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Meeting aerosol coatings MIR limits with Eastman™ ester solvents

Introduction

In March 2008, the Environmental Protection Agency (EPA) published new Volatile Organic Content (VOC) Emission Standards for 36 aerosol coatings categories. The rule regulates the VOC content based on ozone formation potential of the individual formulation components, rather than the older mass-based approach. With this publication, EPA established the first federal reactivity based rule. Prior to this rule, only the Air Resources Board — California (ARB-CA) had used reactivity based VOC regulations.

With traditional mass-based VOC regulations, compounds are designated as a percentage VOC or as VOC-exempt. Even though some products are LVP-VOC or partial VOC in mass-based regulations, the difference between mass-based and MIR regulations is that MIR uses a value indicating a compound's potential to create ground level ozone (reactivity). This provides an additional level of differentiation in environmental impact. Lower density, high activity solvents are more beneficial in mass-based regulations. In the new methodology, all VOC materials are assigned a Maximum Incremental Reactivity (MIR) value which counts toward the coating category reactivity limit. Higher MIR values indicate more reactive compounds that have a greater tendency to form ground level ozone. The MIR of each VOC is used to calculate the grams of ozone formation potential per gram of formulated product. This is often referred to as the product-weighted MIR (PWMIR, g O_3/g product). Ester solvents typically have low MIR values which are beneficial when meeting reactivity-based limits.

While EPA modeled the new rule after California's reactivity based VOC regulations, there are differences. One major difference is the list of VOCs with approved MIRs. On June 23, 2009, EPA published the Final Rule which included an expanded list of solvent MIR values.[1] Although not as extensive as ARB-CA, the updated list provides formulators with more options in meeting aerosol coatings MIR limits than the May 2008 version of the EPA rule.

[1]*Federal Register, Environmental Protection Agency, 40 CFR, Parts 51 and 59, National Volatile Organic Compound Emission Standards for Aerosol Coatings — Final Rule, June 23, 2009.*

Eastman™ ester solvents

To reformulate existing aerosol coatings to meet either federal or California reactivity limits, the use of low MIR (< 1) solvents is necessary. Eastman offers several low MIR ester solvents to assist formulators in meeting aerosol coating category MIR limits (see Table 1).

Table 1 Eastman™ ester solvents — MIR values

Eastman™ solvents	Evaporation rate (n-BuOAc = 1)	MIR values[1]
Methyl acetate – high purity	6.2	0.07
Ethyl acetate, 99%	4.1	0.64
n-Propyl acetate	2.3	0.87
Isobutyl acetate	1.4	0.67
n-Propyl propionate	1.2	0.93
n-Butyl acetate	1.0	0.89
n-Butyl propionate	0.5	0.89
Isobutyl Isobutyrate (IBIB)	0.4	0.61
2-Ethylhexyl acetate	0.04	0.79
Ethylene Glycol Diacetate (EGDA)	0.02	0.72[2]

[1]*Approved MIR values by ARB-CA and EPA for aerosol coatings except EGDA which is ARB-CA approved only.*
[2]*ARB-CA approved only.*

Reformulating aerosol coating solvent blends using low MIR solvents

A clear coating aerosol formulation is shown in Table 2 with a PWMIR of 2.543. The federal and California Aerosol — Clear Coating limit is 1.5 g O_3/g product. To meet the limit, low MIR solvents are needed. Per Table 1, several options exist to reformulate the coating solvent blend. In addition to satisfying the MIR category limit, the evaporation rate and activity of the blend must be maintained.

Table 2 Clear coating aerosol formulation[1]

Ingredient	Weight percent	MIR (g O_3/g VOC)	Weighted MIR
Acetone	20	0.43	0.086
Toluene	20	3.97	0.794
Propane	10	0.56	0.056
Xylene	20	7.37	1.474
Butane	10	1.33	0.133
Solids	20	0.00	0.00
Total			**2.543**
Evaporation rate			1.6

[1]Chemical Engineering, December 2000.

In Table 3, xylene was replaced with Eastman™ n-Butyl acetate to reduce MIR. The blend was adjusted to maintain evaporation rate.

Table 3 Aerosol reformulation #1 — xylene replacement

Ingredient	Weight percent	MIR (g O_3/g VOC)	Weighted MIR
Acetone	20	0.43	0.086
Toluene	10	3.97	0.397
Propane	10	0.56	0.056
n-Butyl acetate	30	0.89	0.267
Butane	10	1.33	0.133
Solids	20	0.00	0.00
Total			**0.939**
Evaporation rate			1.7

In Table 4, toluene was replaced with Eastman™ isobutyl acetate to reduce MIR. The overall solvent blend was adjusted to maintain evaporation rate.

Table 4 Aerosol reformulation #2 — toluene replacement

Ingredient	Weight percent	MIR (g O_3/g VOC)	Weighted MIR
Acetone	20	0.43	0.086
Isobutyl acetate	27	0.67	0.181
Propane	10	0.56	0.056
Xylene	13	7.37	0.958
Butane	10	1.33	0.133
Solids	20	0.00	0.00
Total			**1.414**
Evaporation rate			1.6

Eastman™ methyl acetate – high purity

Eastman™ methyl acetate – high purity has an approved MIR of 0.07 for use in aerosol coatings. The fast evaporating ester is a suggested replacement for acetone in coatings applications. By utilizing Eastman™ methyl acetate – high purity, formulators can achieve the desired weighted MIR with greater toluene and/or xylene content as compared to acetone (see Tables 5 and 6).

Table 5 Aerosol reformulation #3

Ingredient	Weight percent	MIR (g O_3 /g VOC)	Weighted MIR
Methyl acetate – high purity	20	0.07	0.014
Toluene	13	3.97	0.516
Propane	10	0.56	0.056
n-Butyl acetate	27	0.89	0.240
Butane	10	1.33	0.133
Solids	20	0.00	0.00
Total			**0.959**

Table 6 Aerosol reformulation #4

Ingredient	Weight percent	MIR (g O_3 /g VOC)	Weighted MIR
Methyl acetate – high purity	20	0.07	0.014
Isobutyl acetate	26	0.67	0.174
Propane	10	0.56	0.056
Xylene	14	7.37	1.032
Butane	10	1.33	0.133
Solids	20	0.00	0.00
Total			**1.409**

Summary

To meet federal and California aerosol coating category MIR limits, the use of low MIR solvents is necessary. Ester solvents typically have lower MIR values compared to other oxygenated solvents and aromatic hydrocarbons such as toluene and xylene. Eastman offers a broad product line of ester solvents with low MIR values. Evaporation rates of these ester solvents range from fast to slow. Whether you are reformulating to meet California or federal aerosol coatings rules, Eastman is the one-stop source for ester solvents.

Please contact Eastman Chemical Company for more information on Eastman™ ester solvents for aerosol coatings.

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