The Impact of ADDITIVES on 'GREEN' COATINGS

By **Cynthia Challener**
CoatingsTech
Contributing Writer

Although additives represent only a small fraction of the total content of a paint or coating formulation, they have a significant impact on performance and functionality. As coating manufacturers increasingly shift their focus to the development of more environmentally friendly, "greener," sustainable products, they often turn to additive suppliers for technology that is not only greener, but that also enables the preparation of cost competitive, high-performing, sustainable paints.

"As consumers take more responsibility for sustainable lifestyles, they are becoming more aware of the health and environmental risks associated with the ingredients used in paints. And, combined with more stringent regulations and the demand for ever better performance, their greater environmental awareness is increasingly driving manufacturers to find innovative, environmentally compatible solutions and market-ready concepts for paints and coatings," states Shailesh Shah, director of global marketing for coating additives with Cognis in North America. "The ideal consumer product combines sustainability and high performance—and this is what paint and coating manufacturers are increasingly trying to do. Manufacturers are working to develop products that comply with new regulations and can be marketed as environmentally sound, but without sacrificing application and coating film properties. They are therefore looking for green ingredients that provide performance and efficiency as good as—if not better than—traditional products," he observes.

There are three major aspects to consider when defining a "green" additive, according to Christopher Henkee, Americas marketing manager for specialty additives with Air Products. The physical and chemical properties of the additive itself as determined by its environmental, health, and safety characteristics, including whether or not it is HAPS-free, low- (or zero-) VOC, low- (or zero-) odor, and APE-free is one factor. The carbon footprint or percentage of the product derived from natural or renewable resources is another. However, since additives constitute only a small percentage of any given formulation, the impact of an additive on the carbon footprint of the final product is not very significant. The ability of the additive to influence the use (or minimization) of other coating formulation ingredients is the third. For example, multifunctional additives, as the classification implies, provide more than one function and can eliminate or minimize the need for other raw materials. The ability of additives to enhance the performance of

greener formulations is an additional, critical consideration, according to John Foley, vice president of industrial formulations for Rhodia Novecare.

In the case of defoamers, thickeners, dispersants, and surfactants, green additives can generally be defined as APE-free, with no added formaldehyde, low-VOC, and containing no hazardous substances, notes Michael C. Kaufman, coatings development leader with Arkema Emulsion Systems. These products may also be manufactured from a renewable resource, have low odor, display a low carbon footprint, and/or meet specific green initiatives commonly found in the coatings industry.

Green biocidal additives in particular should be characterized by favorable human toxicology profiles. They should not cause substantial impact to the environment at use levels and they ideally should not be sensitizers, according to David Tierney, global building products business manager for Arch Chemicals' industrial biocides business. Further, biocides should possess specific and targeted activity in order to avoid unnecessary impacts on the wider environment.

BASF utilizes eco-efficiency analysis to evaluate the environmental impact of the production, use, and disposal of a product or process in the areas of energy and resource consumption, emissions, toxicity and risk potential, and land use, explains Mike McHenry, vice president of the resins and additives business for BASF in North America. The company also evaluates the life cycle costs associated with the product or process by calculating the costs related to—at a minimum—materials, labor, manufacturing, waste disposal, and energy.

Overall, green additives can be summed up as ingredients that have the lowest contribution of components that are potentially harmful and may persist in the environment, according to Peter Sheridan, director of performance additives with Troy Corporation. Clearly, though, there are many different definitions and approaches to the idea of green additives, and often-confusing messages that ultimately reach end users. As a result, observes Shah, "the emphasis should really be on eco-friendly formulations that result in truly sustainable solutions—and tools to measure their efficacy."

Efficacy is indeed very important for additives, even though they are used at very low percentages. "Although used at low concentrations, additives can have a profound effect on nearly every aesthetic and physical property of a coating," states Henkec. For Air Products, the major objective in developing a green additive is to develop a product that is more effective than the additives currently on the market while maintaining the same cost-in-use. The major challenge is to do so for formulations that often use new green resins and other components.

The impact of additives on a formulation can vary depending on the application, but every component makes a difference. "In general, additives have had a tremendous impact on the application properties such as flow and leveling and sag resistance; they can accelerate cure speed, and drastically improve physical performance properties of paint formulations including exterior durability, thermal resistance, and corrosion resistance," explains McHenry. "Ideally, green additives should have the same effects as the less-desirable chemistries they are intended to replace," he adds.

At Rhodia Novecare, the preference is to consider "green" as an evolution and look at the development of greener and more sustainable additives rather than simply green products, according to Pierre Hennaux, business development manager for coatings. "Our focus has been on addressing performance shortcomings of newer, greener waterborne formulations, particularly in the areas of freeze-thaw, open-time, and wetting characteristics. Carefully designed additive technologies can be green themselves and help formulators create green coatings that provide the functional performance that their customers expect," he comments.

Additives, notes Shah, are crucial to achieving environmentally sound formulations. Cognis has developed expertise in natural-based products and has demonstrated through its numerous product offerings that it is possible to achieve greater performance with such additives than with their fossil-based counterparts while providing truly environmentally friendly alternatives for the paint and coatings industry.

Silicone additives are absolutely necessary components of greener formulations, according to Dow Corning additive coatings chemist Vicky James. "Moving from solvent to water as the delivery system brings with it very real issues in substrate wetting. One hundred percent silicone additives can be used in very low levels (typically <0.5%) to achieve excellent wetting properties of water-based paints with negligible impact on the VOC of the final paint," she explains. Silicone additives can also improve the longevity of paint, thus reducing the repainting frequency. Additionally, they are often multifunctional, making it possible to replace two or three current additives with one.

Biocides, according to Tierney, present a special challenge, since they are by definition harmful to certain classes of organisms. They also have an extremely important impact on the stability and performance of paints and coatings. "In this context, the selection of the correct dry film ac

tive components can ensure long-term protection without damaging side effects on surrounding vegetation and ecosystems. It is also why Arch invests resources to avoid any unwanted environmental effects," he remarks.

These issues appear to be a prime consideration in architectural coatings because of the greater involvement of consumers with these products. "At Arkema Emulsion Systems, we believe that architectural coatings formulators are at the forefront in demanding more green additives and binders. Ever-increasing consumer awareness and demand for more environmentally friendly architectural coatings will continue to drive this trend," observes Kaufman.

Surfactants and related additives—defoamers, dispersants, and other compounds that affect performance based on surface chemistry—are perhaps the easiest class of additives to target for developing green alternatives, since their chemical structures are well suited for synthesis from naturally derived materials. Suppliers, however, are developing new greener technologies for all types of additives. "There is a real response in the additives sector to the need of paint formulators for effective greener additives," Foley believes.

Much of the emphasis in recent years has been on developing low- or no-VOC additives that are also APE-free. Other technologies that have been developed, according to McHenry, include very low (<100 ppm) to non-migrating/non-extractable additives for use in food packaging applications and encapsulated products that prevent

NEW PRODUCT ROUNDUP

New additives from Air Products are APE-free and low-VOC. EnviroGem® 2010 surfactant is a zero-VOC, APE-free wetting agent that provides good surface tension reduction, excellent pigment and substrate wetting, and efficient pigment grinding, while also improving color acceptance and tint strength and freeze-thaw and viscosity stability, according to Henkee. Zero-VOC and APE-free Carbowet® 13-40 surfactant can be used as an APE-free "drop-in" replacement for 30–40 mole APE-containing surfactants while providing equivalent or superior coating properties. Surfynol® DF-110C defoamer, a zero-VOC molecular defoamer based on Air Products' unique Gemini surfactant technology, provides excellent elimination of microfoam while at the same time providing superior compatibility. Zero-VOC defoamer Surfynol DF-178 offers a high degree of compatibility in an efficient siloxane-based defoamer. Because it also functions as a coalescing surfactant, the superwetting surfactant EnviroGem 360 can be used at very low concentration to obtain excellent wetting, flow and leveling, and film formation while reducing or eliminating the need for solvents that are VOCs.

Photo courtesy of Air Products and Chemicals, Inc.

Arch Chemicals is cooperating with leading crop protection company Syngenta on the development of new dry film combinations. "In this context we are jointly screening active ingredients from other application areas (e.g., wood, agriculture) to find the next generation of biocidal actives," explains Tierney. Recently the company introduced in-can preservative Proxel® BZ Plus, which provides performance comparable to traditional formaldehyde and CMIT-containing systems without risk of sensitization at use levels. Arch is also investigating suitable co-biocides to further enhance the performance of the dry film preservative Zinc Omadine® ZOE, which has attracted growing interest because zinc pyrithione offers extremely good long-term performance without impacting surrounding vegetation or the wider environment, according to Tierney.

"The need for materials that improve the performance of green paint systems drives much of Arkema Emulsion Systems' research on new products," says Kaufman. For example, the company's EnVia™ certification standards enable formulation of paints that will meet the latest industry green formulating standards. Currently 10 products meet EnVia certification standards, and the company has committed to ensuring that all new latex products will be EnVia-compliant. Longer term, Arkema is exploring technology to use renewable resources as a feedstock for acrylic acid which is further converted to binders and additives that are widely used in the coatings industry.

migration, which could improve the environmental impact of less green chemistries by making them reactable. In the biocides area, the focus has been on chloromethylisothiazolinone- (CMIT) and formaldehyde-free in-can preservative systems and diuron/carbendazim-free dry film protection, according to Tierney. "BIT (benzisothiazolinone)/ ZPT (zinc pyrithione) formulations have also been recognized to provide excellent broad spectrum, non-sensitizing protection," he notes.

Looking forward, some of the more promising technologies McHenry sees as being of keen interest include high solids or 100% solids and non-extractable additives, additives that can be crosslinked into the system to help minimize migration, macromolecular products that perform as well as their small molecule precursors, products that are easier to handle yet still do not migrate and resist extraction, and additives that enable the replacement of heavy metal-containing photolatent catalysts with an organic-based product. Shah adds that there is also great interest in and need for green coalescents, open time improvers, and freeze-thaw improvers.

These needs are not by any means limited to the architectural coatings sector. "Although certain market segments or coating types may be at different points in their evolution towards being green, additive manufacturers are looking down the road to develop products that will not only be considered green today in particular formulations, but will also be considered green tomorrow as these markets continue to become greener," says Henkee. "In addition, since many additives are often used in several market segments or formulation types, it behooves us to develop the greenest products possible. Our understanding of green is evolving and raw material suppliers, including additive suppliers, must advance and stay ahead of this evolving concept of green chemistry," he concludes.

BASF's acquisition of Cognis was a significant deal in the additives market space. "The acquisition of Cognis strengthens our position in coatings additives, and will enable us to offer a wider and more attractive range of products and services, as well as greater research and development expertise," observes McHenry. One example of a new line of greener products from BASF is the Tinuvin®-DW series of light absorbers and hindered amine light stabilizers, which are encapsulated in acrylic polymers to slow migration and do not require the use of co solvents for incorporation into water-based coatings.

From Cognis, Loxanol® EFC 300 is a highly efficient, VOC-free, natural oil-based coalescent that offers excellent efficiency in reducing the minimum film-forming temperature while providing improved pick-up resistance compared to petrochemical-based benchmarks. Hydropalat® 216 is a more efficient and APEO-free wetting and dispersing agent suitable for organic and inorganic pigment concentrates, tint bases, and factory-finished paints. Higher efficiency rheology modifiers include DSX® 3291 for easy handling, easy incorporation without high shear mixing and excellent sag resistance in thick coatings, and Newtonian high shear (ICI) viscosity builder DSX 3121, which provides improved syneresis resistance for one-coat coverage. Several new hydrocarbon and silicon-based defoamers have also been introduced that have been specifically designed for low VOC paints across the full PVC range and for tinting systems (Dehydran® and FoamStar EF® 20 brands).

Photo courtesy of BYK.

BYK developed its "Greenability" strategic initiative in 2008 to meet the needs of its customers for lower-VOC products that comply with various eco labeling programs such as Blue Angel in Germany, Ecolabel in Europe, and Green Seal in the U.S. and provide superior performance. Products in the Greenability portfolio have no or very low VOC; do not contain phthalates, formaldehyde, or APEs; and are not sensitizers or toxic. Early in 2010 the company introduced DISPERBYK®-2155, a VOC free, 100%-solids pigment wetting and dispersing additive for solvent-free and solventborne systems that combines improved flowability of the additive with a high molecular weight base, providing good millbase viscosity reduction and excellent pigment deflocculation and stabilization.

The newest silicone additives from Dow Corning—Dow Corning® 87 and 88 Additives add water repellency and prevent water absorption in architectural coatings and are both solvent-and APE-free. These additives, according to James, are ideal for low-VOC waterborne coatings formulated for the do-it-yourself market.

The Solus™ line of additives from Eastman Chemical Company is a new rendition of its

continued on page 40