solids system is more cost-effective than other products even though the initial cost per gallon is higher. "We found that the high-solids system provided better coverage in fewer passes with less overspray, allowing us to use less paint. In addition, we are able to meet the required coating millage consistently in just three coats, which saves us labor and production costs."

Water-borne Coatings. In the future, VOC laws are expected to become increasingly stringent. In order to meet existing and anticipated compliance needs, coatings manufacturers have devoted significant resources to the development of water-borne coatings, which have the potential to offer very low levels of VOCs. While most water-borne coatings currently available have VOC levels of 2.0 to 3.5 lbs/gal, new products are becoming available with VOC levels below 1.0 lb/gal.

Many finishers, anticipating stricter VOC laws, see water-borne coatings as the ideal long-term solution to their compliance needs. Rather than adopt a high-solids system now and convert to water-borne coatings down the road, these finishers prefer to change coating systems once. Newer water-borne coatings with high-performance characteristics are enabling them to confidently select a system that can meet their needs for years to come.

For years, water-borne coatings were considered inferior to solvent-borne systems, for good reason. Until recently, the technology simply did not exist to create high-quality water-borne coatings. Fortunately this is no longer the case. Water-borne coatings are currently used by many major OEMs serv-

ing a variety of industries, particularly in the business machine and medical equipment markets.

Other advantages. In addition to low-VOC levels, water-borne coatings offer other advantages, such as soap-and-water clean-up, lower odor for improved working conditions, and a high flashpoint that lowers fire hazards, resulting in reduced insurance premiums and increased worker safety. There are new water-borne coatings that perform well on metals, and in the future, look for others offering higher adhesion to a variety of plastics.

Still, water-borne coatings are not for every application. They work best up to 1.2 mils dry-film thickness, and where humidity is high, they take longer to dry, so air circulation or exhaust systems may be needed. Under extremely humid conditions, water-borne coatings require extra time to flash-off. Water-borne coatings typically apply easily by conventional, airless, HVLP, and air-assisted airless spray, though a longer fluid tip for greater atomizing is usually required.

Like high-solids coatings, water-borne coatings are available in alkyd, acrylic and urethane and polyester formulations. Other resins used in water-borne coating formulations include acrylic latex, epoxy and acrylic epoxy hybrids. Acrylic latex formulations are extremely popular for plastics finishing applications, while alkyds and acrylics are frequently selected for general metal finishing applications. Water-soluble epoxy esters and alkyds dominate the automotive components area.

Water-reducible epoxies are most often used as primers that can be topcoated with most other coatings. Frequently, water-borne epoxy primers are topcoated with polyurethanes when good corrosion resistance and high performance properties are required.

Complying with VOC laws. All finishers need to assess the regulatory situation in their local areas. What regulations are on the books today? What tightening in laws or enforcement can be expected? Most rulings are phased in over a period of years to allow finishers to develop a long-term compliance solution. If existing regulations are not currently being enforced, it is likely that they will be in the future.

Though the regulatory net is becoming tighter, substantial research and development efforts and new resin technology have made available many kinds of VOC-compliant coatings. Finishers should find an acceptable range of solutions to the challenge of complying with VOC laws. **PF**

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