Brief Formulating Guidelines for Using K-FLEX® Non-Phthalate Coalescents in Coatings
Introduction

Emerald Kalama Chemical produces a platform of coalescing aids for the coatings industry. The following is a brief formulation guide that provides formulating tips on how to incorporate benzoates into an already existing formulation. Compared to some of the traditional coalescents that have been used, such as 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (TMPDMIB) and tri(ethylene glycol) bis(2-ethylhexanoate) (TEGDO), the benzoates are low VOC and low-odor. The key to using low-VOC coalescing aids in paints is the formulating approach.

K-FLEX® Benzoate Technology

Emerald Kalama Chemical has a portfolio of coalescing aid products for applications in the coatings industry. Dibenzoate- and monobenzoate-based coalescing aids are available and listed below.

K-Flex® 850S is a blend of diethylene and dipropylene glycol dibenzoates, optimized for waterborne latex applications.

K-Flex® 975P is a blend of dipropylene, diethylene and propylene glycol dibenzoates which was designed for enhanced compatibility for a more broad range of polar polymers; this blend has a lower freeze point for easier handling.

K-Flex® 500 is a 1:1 weight blend of dibenzoates.

K-Flex® 500P is similar to K-FLEX® 500; it is lower in VOC than any of the other K-FLEX® products.

K-Flex® 613 (3-phenyl propyl benzoate) is not commercially available yet. It is a flavor additive in the EU and has applications in coatings, as well as in vinyl and adhesives.

K-Flex® BOB (benzyl benzoate) is commercially available and functions well in coatings. It is also a flavor additive.

Formulation steps

- The first step is to replace the existing coalescent weight for weight, normally replacing TMPDMIB in the formulation, and test for either efficiency in attaining 4.4°C of MFFT or physical performance equivalent. In most cases, the same level of coalescent as TMPDMIB will work.

- In a limited number of cases, such as some hard styrenated-acrylic types, the most likely reason for poor performance is that partitioning of the coalescent into the latex may require a change either in mix intensity, order of addition, or the type of surfactant.

- Testing for Low Temperature Coalescence (LTC) should be first, and then Minimum Film Formation Temperature (MFFT) should be run on simple ternary blends of binder, coalescent, and surfactant package.

- If the initial screening shows acceptable properties, then continue with the full evaluation. If not, consider partitioning issues and continue to evaluate for coalescent efficiency.

Coalescent Efficiency

Studying coalescent partitioning behavior and partitioning rate starts as a coalescent efficiency evaluation; coalescent is added at varying concentrations on a binary blend (binder and coalescent). The concentration required depends on the glass transition temperature (Tg) of the binder; that which is selected will depend on the MFFT requirement for the application conditions. Other methods for evaluating coalescent efficiency exist, and scrub efficiency of the final paint is one of them. If the film is under or over coalesced scrub resistance is compromised. For this method the level of coalescent in the starting point formula is reduced at incremental intervals from the starting point. Figure 1 is scrub efficiency data of a gloss paint based on a styrenated-acrylic (Tg = 32°C).

Volatile Organic Compounds

VOC in paints is a global concern for coatings companies; different regions have defined methods of measuring VOC:

- US EPA 24 D2369 volatility test – TMPDMIB and DIB are 100% VOC. All of the di- and monobenzoates are significantly lower.

- EU Directive 2004/42/CE, ISO 11890-2 (boiling point of >250°C to be non-VOC). All di- and monobenzoates are zero-VOC.

- In Asia, the EU boiling point criterion is generally used.
Coalescent Partitioning and the Partition Rate

Many categories of latex emulsions and waterborne polymers exist: (vinyl acryls, polyvinyl acetates, styrenated-acrylics, ethylene-vinyl acetates, or 100% acrylics). Partitioning will depend on the individual binder composition. Partitioning into the latex polymer is usually improved through sample aging, process mixing rate, or the addition of nonionic surfactant.

To improve coalescent efficiency the nonionic surfactant package can be adjusted in the paint formulation. A selection of nonionic surfactants with an HLB in the range of 8-10 is recommended when formulating the benzoates into some harder styrenated-acrylics. When altering the nonionic surfactant package, testing for paint package stability such as freeze-thaw stability, heat age stability, low temperature coalescence of the paint film, and color acceptance is needed.

Order of addition

Order of addition is a critical stage in any reformulation work for optimizing coalescent partitioning and efficiency. It is recommended that the coalescent be added in the letdown phase. Table 1 and Table 2 are an original and reformulated gloss paint that was used for the scrub efficiency work shown in Figure 1. The original formula resulted in an unstable grind. The reformulated paint was stable.

<table>
<thead>
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<th>Description</th>
<th>Control</th>
<th>Description</th>
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<td><strong>GRIND</strong></td>
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<td>Polyphase 678 (@ 0.6% wt/wt)</td>
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<td><strong>Total Formula Weight</strong></td>
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Conclusion

To summarize, there are a number of stages to consider in working with the coalescent package of a coating. It is suggested with any changes to a formulation that the physical and performance properties of the final coatings system be evaluated. Whether the need is to reduce the volatile organic content of the coating, remove a phthalate, or improve performance, to each end the value of the coatings product is increased when the benzoate coalescent is assessed properly.
STORAGE AND HANDLING:
At Emerald Kalama Chemical’s production facility, K-FLEX® plasticizers are stored in type 304 stainless steel storage tanks. These storage tanks are nitrogen padded to reduce discoloration of the product. Type 304 stainless steel pipe and valves are also used. High density polyethylene has been shown to be suitable for product shipment, but we have no direct experience in piping systems. Since K-FLEX® products are excellent plasticizers for polyvinyl chloride (PVC), PVC piping systems should not be used. Sliding vane type positive displacement pumps have given us excellent service.

It is recommended that storage tanks be heated and insulated and that pumps and transfer piping also be heat-treated and insulated. Our engineers are always ready to discuss the storage and handling of any of our products.

Additional information can be found in the Material Safety Data Sheets.


Many K-FLEX® products are FDA-approved for safe use in food contact applications. Please contact us for additional details.

Business Group Information

Emerald Kalama Chemical – 360.673.2550 / 800.223.0035
Emerald Kalama Chemical BV – +31.88.888.0500
Leading producer of ingredients sold worldwide as plasticizers, food and beverage preservatives, flavors and fragrance, and pharmaceutical and industrial intermediates.

Emerald Specialties – Hilton Davis – 513.841.4000 / 800.477.1022
One of the leading producers of certified dyes and lakes used to add color to food, cosmetics and pharmaceutical products. Also a leading producer of high-quality pigment dispersions for coatings, graphic arts, plastics and many specialty applications.

Emerald Specialties – Foam Control – 307.634.7699 / 800.770.5226
Produces foam control additives and silicone-based products for a broad range of applications. It maintains a large number of clearances for food applications, such as Kosher, Halal, FDA and HACCP.

Emerald Specialties – Carolina Chemical – 704.393.0089 / 877.300.9545
Largest U.S. producer of glyoxal resins, used in the paper and textiles to improve wet strength, impart wrinkle-resistance and control shrinkage. Leading manufacturer of sulfated oils, water repellents, industrial foam control, reactive silicone materials and waxes.

CVC Thermoset Specialties – 856.533.3000 / 800.296.0040
A leader in the manufacture of unique reactive liquid polymers, epoxy resins, reactive modifiers, catalysts and accelerators. CVC products are sold worldwide and are integral components of coatings, adhesives, electrical potting, compounds, encapsulants and composites.

Emerald Polymer Additives and Nitriles – 330.374.2418 / 888.889.9150
One of the largest North American producers of polymer additives (antioxidants and accelerators) and the only North American producer of TMQ (Good-Rite*) and ODPA (Stalite*). Also the largest U.S. producer of specialty nitrile emulsions, water-based polymers used in specialty coatings, paper, coal tar emulsions and other industrial end uses.

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