EASTMAN

Formulating VOC and HAP compliant coatings with Eastman™ MAK and MIAK

Introduction

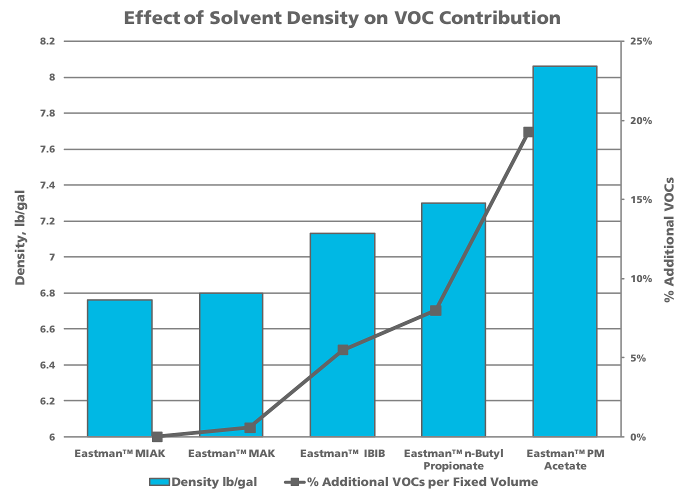
As VOC (volatile organic compound) regulations continue to push for more stringent limits, formulating compliant coatings with exempt solvents will become more challenging. Lower VOC limits mean that the use of exempt solvents will increase and there will be less latitude for the use of nonexempt solvents in formulations. This change means that formulators will have to carefully select each solvent they put into their formulas to have ***maximum impact on performance with minimal impact on VOCs.***

The purpose of this technical tip is to aid formulators by illustrating how Eastman™ MAK (Methyl N-Amyl Ketone) and Eastman™ MIAK (Methyl Isoamyl Ketone) can be used in conjunction with exempt solvents to formulate high performance coatings that are VOC and HAP (hazardous air pollutant) compliant.

Data

Eastman™ MAK and MIAK are slow evaporating solvents with exceptional solvency power. This combination of evaporation rate and solvency power makes them excellent tail solvents. In addition, they have low densities which means they contribute fewer VOCs per fixed volume than solvents with higher densities. And, they are non-HAPs. These attributes make MAK and MIAK particularly useful tools for formulating low VOC, non-HAP coatings with exempt solvents.

Figure 1 **Effect of solvent density on VOC contribution for a fixed volume of solvent**



The greatest challenge that formulators face is the limited options available to them. The list of commonly used exempt solvents is short, and each has its limitations.

Table 1 **Exempt solvents and their properties**

	Acetone	Methyl Acetate[1]	t-Butyl Acetate	PCBTF
Relative evaporation rate (nBuOAc = 1)	6.3	6.2	2.8	0.9
Density, lb/gal (g/L) @ 20°C	6.60 (792)	7.78 (933)	7.24 (862)	11.2 (1340)[2]
Flash point, TCC °F	−4	5[3]	40	109
Water solubility @ 20°C, wt% in water/ water in	100/100	22.7/8.8	0.3/ —	na

[1]Eastman™ Methyl Acetate – High Purity
[2]Density, g/L @ 25°C
[3]Setaflash

Acetone and methyl acetate both have excellent solvency but, they are very fast evaporating, extremely flammable and have high water solubility. Without blending with other slower evaporating solvents, formulating with either acetone or methyl acetate could lead to application difficulties and surface defects that could ultimately lead to poor coating performance and adhesion problems.

T-butyl acetate is a moderately efficient solvent, but its evaporation rate is too fast to be useful as a tail solvent. PCBTF (parachlorobenzotrifluoride) is the slowest evaporating exempt solvent that is commonly used in coatings. However, due to its lack of solvent activity, it is not a suitable tail solvent for many systems.

Table 2 **Common film defects – causes and cures**

Defect	Cause	Cure
Air entrapment	Fast solvent High viscosity	Slower solvent Lower viscosity
Humidity blushing	Fast solvent Humidity	Slower solvent Blush resistant
Solvent blushing	Incompatible tail solvent	Compatible tail solvent
Solvent popping	Fast solvent High volatility	Slower solvent Lower volatility
Orange peel	Fast solvent High viscosity	Slower solvent Lower viscosity

Table 2 lists some common coating film defects that result from improper solvent selection. These defects usually result from formulating with solvents that evaporate too quickly, like acetone and methyl acetate, or tail solvents with poor solvent activity, like PCBTF. Surface defects like the ones mentioned here are often cured by incorporating a good tail solvent, such as Eastman™ MAK or MIAK, into the solvent blend.

Demonstration

Photo 1 below demonstrates how a small amount of Eastman™ MAK was used to eliminate humidity blushing in a NC (nitrocellulose) lacquer. By offsetting the fast evaporation rate of the acetone and by having good compatibility for NC, the humidity blushing was eliminated.

To demonstrate the importance of selecting the proper tail solvent, a similar lacquer was prepared in methyl acetate using PCBTF to attempt to offset the fast evaporation rate. Since PCBTF is a poor solvent for NC and is the last solvent to leave as the film dries, solvent blushing occurred. Incorporation of a small amount of Eastman™ MAK eliminated the solvent blushing as seen in Photo 2 below.

Photo 1

Humidity blush
(40% humidity @ 72 °F)

NC/Acetone (10/90 wt.%) — NC/Acetone/MAK (10/85/5 wt%)

Photo 2

Solvent blush

NC/MeOAc/PCBTF (10/60/30 wt%) — NC/MeOAc/PCBTF/MAK (10/54/27/9 wt%)

In addition to surface defects prone to occur with the use of exempt solvents without incorporation of a suitable tail solvent, application difficulties could also arise. Cobwebbing and dry spray are, among a variety of spray condition variables, related to solvents evaporating too quickly.

The following photos illustrate how the incorporation of Eastman™ MAK (Formulation #3) eliminated dry spray.

Formulation #1

Formulation #2

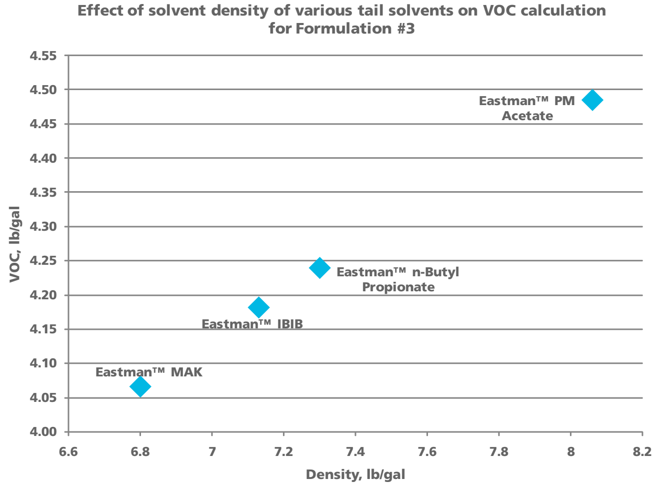
Formulation #3

Table 3 **Formulations**

Ingredient	Formulation #1 wt %	Formulation #2 wt %	Formulation #3 wt %
Eastman™ CAB 551-0.2	3.76	3.76	3.76
Eastman™ CAB 381-0.1	6.3	6.3	6.3
Paraloid™ B-66	10.8	10.8	10.8
Eastman™ 425 Pz	2.64	2.64	2.64
Acetone	76.5	26.77	51.88
PCBTF	0.0	49.73	0.0
Eastman™ MAK	0.0	0.0	25.32

Although Eastman MAK and MIAK are VOCs, they might be considered “VOC-lite” because they can be used to formulate coatings that have a lower VOC density. Figure 2 shows how substituting tail solvents of different densities for MAK affects the VOC calculation for Formulation #3 (above). This assumes equal solvent efficiencies, which is not the case, since ketones are typically known to be more efficient solvents than esters.

Figure 2 **Effect of solvent density of various tail solvents on VOC calculation for formulation #3**



Conclusion

These powerful solvents deliver high performance at a minimal VOC expense. This combination of attributes makes Eastman™ MAK and MIAK smart choices for formulators looking for low VOC, non-HAPs formulation options.

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