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Incorporating Eastman Solus™ 3050 performance additive into automotive OEM and refinish basecoat formulations

This technical tip is centered on providing information that may be helpful to a formulator when first introducing Eastman Solus™ 3050 performance additive into an automotive OEM or refinish basecoat formulation. This tech tip covers

- Resin compatibility
- Solvent selection
- Solution preparation
- Example formulations
  - OEM basecoat
  - Refinish basecoat

Resin compatibility

Eastman Solus™ 3050 performance additive, in general, is compatible with acrylic emulsions and selectively compatible with styrene-acrylic and polyurethane dispersions.

Solvent selection

Eastman Solus™ 3050 performance additive is an additive supplied as a powder and used in waterborne systems. In order to make an aqueous solution of Solus 3050 a co-solvent is needed. A variety of solvents were considered as potential co-solvents for Solus 3050 (see Appendix 1). They include nine glycol ethers, an acetate, four alcohols, and two ketones. Of the nine glycol ethers, five have evaporation rates of 0.09 and greater. This includes Eastman™ EB butyl glycol and propylene glycol n-propyl ether (PnP), two of the most popular solvents for waterborne systems. The remaining four glycol ethers of the nine chosen have lower evaporation rates (0.02 and less) and are often used in low VOC systems to aid in film formation. Propylene glycol methyl ether (PM) acetate was evaluated because it is a more traditional solvent found in waterborne systems. A set of alcohols was assessed since they are sometimes found in OEM formulations for stabilization of the melamine. Also on the list are two ketones often used in solvent-based systems where Solus 3050 may also have application. Last on the list in Appendix 1 to be evaluated is N-methyl-2-pyrrolidone (NMP), not because it was in consideration as a solvent for Solus 3050, but because it is used as a solvent for pigment dispersions, and hence solubility of Solus 3050 in that solvent might be of interest.

The first step in the evaluation of the potential solvents was to determine the solubility of Eastman Solus™ 3050 performance additive at 10% solids in the solvent and in a solvent:water mixture with an amine neutralizing agent. Results show that Solus 3050 performance additive is soluble in the pure solvent and in the solvent:water mixture in the case of the five glycol ethers with evaporation rates higher than 0.09, in ethanol and in the two ketones [methyl ethyl ketone (MEK) and acetone]. Solus 3050 was insoluble in pure PM acetate. However, it formed a cloudy solution in the PM acetate: water mixture.

After doing the solubility testing, the viscosity was determined on those that "passed" the solubility tests. From this data, it appears that EB, PnP, and PM acetate are the only solvents that yield an acceptable viscosity in the solvent: water mixture with viscosities of 2160, 1145, and 1728 centiPoise (cP), respectively. The viscosities of the solvent: water mixtures for ethylene glycol propyl ether (EP) and propylene glycol n-butyl ether (PnB) are measurable at 3517 and 9500 cP, respectively, but too high for practical application. Others that passed the solubility test had viscosities that were too high to even measure.

From this, it is concluded that of the solvents evaluated, EB, PnP, and PM acetate are the only three suitable as single solvents for Eastman Solus™ 3050 performance additive.

Viscosity spike at lower glycol ether concentrations

There is one caution to point out when using the glycol ether solvent systems. Although the viscosity of a 20% solids solution of Eastman Solus™ 3050 performance additive solution in glycol ether such as EB and DI water may be within the workable range, the viscosity of this solution increases dramatically as it is diluted with DI water as shown in Figure 1. This could cause problems when incorporating an aqueous solution of Solus 3050 into a waterborne paint formulation.

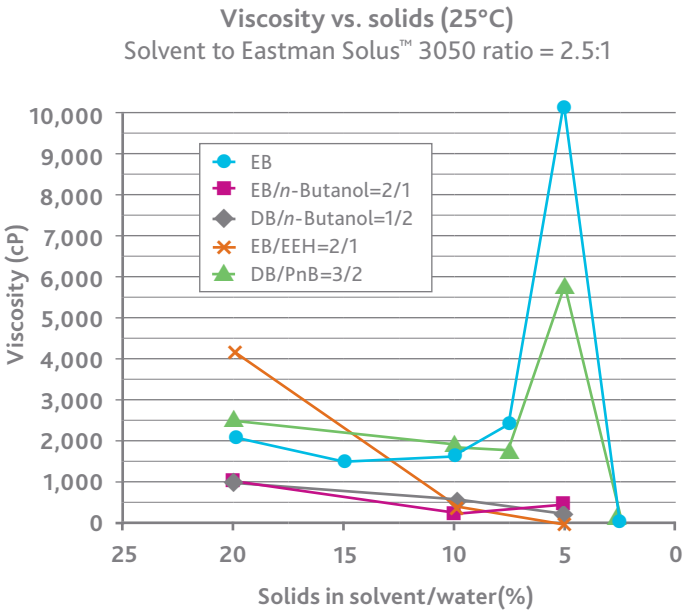
This can be avoided in one of two ways. One option is to first mix the solution of Eastman Solus™ 3050 performance additive with the pigment portion (pigment and aluminum paste) and part of the free solvent and water available in any formulation. This will ease the incorporation of Solus 3050 and will help with pigment wetting.

The second option is to replace part of the EB with butanol. As can be seen in Figure 1, when part of the EB was replaced with butanol, but the ratio of solvent to Eastman Solus™ 3050 performance additive was maintained at 2.5:1, the viscosity peak disappeared. Although butanol is not an active solvent to Solus 3050 as shown in Appendix 1, the incorporation of butanol reduced the overall system viscosity probably due to reduced hydrogen bonding. It should be noted that the solution of Solus 3050 containing butanol may look slightly cloudy at certain solids content due to the limited water solubility of butanol. This should not cause any problems as long as attention is paid to the overall solvent balance.

Beyond an EB/butanol blend, there is a myriad of other combinations that might reduce the solution viscosity and/or eliminate the viscosity spike. Two examples illustrated in Figure 1 are of DB combined with *n*-Butanol and EB combined with ethylene glycol 2-ethylhexyl ether (EEH).

Figure 1

The viscosity of 100% neutralized Eastman Solus™ 3050 performance additive solution versus solids



In Figure 1, the 20% solids aqueous solutions were first made at a solvent to Eastman Solus™ 3050 performance additive ratio of 2.5:1. Solids were then adjusted to the target level by adding DI water. The viscosities were measured at 25°C using a Brookfield viscometer with #5 spindle at 50 rpm.

Solution preparation

Eastman Solus™ 3050 performance additive is supplied in powder form. A 20% solids aqueous solution of Solus 3050 can be prepared based on Table 1.

Table 1 100% neutralized solution

1	Eastman™ EB (butyl glycol)	300.0
2	DI water	171.6
3	DMEA	8.5
4	Eastman Solus™ 3050 performance additive	120.0
5	DMEA	1.5 (adjust pH to 6.8 –7.5)

Add the Eastman Solus™ 3050 performance additive to the solvent/water/amine mixture (No. 1 through 3) under agitation with high-shear mixing over 2–3 minutes. The agitation speed should be adjusted to maintain a vortex. The proper blade to use is a heavy-duty, serrated-edge blade. After the addition of Solus 3050 is complete, raise the agitation speed to 3500 rpm and continue the agitation until all of the Solus 3050 particles are dissolved and a clear, viscous solution forms. The process should generate heat and warm the solution. This is important to speed the dissolving process, which should take about 30–60 minutes. Then the pH should be adjusted to 6.8–7.5 using additional DMEA under low speed agitation.

Example formulations

Add A to pot. Mix ingredients of B, C, D, and G separately using separate containers. Then add B through I in listed order to the pot under agitation.

Automotive OEM metallic basecoat formulation

	Raw materials	Description	Control	With 6% Eastman Solus™ 3050 performance additive
A	Macrynal VSM 6285w/43WABDG	Cytec acrylic emulsion	25.33	25.33
	Maprenal MF 900/95	Ineos melamine cross-linker	4.89	5.27
B	Viacryl VSC 6279w/45WA	Cytec styrene acrylic emulsion	5.34	5.34
	DI water		8.62	8.62
C	10% Viscalex HV 30 solution[a]	BASF acrylic swellable thickener	6.89	6.89
	DI water		5.51	5.51
D	Laponite RD	Rockwood synthetic clay	0.34	0.34
	DI water		13.23	13.27
E	Foamex 825	TEGO defoamer	0.07	0.07
F	10% Dimethyl ethanolamine (DMEA)	Neutralizing agent	2.76	3.00
G	Eastman™ EB butyl glycol	Solvent	4.29	4.13
	N-methyl-pyrrolidone	Solvent	1.03	1.03
	Additol XL 250	Cytec pigment wetting agent	0.52	0.52
	20% Solus™ 3050 solution	Performance additive	n/a	5.55
	DI Water		0.0	15.51
	Stapa Hydrolan 8154 AL pigment	Eckart aluminum pigment	5.34	5.76
H	10% DMEA — adjust pH to 7.8–8.1		0.33	0.44
I	DI water		13.39	13.79
	Eastman™ EB butyl glycol	Solvent	2.12	0.0
	Total		**100.00**	**120.37**
	Pigment/binder ratio		0.16	0.16
	Percent of solids		22.40	20.07
	Melamine/total resin ratio		0.26	0.26
	VOC (g/l)		417	418

[a] *10% Viscalex HV 30 solution was made by mixing 64.2% of DI water, 2.5% of 10% DMEA solution and 33.3% of Viscalex HV 30.*

Example formulations continued

Add A to pot. Mix ingredients of D1 and then D in a separate container. Then add B through G in listed order to the pot under agitation.

Automotive refinish metallic basecoat formulation

		Raw materials	NV(%)	Control	With 8% Eastman Solus™ 3050 performance additive
A		Nuplex Setalux 6803 AQ-24[a]	24.00	556.0	556.0
		Cytec Daotan VTM 1262/35WA[b]	35	163.0	163.0
		DI water	0	68.6	68.6
		Eastman™ EB butyl glycol	0	24.0	24.0
B		TEGO Foamex 825	26	0.9	0.9
C		10% DMEA	0	13.7	13.7
D	D1	Eastman™ EB butyl glycol	0	61.8	48.1
		Cytec Additol XL 250	47	5.5	5.5
		DI water	0	0.0	34.3
		20% Solus™ 3050 solution	20	0.0	76.2
	D2	Eckart Stapa Hydrolan 8154 AL pigment	60	58.4	61.8
E		10% DMEA (adjust PH to 7.8–8.1)	0	6.9	6.9
F		DI water	0	34.3	68.6
G		Eastman™ EB butyl glycol	0	6.9	0.0
		Total		**1000.0**	**1127.7**
		Pigment/binder ratio		0.165	0.162
		Percent of solids		22.83	21.78
		VOC (g/l)		405	407

[a] *Rheology modified acrylic emulsion Nuplex*
[b] *PUD from Cytec*

Appendix 1 Potential co-solvents for making Eastman Solus™ 3050 performance additive solutions

Brand name	Evaporation rate	Chemical name	Solubility	Solubility in solvent/water mixture[a]	Viscosity of 20% Solus™ 3050 solution @25 °C (cP)[a]
Eastman™ EP	0.2	Ethylene glycol propyl ether	✓	✓	3517
Eastman™ EB	0.09	Ethylene glycol butyl ether (butyl glycol)	✓	✓	2160
Eastman™ PM	0.7	Propylene glycol methyl ether	✓	✓	*see footnote*[b]
Dow Dowanol PnP	0.2	Propylene glycol n-propyl ether	✓	✓	1145
Dow Dowanol PnB	0.09	Propylene glycol n-butyl ether	✓	✓	9500
Eastman™ DM	0.02	Di-ethylene glycol methyl ether	X	Not tested	N/A
Eastman™ DB	0.003	Di-ethylene glycol butyl ether	X	Not tested	N/A
Dow Hexyl Cellosolve	0.01	Ethylene glycol monohexyl ether	X	Not tested	N/A
Eastman™ EEH	0.003	Ethylene glycol 2-ethylhexyl ether	X	Not tested	N/A
Eastman™ PM acetate	0.39	Propylene glycol methyl ether acetate	X	Cloudy	1728
IPA	1.7	Isopropyl alcohol	X	Insoluble	N/A
Ethanol	1.7		✓	✓	*see footnote*[b]
n-Butanol	0.5		X	Insoluble	N/A
2-Ethylhexanol	0.01		X	Not tested	N/A
Acetone	6.1		✓	✓	*see footnote*[b]
MEK	3.8	Methyl ethyl ketone	✓	✓	*see footnote*[b]
NMP	0.04	N-methyl-2-pyrrolidone	✓	Not tested	N/A

[a] *20% Solus™ 3050 performance additive in 2.5:1, solvent:water mixture; 100% neutralized with DMEA.*
[b] *The viscosity was too high to measure, but the solution was transparent and free of seeds after further reduction with DI water or a solvent/DI water mixture.*

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