Meeting VOC regulations in architectural coatings

Featured in the February 2005 issue of *Paint & Coatings Industry*, this is the fourth in a series of articles regarding the "nuts and bolts" of formulating. The author, Jerry Mitchell, discusses how to meet U.S. VOC requirements using coalescent formulating solutions.

For decades, contractors and consumers have used latex paints in architectural applications, coating the interior and exterior walls of homes and businesses. The ease of soap and water cleanup and lower odor than solvent-based systems has led to an increase in the use of water-based paints in architectural, industrial maintenance, and even automotive coatings.

Recently, increasingly stringent environmental regulations have required changes in how latex paints used in architectural applications are formulated. A variety of formulating methods and new raw materials have been developed to help paint manufacturers meet the new regulations. Now formulators can meet volatile organic compound (VOC) regulations, while maintaining performance properties in architectural coatings.

This article provides an overview of formulation techniques to help balance performance and regulatory compliance in latex paints for architectural applications.

Regulatory issues

Paint formulators in certain U.S. regions struggle to achieve the correct balance between meeting today's stringent VOC requirements and the performance properties of their architectural coatings. The two main additives that add VOC to a latex paint are antifreeze/open time additives (i.e., ethylene and propylene glycol) and coalescents. Conventional coalescents add VOC, but mixing and matching with other types of coalescents can actually reduce the VOC of latex paints.

Coalescents

Latex paints used in architectural coatings are made from a variety of different polymers, which are selected based on performance requirements and cost. Monomers used in these polymers determine the glass transition temperature (T_g), which characterizes the hardness of the final polymer at a given temperature.

The T_g and polymer type influence the amount and type of solvent required to coalesce the polymer. Substrate, application, dry time, compatibility, VOC regulations, and efficiency all play a role in determining the type of solvent or combination of solvents to be used.

A conventional coalescent temporarily lowers the T_g, providing mobility to the polymer chains. The softened polymer can then flow and fuse with other polymer chains in the system, creating a protective, decorative film. To be effective, the coalescent has to remain in the film after the water has evaporated to ensure that a homogeneous film develops.

A conventional coalescent will evaporate out of the film after a period of time, and the film will regain its initial T_g and hardness. Various coalescents can be used individually or in combination to help formulators optimize performance in their architectural coatings, while meeting VOC regulations.

Formulating options

Glycol removal

There are many options for formulators striving to meet VOC requirements. One way, for example, is glycol removal. In a typical latex paint, the largest contributor to VOC comes from glycol, added for freeze/thaw stability and increased open time. It is normally at levels 2 to 3 times the amount of the coalescent. In most cases, formulators could meet VOC requirements by simply leaving out the glycol but this can lead to problems in colder climates where freezing can occur, and in paints where open time is important.

Use of a lower T_g latex

Another method is to use a lower T_g latex, which requires little to no solvent to form a film. However, these latexes generally have limited formulation latitude. This option requires the formulator to reformulate and test the paint, which can be time-consuming and expensive. In addition, these polymers are inherently soft and remain soft throughout the life of the paint, never regaining hardness like conventional latexes that have been coalesced to form a film. In addition, these low T_g latexes are susceptible to freezing unless formulated with glycol.

Use of nonfugitive or reactive coalescents

An additional option is to replace some of the conventional solvents used in latex paints with a higher-boiling film former, which is either non- or partially fugitive. Recently, nonfugitive film formers have been advertised to help companies formulate low-VOC paints while using their current latexes.

Nonfugitive implies that the coalescent remains in the film for the life of the coating, or at least much longer than a conventional coalescent. A nonfugitive coalescent allows the formulator to lower VOC while minimizing any adverse effects, such as hardness development. Care should be taken to evaluate the impact of these materials on surface properties such as dirt buildup and block resistance.

Another nonfugitive coalescent approach to lowering VOC is the use of materials that react or cross-link at ambient temperature after paint application. Reactive coalescents are said to cross-link using an alkyd-like oxidative cure mechanism. One issue with this type of system is that unsaturation can cause yellowing in a latex emulsion. There is little evidence to suggest that reactive coalescents lead to cross-linking significant enough to positively influence paint properties. If a formulator needs to use a low-VOC film former, it is best to use one that is nonyellowing.

Formulation alternatives to achieve desired VOC levels

For some time, the paint industry has used 2,2,4 trimethyl-1,3-pentanediol monoisobutyrate (trade name: Eastman Texanol™ ester alcohol) as the standard coalescent for architectural paints (see Table 1). However, in regions where formulators are hindered by VOC limits, it may be necessary to replace one coalescent with another that is more efficient or blend it with a film former that does not contribute to the volatility of the paint.

Volatility of the paint's components can be tested by ASTM D2369, which is one of the tests outlined in EPA's Method 24.

A formulator could replace all or some of the coalescent with one that is more efficient in lowering the T_g of the polymer, such as Eastman EEH solvent (see Table 2). Another possibility is to substitute a portion of the conventional coalescent with a low-VOC film former like Eastman Optifilm™ enhancer 400 (see Table 3). Optifilm 400 is only about 2% VOC when the neat material is measured by ASTM D2369.

Table 1. **<50 g/L interior flat with Eastman Texanol™ ester alcohol, 100 gallon batch**

Components	Amount, lb
Grind	
Water	445.00
Natrosol™ Plus 330	6.00
Proxel™ GXL	1.00
Tamol™ 731A	12.00
Igepal™ Co-630	2.20
AMP-95™	2.50
DrewPlus™ L-475	2.00
Tiona™ RCL-#	200.00
Satintone™ W	100.00
Snowflake™	100.00
Celite™ C281	25.00
Attagel™ 50	10.00
Letdown	
Water	42.30
UCAR™ 379G	167.93
Ethylene glycol	6.63
Eastman Texanol™ ester alcohol	3.46
DrewPlus L-475	2.00
Total	1128.02

Table 2. **<50 g/L interior flat with Eastman EEH solvent, 100 gallon batch**

Components	Amount, lb
Grind	
Water	445.00
Natrosol Plus 330	6.00
Proxel GXL	1.00
Tamol 731A	12.00
Igepal Co-630	2.20
AMP-95	2.50
DrewPlus L-475	2.00
Tiona RCL-#	200.00
Satintone W	100.00
Snowflake	100.00
Celite C281	25.00
Attagel 50	10.00
Letdown	
Water	42.30
UCAR 379G	167.93
Ethylene glycol	7.37
Eastman EEH solvent	2.72
DrewPlus L-475	2.00
Total	1128.02

Table 3. **<50 g/L Interior flat with Eastman Texanol™ ester alcohol and Eastman Optifilm™ enhancer 400, 100 gallon batch**

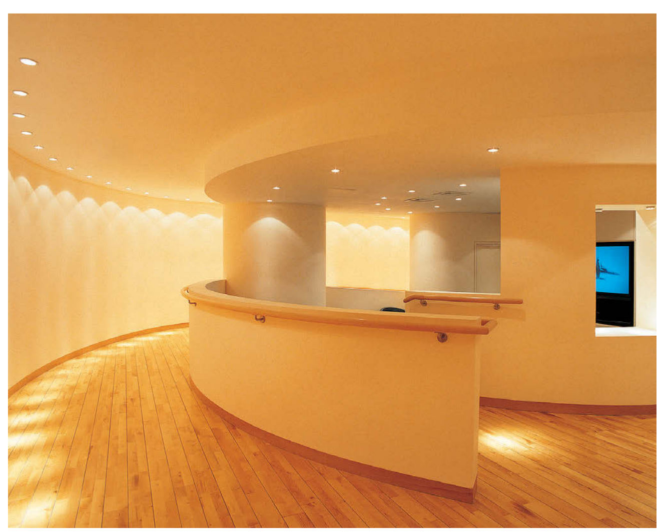
Components	Amount, lb
Grind	
Water	445.00
Natrosol Plus 330	6.00
Proxel GXL	1.00
Tamol 731A	12.00
Igepal Co-630	2.20
AMP-95	2.50
DrewPlus L-475	2.00
Tiona RCL-#	200.00
Satintone W	100.00
Snowflake	100.00
Celite C281	25.00
Attagel 50	10.00
Letdown	
Water	42.30
UCAR 379G	167.93
Ethylene glycol	7.64
Eastman Texanol™ ester alcohol	2.42
Eastman Optifilm™ enhancer 400	1.03
DrewPlus L-475	2.00
Total	1129.02

Table 4. **Raw materials suppliers**

Materials	Supplier
AMP-95	Angus
Attagel 50	Engelhard
Celite C281	Celite Corp.
DrewPlus L-475	Ashland
Eastman EEH solvent	Eastman Chemical Company
Ethylene glycol	Adrich
Igepal CO-630	Stepan
Natrosol Plus 330	Hercules
Eastman Optifilm™ enhancer 400	Eastman Chemical Company
Proxel GXL	Avecia
Satintone W	Engelhard
Snowflake™	ECC International
Tamol 731A	Rohm and Haas
Eastman Texanol™ ester alcohol	Eastman Chemical Company
Tiona RCL-3	SCM Chemical
UCAR 379G	The Dow Chemical Company

Summary

Historically, paint formulators have always had to deal with making high quality paint while keeping the overall cost as low as possible. Today's VOC regulations create additional challenges to formulating paint. Formulators must meet these environmental regulations while still maximizing the original performance qualities of their coatings. To remain competitive in an ever-changing market, formulators will need to learn what products can enable them to offer the best value to their customers with minimum compromise.



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