

The VOC Factor, Part 2: ADDITIVES

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The first part of this two part series discussed the impact of VOC regulations on resin and paint manufacturers (COATINGS TECH January 2005). In this second installment, the impact that reductions in VOC limits have had on additive producers is presented.

Although additives do not make up the majority of the final paint or coating formulation, they play a significant role in determining the performance capabilities of these products. As resin and paint manufacturers have responded to increasingly strict VOC regulations by switching to different technologies (waterborne, powder, high solids, radiation cure), additive makers have reacted in kind, developing new products that enable their customers to create formulations with the level of performance and functionality demanded by the marketplace. Throughout this period, they have faced and overcome significant challenges.

The difficulties posed by VOC restrictions have been numerous and varied. The biggest challenge has been achieving required perform-

ances similar to conventional, lower-solids coating systems in today's VOC-compliant coatings, according to Del Rector, manager, coating specialties technical service for Eastman Chemical Company. "Everyone knows that additive packages can be quite complex, with synergies and antagonisms among the various additives used. Compliance with VOC regulations, yielding the trend toward higher-solids and waterborne coatings, has made that issue more prominent. Changes in the solvent composition of a coating can drastically alter the compatibility of the raw materials or, in the case of a move to waterborne formulation, completely alter the chemistry required for the materials," he explains. These changes can dramatically impact performance. "Significant investment in product development and reformulation is required on the part of both the additive supplier and the coating manufacturer in order to address this issue," says Mr. Rector.

Specifically, additives suppliers face the challenge of developing new products that do not require a

diluent, or that contain low levels of a VOC-compliant diluent. "They must balance this selection with the additive's solubility and long-term stability in these diluents, and with the end-uses that may restrict the type of diluents that are acceptable," says Steve Knight, coatings sales manager with King Industries. For additives such as coalescing agents, there is pressure for viscosity reduction of additives and a need for the curing speed to remain acceptable, according to William McNamee, senior research associate, Americas, with Uniqema. According to Dr. Gary Horacek, technical support manager with Troy Corporation, eliminating VOCs may result in a switch to dispersions, which do not have the same physical stability as solvent-based products.

Testing is yet another complicating factor for additive suppliers. "In general, there are long testing periods for new coatings formulations resulting in long approval times and lack of clarity in the preferred compliant system. As a result, investment decisions can often be postponed," says Hans Ridderikhoff, Uniqema's sales development manager for Europe. VOC definitions and test methods also vary widely around the world, and a global standard method for the determination of the VOC component of paints needs to be established, according to Dr. William Woods, manager, biocides business development for International Specialty Products (ISP). In addition, because most current test methods were originally developed for solvent-based systems, they often begin to fail as the VOC content is reduced. "Formulators and their suppliers must be aware of test methods and their limitations when formulating lower VOC coatings," stresses Bruce Gustafson, director of global business technology, coatings, with Eastman Chemical Company.

Deciding which new coating technologies to target is also an issue for additives manufacturers. "A major technical challenge for us has been choosing which technologies to latch on to and to support," says Perstorp's technical service manager Jeff Jones. "Additives producers need to support down stream product development in conjunction with their own product development efforts." Dr. Woods adds that, because the additives are new products, it is natural that paint manufacturers expect additives suppliers to provide formulations support as well as to ensure that their products offer both efficacy and compatibility.

Providing such novel products in a cost competitive manner continues to be a challenge, especially at a time when high energy and raw material prices are already resulting in reduced margins for most players in the paint and coatings industry. "Raw materials designed to meet evolving VOC regulations are generally perceived to be higher in cost than conventional materials, and these cost differences can be very difficult to pass on to customers," notes Mr. Rector.

There is also the problem that VOC regulations vary, not only around the world but also from state to state in the U.S. A formulation that is compliant in one state, region, or country may not be appropriate in others. "Given the global and even broad regional nature of much of the industry, this situation can lead to a single manufacturer having multiple—sometimes very different—formulas designed to achieve similar performance in a common application," explains Mr. Rector. Globally, requirements and regulations are diverse per region and application. "Additive suppliers will need to work closely with formulators to understand product needs," adds Mr. Ridderikhoff.

The length of time from development to commercialization also poses a challenge for additive suppliers. The pressure associated with getting new products launched in time to support customers can be overwhelming. "There is a significant challenge in coordinating the marketing campaign with the development process so that the message about new products gets out to customers in a timely fashion and products are ready to be delivered when the orders come through," adds Mr. Jones.

In fact, issues such as logistics, handling, and storage may arise as a result of reformulation to compliant preservatives and additives. "Aqueous products have a freezing issue, which must be accommodated in transit and in storage, and VOC-exempt solvents such as acetone have flammability issues," explains Dr. Horacek.

Despite these challenges, additive suppliers have been able to develop new products that meet VOC regulation requirements. Initially companies focused on the development of new versions of existing products that use VOC-exempt solvents, have reduced quantities of solvents, or have the solvent removed altogether. However, that low-hanging fruit has been exhausted over time, notes Mr. Rector. "As regulations have become more stringent, and end-users have been forced toward ever-higher solids and alternative technologies (e.g., waterborne), additive suppliers have invested considerable time and effort in the development of new chemistries and technologies to meet the needs of coating formulators and their customers."

King Industries has explored solvent-free, lower VOC and HAPS-free versions of commercially available products as well as researched new technologies that may offer formulators an alternative route. The company has introduced solvent-free versions of corrosion inhibitors for powder primers and solvent-free polyester modifying resins that can be used in elevated and room temperature cure applications. King has also increased its technical service efforts in order to demonstrate the proper use of additives in waterborne coatings.

Research on new catalysts by King Industries has led to other new products, including one for reducing the

Table 1—EPA Categories of Industrial Surface Coatings Operations^a

Automobile and Light Duty Truck
Coating/Manufacturing
Boat Manufacturing
Fabric Coating, Printing, and Dyeing
Wood Building Products
Large Appliances
Metal Can
Metal Coil
Metal Furniture
Miscellaneous Metal Parts and Products
Paper and Other Web (Film and Foil)
Plastic Parts and Products
Reinforced Plastic Composites Manufacturing
Aerospace Coatings
Automobile Refinishing
Consumer Products
Shipbuilding
Wood Furniture Coatings

(a) Source: EPA website: www.epa.gov/ttn/atw/coat/coat.html.

cure response of uretdione crosslinking resins that do not release a blocking agent and therefore have reduced VOC emissions. King has also developed a new line of catalysts to promote the homopolymerization of aliphatic epoxies, offering formulators an alternative, formaldehyde-free technology for thermoset coatings based on melamine formaldehyde or urea formaldehyde compositions.

Reactive diluents and aqueous dispersions are two examples of newer technologies. Perstorp has invested in the additives for high-solids coatings. "In addition to additives, we also supply monomers for the alkyd market. We are working to support the changes in the market from an additives standpoint so that the market remains viable," says Mr. Jones. In this area, Perstorp's main focus has been on reactive diluents and high-solids products. Two new products, both dendritic polymers, have been launched under the Boltorn trade name. One is a reactive diluent for high-solids coatings. The other is a polymeric surfactant designed to disperse conventional alkyds into waterborne systems. The company also has an interest in additives for radiation-cured coatings. "Perstorp formed partnerships with far-seeing companies several years ago to develop precursors for rad-cure formulations so that customers can convert their products from more traditional formulations to ones that are appropriate for this new technology platform," Mr. Jones adds.

ISP has developed new products by using non-volatile carriers and aqueous dispersions. The company has new low-VOC, low-odor formulations of mildewcides and in-can preservatives sold under the trade names Fungitrol® and Nuosept®. "ISP will continue to

guide the formulation of products in accordance with the principles of green chemistry and green engineering," notes Dr. Woods.

Troy Corporation successfully developed and commercialized solvent-free, VOC-free water-based preservatives. Polyphase® 662 and 663, two broad-spectrum fungicide/algacides, and Polyphase 678, a full-spectrum fungicide, are the company's latest zero-VOC dry film preservatives that provide optimum activity against a wide range of microorganisms and also offer broad compatibility, high stability, excellent toxicology profiles, and safe handling. Mergal® K10N is a zero-VOC, in-can preservative for use in low-VOC paints and coatings that offers fast-acting, long-lasting efficacy, as well as broad pH compatibility and a higher partitioning rate into the water phase of the paint.

Troy is also promoting several other specialty additives that enhance the performance of low- and zero-VOC latex coatings. Troysol™ LAC is a multipurpose, silicone-free additive that improves substrate wetting, coating flow and leveling, adhesion, gloss, and color uniformity in aqueous coatings when performance has been lost due to the removal of solvent. Troykyd® D734 and D740 are low-VOC, high-performance defoamers offering excellent bubble-break performance, elimination of microfoam, and enhancements to gloss and film clarity. Troykyd D726 is a low-VOC, general-purpose defoamer that eliminates pinholes, craters, and microfoam and is effective in a wide range of coatings, from flat to gloss. Troysperse™ 200SE, the newest solvent-free dispersant from Troy, offers dispersion of difficult pigments such as organics and carbon black in a wide range of formulations, including low-VOC systems.

Uniqema offers effect chemicals to paint and coatings formulators as well as building block technologies to resin producers. The company offers several technologies for addressing VOC requirements and recently launched several new products. Maxemul™ anionic and non-ionic nonmigratory surfactants, designed for emulsion polymer systems, provide reduced moisture sensitivity and improved appearance of applied films. Priplast™ polyester polyols based on dimer acid technology are designed for polyurethane dispersions that go into VOC coating systems requiring high flexibility and good hydrophobic properties. Atlas™ G polyol akloxyates function as rad-cure monomer diluents. Atlas™ G 5000 is also a polymeric emulsifier for alkyd resin emulsification. Reactive surfactants for this application are under investigation.

Uniqema offers other technologies for low-VOC formulations. Its Hypermer™ polymeric surfactants are for use in water dilutable alkyd resin systems to stabilize the colloidal system, reducing the total VOC level of the paint with no effect on the total costs. The company also has a new surfactant technology designed for

externally emulsified alkyd resin formulations using inverse emulsification to produce well-defined particle size distribution. Another new ester technology from Uniqema, that can be used for plasticizers, coalescent agents, and/or solvents, possesses improved environmental and toxicological properties (non-VOC, non-skin irritant).

As a manufacturer of specialty solvents, Eastman has over the years introduced numerous solvents designed for efficient viscosity reduction. The company has also developed solvent reformulation capabilities to assist customers in achieving the optimum balance of solubility, evaporation rate, and VOC content.

Eastman has synthesized and evaluated dozens of candidate coalescent molecules, targeting greater efficiency and/or lower volatility in architectural coatings. In the U.S., the company recently launched Optifilm Enhancer 400, a low-VOC, low-odor coalescent that completes a portfolio of coalescents for the U.S. architectural market that includes its flagship Texanol ester alcohol and Eastman FEEI solvents. "When used individually or in combination, these coalescents can help formulators balance performance and regulatory compliance issues, providing them with more options," says Mr. Rector. In Europe, Eastman launched Optifilm Enhancer 300, which is an efficient, VOC-exempt (by European regulations) and low-odor coalescent.

The company has also invested heavily in bringing the desirable performance of its cellulose ester and adhesion promoting additives to the evolving technologies in higher-solids and waterborne coatings. The company is continuing work with CMCAB Cellulose Ester, introduced in the last few years as a rheology control and defect reduction additive for waterborne coatings.

In addition to its new product development activities, Eastman has, along with other members of the solvents industry, made a significant investment in time and resources to ensure that VOC test methods are reliable, and that VOC regulations are based on sound science. "Understanding the true impact of VOCs on the environment helps regulators and customers make better choices when moving to lower VOC levels," notes Dr. Gustafson. The company has been actively working with other members of the American Solvents Council (ASC) to support the development of the science of solvent reactivity in the atmosphere. "We support the extension of photochemical reactivity-based regulations, currently used for aerosol coatings in California, to other coatings systems. Reactivity-based regulations are a better measure of the environmental impact of a solvent, because they examine the real reaction of solvents in the environment," Dr. Gustafson explains.

As a member of the Emulsion Polymers Council, Eastman has also been working to develop alternatives to EPA Method 24, the current standard VOC test

method in the U.S. The company has also proposed improvements to ISO 11890-2, the test method currently proposed in Europe to ensure compliance with the Paint Directive. Eastman was also awarded the Green Label in China for two of its coatings additives.

The activities of these various companies underline the significance of the impact that VOC regulations have had on producers of additives for paints and coatings. No one expects the situation to change any time soon. "VOC regulations will continue to drive R&D projects for additive suppliers," says Mr. Knight. "An increase in solvent-free and waterborne coating formulations will demand additives of the same type. Growth in developing nations to produce paints and coatings will also place future demands on lower VOC in areas outside of the U.S.," he continues.

"VOC and other regulations will continue to be more restrictive in the U.S. and Europe, and then followed by Asia Pacific and other regions. In response, additive manufacturers are moving toward global product lines (with regional differences, of course) to meet the needs of their multi-national customers," adds David Faheny, vice president of marketing for Troy Corporation. He also expects this trend will accelerate the phase out of older non-compliant products.

Regulators will respond to industry developments. "As companies begin to commercialize high-performing, low-VOC paints and coatings, they will be demonstrating to regulators that it is technically feasible to develop these products," adds Mr. Jones. At the same time, as the industry and regulators learn more about how VOCs react in the atmosphere, sound scientific data will be generated that will allow regulators to develop regulations and regulatory changes that reflect this greater understanding, according to Dr. Gustafson. Recent actions such as the EPA exemption of tertiary-butyl acetate (t-BAC) from the list of VOCs, the removal of ethylene glycol monobutyl ether (EGMBE) from the Clean Air Act list of hazardous air pollutants (HAPs), and the advent of regulations in California based upon the photochemical reactivity of a solvent, are indicative of such a change.

"Pollution prevention and protection of the environment should be a part of doing business for everyone in the paint and coatings industry," says Mr. Jones. "There is no doubt that VOC reduction has an economic cost associated with it. However, it also creates opportunities for companies to innovate and differentiate themselves." Dr. Woods adds that, "VOC regulations reflect the growing concern of society with regard to the complex issues of environmental stewardship and sustainability. The paint and coatings industry must ensure that new alternative low-VOC formulations meet these concerns." □