

Additives for improved color acceptance in paints and coatings

Air Products is a leading global supplier of innovative additives. This leadership position has been established with over 40 years of experience in advanced materials science and surface chemistry, as well as by working inclusively with customers to find the best solutions to formulation and application challenges. We have an ongoing commitment to develop environmentally compliant, high-performance wetting agents, defoamers, and additives for pigment dispersion. Our product lines offer a full range of specialty additives to improve existing architectural coatings and to optimize new coatings formulations, while helping to meet market needs, including the ever-growing demand for environmental compliance.

Color compatibility and color development: A major formulation challenge for architectural paints

Among the various challenges of paint formulation, issues related to colorant compatibility and color development are certainly some of the most common and difficult to solve. A market assessment conducted by Air Products clearly highlighted these as top concerns of architectural paint formulators.

Tinting systems

The basic concept of a tinting system is that the selected color shade can be formulated by dispensing colorants into a can containing a prefilled base paint under set conditions and at a ratio according to the specific formulation. Excellent compatibility between the main components is necessary to create the desired color and reproduce that color under all relevant tinting processing conditions.

Color and color development

Color development describes the degree of color quality and color uniformity of a paint after tinting. Good color development implies that the color appears uniformly and at the expected strength. Color development in a tinted base paint depends on the stability of the pigments and fillers dispersed in both the base paint and colorant. When the colorant and base paint are mixed, the additives in both can reequilibrate among all the pigments and fillers present. Since many base paints are understabilized, some of the additives needed to stabilize the colorant pigment are redistributed to pigments and fillers in the base paint. This leads to the loss of pigment stabilization and flocculation of the colorant or paint pigments, resulting in an immediate or gradual change in color (Figure 1).

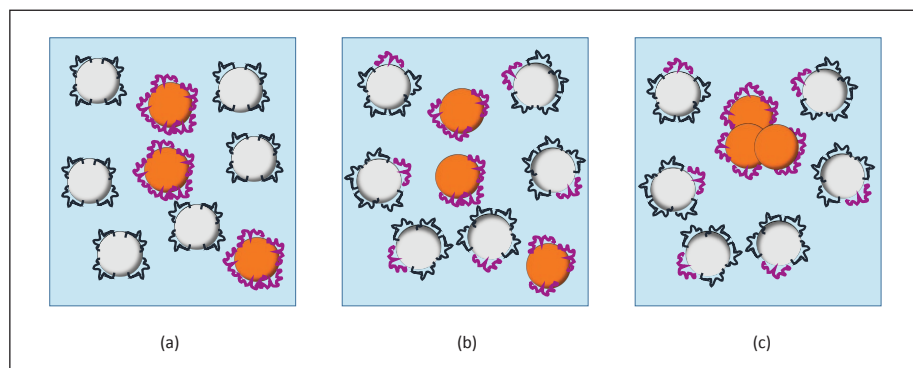



Figure 1. Simple mechanism of colorant destabilization: (a) Colorant pigment (orange) and base paint pigment (white) are mixed; (b) Dispersing additives on colorant pigment redistribute to base paint pigment; (c) Colorant pigments flocculate, leading to loss of color strength. Illustration [] represents different polymeric dispersants.



Color compatibility consequences

If flocculation occurs slowly, poor colorant compatibility may become evident over time, leading to the production of tinted paints with different shades or a finished paint that changes shades over time so that later touch ups result in a color mismatch. A rub-out test can clearly identify color separation or flocculation. The color separation is measured in the dry film as the color difference between the touched and untouched film.

The influence of surfactants on color acceptance

The formulation of pigment dispersions in both base paints and colorants can be enhanced by the use of surface active agents to wet, disperse, and stabilize solid particles or pigments in the medium and to improve application performance. Typically, formulations contain at least two (and often three or more) surface active components that are combined to provide the optimal properties. These materials include traditional polymeric and oligomeric dispersants as well as lower molecular weight surfactants. The surfactants can also help to improve the compatibility of the dispersion for letdown into other systems and to minimize shock

and color acceptance when tinted. It is thought that these surfactants work by migrating to the surfaces created when the dispersing additives redistribute upon mixing, thus preventing the destabilization of the pigments (Figure 2).

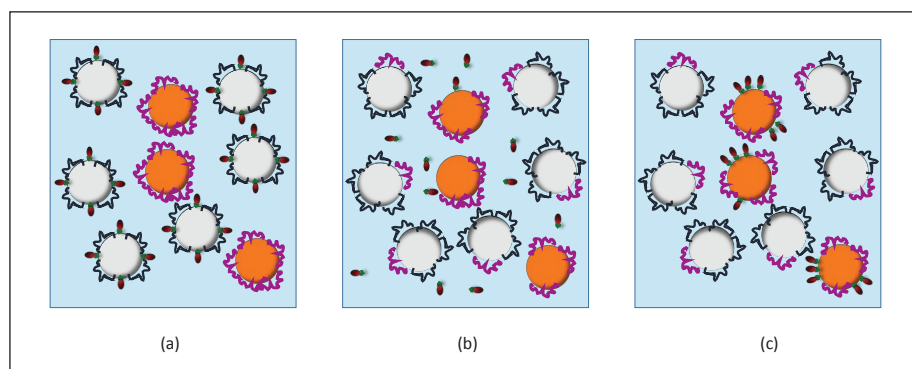



Figure 2. Simple mechanism of surfactants preventing colorant destabilization: (a) Colorant pigment (orange) and base paint pigment (white) are mixed; (b) Dispersing additives on colorant pigment redistribute to base paint pigment; (c) Surfactants [] migrate to colorant surface preventing flocculation and loss of color.

Air Products additives improve color compatibility and color acceptance

Air Products offers a series of additives that can improve pigment wetting and stabilization and consequently help create compatible colorants in water-based and solvent-based systems. This brochure highlights the performance of these additives with colorants identified by the market survey as being particularly problematic in terms of color acceptance in paint tinting. Based on customer feedback, colorants with indices PV23, PBk7, PB15:3, and PR112 are among the most challenging.

Several products from Air Products' Surfynol® surfactant, Carbowet® surfactant, and ZetaSpers® dispersant lines were post-added to base paints of various chemistries at a 1.0% (w/w) dosage and tested with colorants to measure the influence of the additives on color compatibility and color strength.

A selector guide with Air Products additives recommendations for various colorants combined with various types of base paints can be found on page 6.

PV23 colorant

Surfynol 2502 surfactant significantly improved color development in a water-based acrylic paint tinted with PV23 colorant. It also provided high foam control and dynamic wetting with no drop in viscosity.

Figure 3 shows the test method used for determining the color compatibility. The color strength was measured using an X-Rite 939 spectrodensitometer D65/10. Drawdowns were made after 2 and 10 minutes of shaking. A rub-out test was then performed on each of the drawdowns, and the color difference between the rubbed and unrubbed parts also was recorded.

Figure 4 shows how, when used with the PV23 colorant to tint water-based acrylic base paint, Surfynol PSA336 and Surfynol 2502 surfactants helped increase color strength and reduce color difference between the rubbed and unrubbed parts of the drawdown compared to blank paint and paint containing a benchmark compatibilizer.

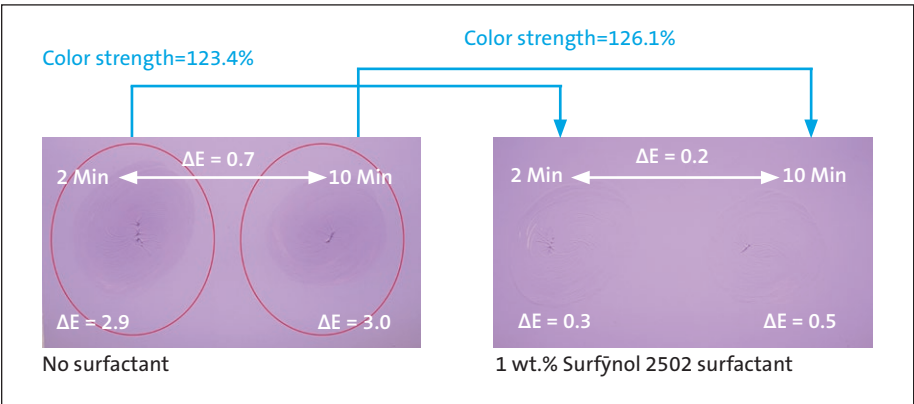


Figure 3. Test methods for color compatibility show enhanced color acceptance in PV23 colorant-tinted water-based acrylic base paint.

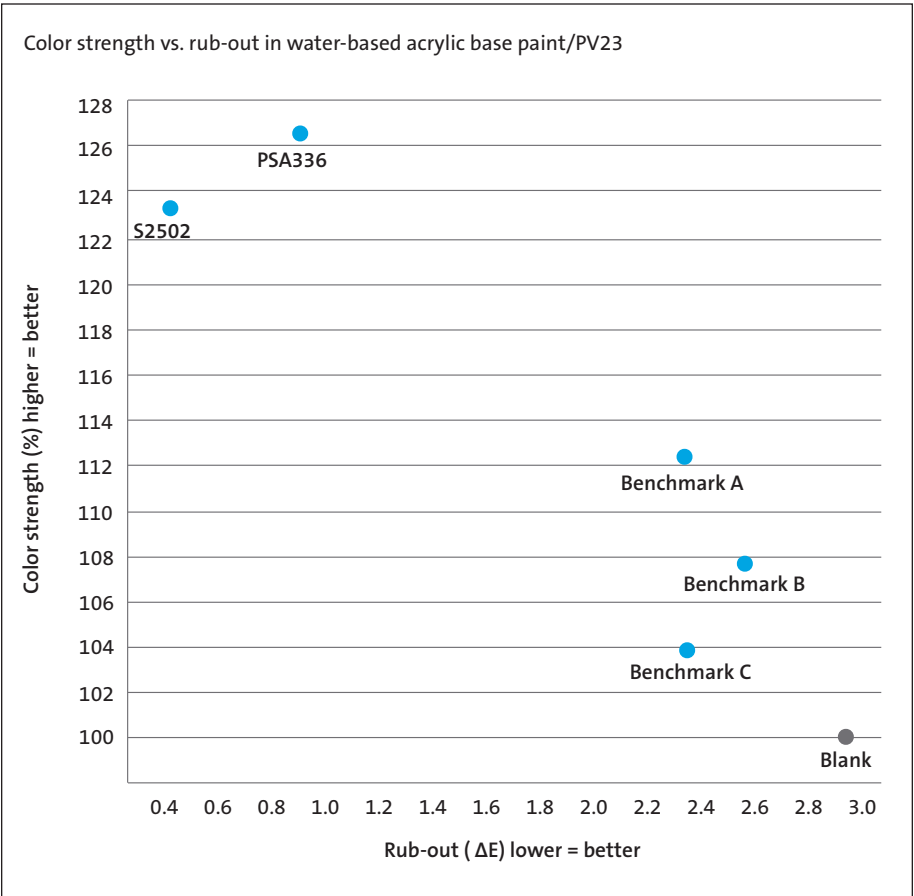


Figure 4. Comparison of color strength and ΔE values using different compatibilizers.



PBk7 colorant

In addition to PV23 colorant, one of the most widely used colorants is PBk7, which is based on a very different chemistry than the organic PV23. With the PBk7 colorant, ZetaSperser 179 and 182 dispersants enabled improved color strength in both a water-based acrylic and a solvent-based alkyd paint. The additives were post-added to the base paint at 1 wt.% before adding 1 wt.% of the tinting paste. The paint samples were shaken with a Scandex shaker for 2 minutes and a sample was taken for a drawdown and rub-out. The samples were shaken again for 8 minutes and another drawdown was made. Color strength was again measured using an X-Rite 939 spectrophotometer D65/10. The formulation without additives, or blank, was used as the reference and its color strength was set to 100%. The results in the solvent-based alkyd paint are shown in **Table 1**.

PB15:3 and PR112 colorants

Similar results were also achieved with other problematic colorants such as PB15:3 and PR112. The addition of nonionic surfactants such as ZetaSperser 182 and Carbowet GA-210 showed improved color development and acceptance of different colorants when they were let down into base paints of different chemistries (**Figure 6**).



Table 1: Color strength and ΔE values in a solvent-based alkyd paint tinted with a PBk7 colorant.

Additives 1 wt.% as supplied	Color strength (%) 2 Min	Color strength (%) 10 Min	Delta E 2 Min vs. 10 Min	Delta E rub-out 2 Min	Delta E rub-out 10 Min
Blank	100.0	100.0	0.42	1.01	0.61
ZetaSperser 179 dispersant	110.4	106.6	0.03	0.22	0.26
ZetaSperser 182 dispersant	110.7	106.8	0.04	0.27	0.26
Benchmark 1	101.2	98.6	0.16	1.26	1.23
Benchmark 2	100.2	96.7	0.02	0.90	0.78

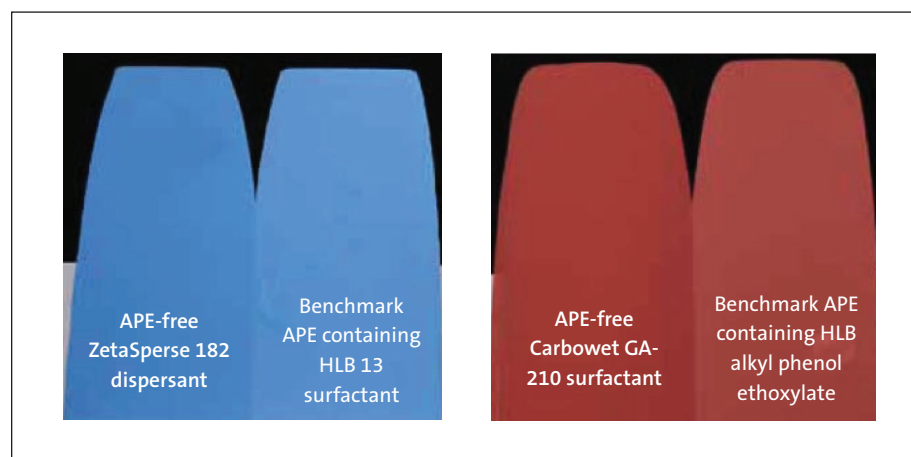


Figure 6: PB15:3 colorants let down into a Vinnapas¹ EZ3010 (VAE) white base paint 45% PVC (left) and PR112 colorants let down into a satin interior paint based on Acronal² 296D (styrene-acrylic emulsion 30% PVC) (right).

¹WackerChemie ²BASF Chemicals

Air Products additives can be used as colorant compatibilizers

These same experiments were repeated using different colorants combined with various types of base paints. Results showed that Air Products additives can be used to improve the acceptance of colorants into different chemistries and types of base paints. Air Products additives help the stabilization of the pigments by slowing down or compensating for the migration of dispersants and other stabilizing surfactants from the pigment in the colorant to pigments in the base paint, or vice versa. **Table 2** can be used as a selector guide to help identify a suitable additive for a specific system (colorant/base paint). Additives are recommended at an initial concentration of 0.5 wt.%. The use level of the additive should then be optimized by running a ladder study.



Table 2: Additives selector guide for improved color compatibility and color acceptance

	WB acrylic flat paint			WB alkyd/PU trim paint	WB styrene-acrylic flat paint			SB alkyd high-gloss paint	
	PV23	PBk7	PR112	PBk7	PBk7	PR112	PB15:3	PBk7	PB15:3
Surfynol 2502 surfactant	●	●	●			●			
Surfynol 485 surfactant						●			
Surfynol PSA336 surfactant	●		●			●			
ZetaSperser 179 dispersant							●	●	●
ZetaSperser 182 dispersant				●	●		●	●	●
ZetaSperser 2500 dispersant									●
Carbowet 106 surfactant			●	●					
Carbowet 138 surfactant		●							
Carbowet GA-210 surfactant						●	●		
Carbowet GA-221 surfactant				●					

Product offering for color compatibility improvement

Surfynol 2502 surfactant	A 100% active, alkoxyated nonionic surfactant that provides low-foam, dynamic wetting properties to coatings and paints.
Surfynol 485 surfactant	A 100% active, ethoxylated wetting agent that provides low-foam surface tension reduction with slight emulsification properties, improved solubility and compatibility in water-based paints and coatings.
Surfynol PSA336 surfactant	A formulated wetting agent that provides very low dynamic surface tension and substrate wetting with minimal foam in water-based paints and coatings.
ZetaSpense 179 dispersant	A high HLB branched surfactant and wetting agent that offers excellent nonionic stabilization properties for dispersion, emulsification, and color acceptance benefits in a variety of coatings and paints.
ZetaSpense 182 dispersant	A high HLB linear surfactant and wetting agent that offers excellent nonionic stabilization properties for dispersion emulsification and color acceptance properties in a variety of coatings and paints.
ZetaSpense 2500 dispersant	A high-performance dispersant (40% active solution in water) that provides excellent viscosity stability and stabilization of demanding organic pigment chemistries in coatings and paints.
Carbowet 106 surfactant	An ethoxylated nonionic surfactant designed to provide performance comparable to NP-6 type and similar alkyl-phenol-based surfactants in water-based coatings and paints. Allows for the surface tension reduction necessary to wet both pigment and substrate, and can enhance/stabilize color acceptance.
Carbowet 138 surfactant	An ethoxylated nonionic mid-HLB (HLB: 13.8) traditional surfactant with balanced properties for use in typical water-based formulations. Low-viscosity, easy-to-handle liquid provides an excellent alternative to APE chemistries of similar HLB.
Carbowet GA-210 surfactant	A nonionic wetting and stabilizing surfactant that offers efficient wetting and stabilization benefits for a wide range of paints and coatings. Compared to its sibling products in the GA series, Carbowet GA-210 surfactant offers the most universal and balanced properties and is suitable for all applications.
Carbowet GA-221 surfactant	A nonionic wetting and stabilizing surface active chemistry that offers low-foam wetting of substrates and pigments and provides compatibility and stability benefits in coatings and paints. Compared to its sibling products in the GA series, Carbowet GA-221 offers the greatest stabilization benefits and is the first choice for organic and carbon black pigment dispersions.





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