SOLVENT FORMULATIONS FOR INDUSTRIAL FINISHES

Industrial coatings manufacturers operate in a climate with increasing demands on solvent formulations that address factors such as health and safety concerns, environment impact, and cost pressures. Even so, there are opportunities for coatings manufacturers to achieve performance and earnings improvements through intelligent reformulation of solvent systems. FlexiSolv® DBE® esters (dibasic esters) offer solvent formulators proven, cost-effective alternatives that are biodegradable, non-flammable, contain no known carcinogen and have a minimum of 55% recycle content.

DBE® esters are efficient solvents that are used commercially in a variety of finishes. Since the mid-1970s, DBE® esters have been a major solvent in automotive coating formulations for many producers in the U.S. and abroad. They continue to be an important component for acrylic lacquer and enamel topcoats, urethane trim paints, and polyester and epoxy primers and primer surfacers. DBE® esters are also used in automotive refinishes.

In the industrial finishes markets, DBE® esters are employed in steel and aluminum coil coating, interior and exterior can coatings, and in finishes for appliances and metal furniture. They also provide an effective alternative to cresylic acid and phenol in magnet wire enamels. Other areas of application are in adhesives, wood treating solutions, and industrial and consumer cleaning and stripping solvents. In institutional and consumer cleaning applications in the United States, FlexiSolv® DBE®-LVP also offers a low-VOC alternative.

TABLE I
DBE® Solvent Properties

Typical Composition, wt %	
Dimethyl adipate	16
Dimethyl glutarate	64
Dimethyl succinate	20
Distillation range, °C	196-225
Solubility parameters [a]	
Nonpolar (δ_D)	8.3
Polar (δ_P)	2.3
Hydrogen bonding (δ_H)	4.8
Specific gravity, 20°/20°C	1.092
Surface tension, 20°C, dynes/cm	35.6
Flash point, °C[b]	100
Viscosity, 25°C, cp	2.6
Electrical resistance, 24°C, megohms[c]	0.5
Status under Rule 442	Non-photochemically reactive

FIGURE 1
Coatings & Solvents
Evaporation vs. Temperature

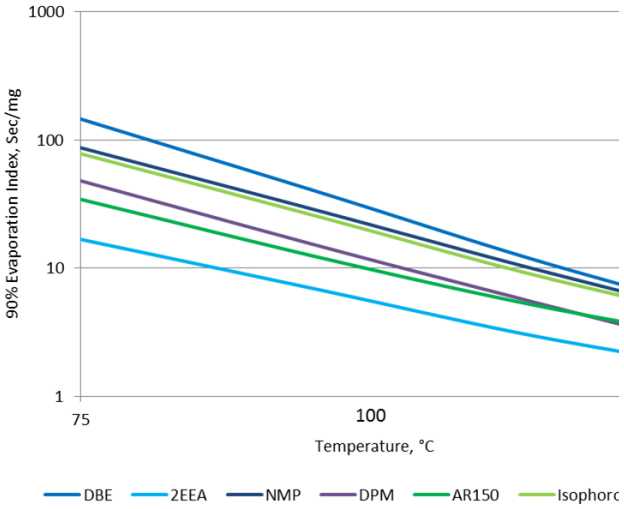
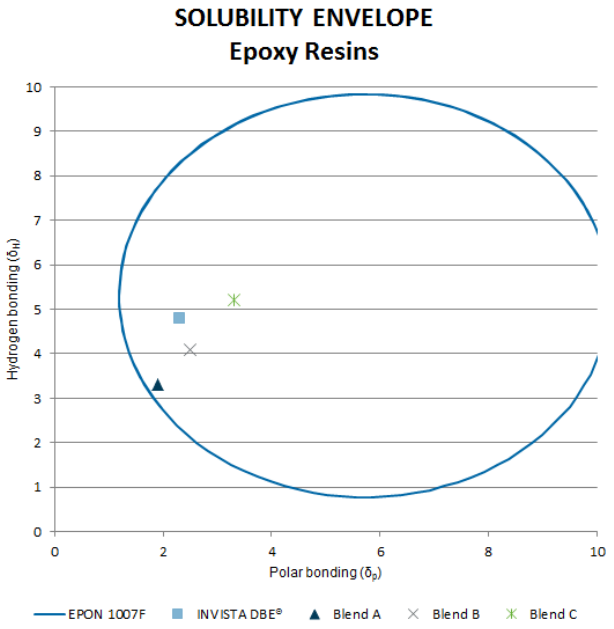


TABLE II
Epoxy Resins: Solvent Blend Suggestions

Solvent	Volume % Blend A	Blend B	Blend C
DBE®	35	12	15
Aromatic 100	50	33	
Xylene			10
n-butanol	15	25	20
Diacetone alcohol		15	
MEK		15	20
Propylene glycol methyl ether			35
Solubility Parameters			
δNonpolar	8.3	8.1	7.9
δPolar	1.9	2.5	3.3
δHydrogen bonding	3.3	4.1	5.2
Density - lb/gal.	7.74	7.28	7.43
Viscosity - Brookfield, 25°C, Centipoise			
EPON® 1007F, 40%	740	540	490

EPON® 1007F is a product of HEXION



DBE® esters are used in a wide variety of commercially important resin systems, including acrylic enamels and lacquers, epoxies, polyester and polyester-imides, polyurethanes and vinyls. DBE® esters and their blends with other low-cost solvents are economic replacements for many solvents, including isophorone, cresylic acid, glycol ethers, glycol ether acetates and cyclohexanone. Their miscibility with most organic solvents and their solvency for many polymers account for their usefulness in the formulations of coatings (goo.gl/4hHW1n).

In formulating with DBE® esters, many users have found that the solvent volatilizes more readily at baking conditions than would be predicted from its boiling point temperature. For example, as measured in the evaporometer at 25°C, the 90% evaporation time of DBE® esters is about 15 times greater than that of 2-ethoxy-ethyl acetate (EE acetate), whereas at 150°C, these evaporation times differ by only about 40%. Results obtained in a series of thermal gravimetric analysis (Figure I) confirm that the evaporation time of the DBE® ester decreases with temperature elevation at a faster rate than that of many other solvents commonly used in coating formulations. Thus, in practice, it is a faster solvent that most formulators would predict based on evaporation times at room temperature.

TABLE III
Acrylic Resins: Solvent Blend Suggestions

Solvent	Volume % Blend A	Blend B	Blend C
DBE®	15	15	15
Aromatic 100	65	50	50
n-butanol		20	
MIBK	20		
MEK		15	
Acetone			20
n-Butyl acetate			15
Solubility Parameters			
δNonpolar	8.3	8.3	8.2
δPolar	1.4	2.0	2.0
δHydrogen bonding	1.9	3.2	2.5
Density - lb/gal.	7.33	7.27	7.33
Viscosity - Brookfield, 25°C, Centipoise			
Elvacite® 2013, 20%	28	31	26

Elvacite® is a product of Lucite International

SOLUBILITY ENVELOPE
Acrylic Resins

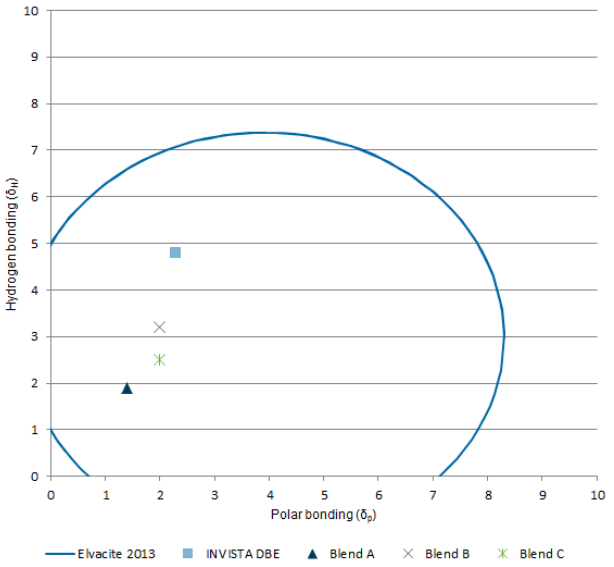
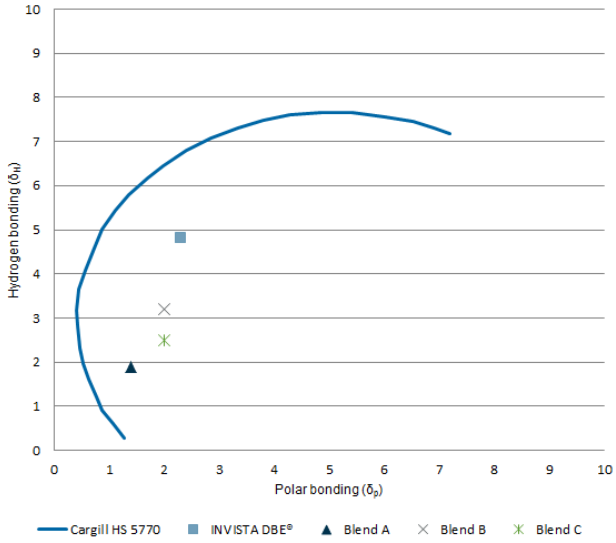


TABLE IV
Polyester Resins: Solvent Blend Suggestions

Solvent	Volume % Blend A	Blend B	Blend C
DBE®	15	5	15
Aromatic 150	60	80	
Aromatic 100			70
n-butanol	5		
MEK	5		
MIBK		5	15
Dipropylene glycol methyl ether	15	10	
Solubility Parameters			
δNonpolar	8.2	8.3	8.4
δPolar	1.7	1.1	1.3
δHydrogen bonding	3.0	22.0	1.9
Density - lb/gal.	7.61	7.47	7.35
Viscosity - Brookfield, 25°C, Centipoise			
Cargill H.S. 5770, 60%	320	400	200

Cargill H.S. 5770 is a product of Cargill, Inc.

SOLUBILITY ENVELOPE
Polyester Resins



Another aid in formulating with DBE® esters uses the solubility parameter concept to choose the best combination and concentration of solvents for blending with DBE® esters. The region, or envelope, of solubility of the resin or resin mixture is determined by examining resin solubility in a series of solvents having known solubility characteristics. A plot of resulting data shows the

resin envelope as the region encompassing the solubility parameters of those solvents that dissolved the resin. Using the Hansen solubility parameter values, which we prefer, the plot is 3-dimensional; however, for practical purposes, the plot of polar (δ_p) against hydrogen bonding (δ_H) parameter values is sufficiently accurate. With the resin envelope defined, combinations of solvents having averages of solubility parameters that lie within the envelope are selected. Computer techniques are useful in the calculations and plotting.

DBE® ester-containing solvent formulations that provide cost and/or performance savings with various kinds of coating resins are described in Tables II, III and IV. In practice, these examples may not be the best combinations of DBE® esters and other solvents for the particular resin, but they serve as starting suggestions for the formulator. Hansen solubility envelopes for typical resins are included to show the region of resin solubility inside the arc and the solubility parameters location of each suggested solvent blend.

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