

Eastman™ methyl *n*-amyl ketone (MAK) and Eastman™ methyl isoamyl ketone (MIAK)

Solvents for high-solids coatings

Title I of the Clean Air Amendment (CAA) requires that volatile organic compound (VOC) emissions from surface-coating processes be reduced. Many coating manufacturers suggest high-solids coatings as an alternative to conventional coatings to lower VOC emissions.

High-solids coatings are formulated with low molecular weight resins and/or oligomers containing functional groups that are cross-linked to produce a high-performance coating. Because of the lower solvent levels, curing conditions, and rheological characteristics of these coatings, the criteria for solvent selection differ significantly from those for low-solids coatings. Solvent activity, density, surface tension, evaporation rate, and boiling point assume greater importance. Experience has shown that ketone solvents such as Eastman™ MAK

(methyl *n*-amyl ketone) and MIAK (methyl isoamyl ketone) provide the best overall balance of these properties for many high-solids coatings. This brochure contains information on the properties of Eastman MAK and MIAK in high-solids coatings.

High solvent activity

High activity is an important solvent property when formulating coatings that must satisfy regulatory guidelines and, at the same time, have the proper application viscosity. Solution viscosity data in Table 1 show that Eastman MAK and MIAK are more effective in lowering the viscosity of high-solids resins than ester, aromatic hydrocarbon, and glycol ether solvents with similar evaporation rates.

Table 1 Solution viscosity

Solvent	Evaporation rate (<i>n</i> -BuOAc = 1)	Solution viscosity, cP, 25°C			
		Aroplaz™ ^a 6755-A6-80 polyester resin (70 wt% solids)	Polymac™ ^b HS 5776 polyester resin (65 wt% solids)	Paraloid™ ^c AT-400 acrylic resin (65 wt% solids)	Acrylamac™ ^d HS 2980 acrylic resin (70 wt% solids)
Xylene	0.7	688	157	1,020	548
Eastman™ methyl isoamyl ketone	0.5	661	85	860	389
<i>n</i> -Butyl propionate	0.5	671	155	910	478
Eastman™ methyl <i>n</i> -amyl ketone	0.4	528	123	772	498
Eastman™ PM acetate	0.4	885	254	1,040	671
Isobutyl isobutyrate	0.4	902	212	1,080	681
Aromatic 100	0.29	775	194	1,230	671
<i>n</i> -Pentyl propionate	0.2	785	200	1,040	551
Eastman™ EP solvent	0.2	902	249	969	621
Oxo-hexyl acetate	0.17	877	225	1,090	685
Eastman™ EEP solvent	0.12	843	210	952	621
Eastman™ EB solvent	0.06	960	311	1,010	665

^aSupplied by Reichold Inc. @ 80 wt% solids in a 65:35 blend of PM acetate and toluene. The resin was diluted to 70 wt% solids with solvent shown.

^bSupplied by Eastman @ 85 wt% solids in PM acetate. The resin was diluted to 65 wt% solids with solvent shown.

^cSupplied by Rohm and Haas @ 75 wt% solids in Eastman MAK. The resin was diluted to 65 wt% solids with solvent shown.

^dSupplied by Eastman @ 80 wt% solids in Eastman MAK. The resin was diluted to 70 wt% solids with solvent shown.

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Solvents for high-solids coatings (Continued)

Low density

Because most VOC regulations limit the weight of solvent per volume of coating, the use of low-density solvents is beneficial. Lower density enables the formulator to add more volume of solvent for a given weight.

The data in Table 2 show that Eastman MAK and MIAK are lower in density than ester, aromatic hydrocarbon, and glycol ether solvents with similar evaporation rates. The low density of MAK and MIAK is a significant advantage in the formulation of low-viscosity, high-solids coatings.

Table 2 Effect of solvent density on volume solids and VOC content of a high-solids coating

Components	Wt%
Ti-Pure™ R-902 TiO ₂ ^a	30.0
Paraloid™ AT-400 acrylic resin ^b	30.0
Cymel™ 303 melamine resin ^c	10.0
Solvent	30.0
	100.0

Solvent	Density @ 20°C	Volume % solids	VOC g/L (lb/gal)
Eastman™ methyl isoamyl ketone	6.76	53.4	377.0 (3.15)
Eastman™ methyl <i>n</i> -amyl ketone	6.80	53.5	378.2 (3.16)
Xylene	7.20 ^d	55.1	389.0 (3.25)
Aromatic 100	7.27 ^d	55.2	390.2 (3.26)
<i>n</i> -Butyl propionate	7.29	55.2	390.2 (3.26)
<i>n</i> -Pentyl propionate	7.30	55.3	390.2 (3.26)
Oxo-hexyl acetate	7.30	55.3	390.2 (3.26)
Eastman™ EB solvent	7.51	55.9	395.0 (3.30)
Eastman™ EP solvent	7.59	56.3	397.3 (3.32)
Eastman™ EEP solvent	7.91	57.3	404.5 (3.38)
Eastman™ PM acetate	8.06	57.7	408.1 (3.41)

^aDuPont

^bRohm and Haas—supplied at 75% NV in Eastman™ MAK—calculation based on 100% NV resin

^cCytec

^d15°C

Low surface tension

In many high-solids coatings, the surface tension of the coating increases as the solids content increases. This higher surface tension can contribute to poor sprayability, insufficient wetting, cratering, and “picture framing.” Because all nondispersed coating components influence surface tension, the use of solvents with low surface tension should help minimize surface defects. Table 3 shows surface tension values for medium- to slow-evaporating solvents.

Table 3 Solvent surface tension

Solvent	Surface tension dynes/cm, 20°C
Isobutyl isobutyrate	23.2
Oxo-hexyl acetate	25.0
<i>n</i> -Butyl propionate	25.1
Eastman™ methyl isoamyl ketone	25.8
Eastman™ methyl <i>n</i> -amyl ketone	26.1
Eastman™ PM acetate	26.4
<i>n</i> -Pentyl propionate	26.5
Eastman™ EB solvent	26.6
Eastman™ EEP solvent	27.0 ^a
Eastman™ EP solvent	27.9 ^b
Xylene	28.7
Aromatic 100	29.0

^a23°C

^b25°C

Slow evaporation rate

The proper solvent evaporation profile for a high-solids coating depends on many factors—method of application, desired surface appearance, wet-film thickness, and curing conditions. Since most of the solvent content of high-solids coatings comes from the resins, little adjustment of the solvent system is possible. However, the solvent system must evaporate slowly enough to prevent solvent popping, prevent paint particles from drying during application and losing their electrostatic charges, and provide sufficient flow and leveling. Medium- to slow-evaporating solvents such as Eastman MAK and MIAK provide good application characteristics in high-solids coatings applications. Evaporation rates for specific solvents are supplied in Table 1.

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Solvents for high-solids coatings *(Continued)*

Boiling point

Eastman MAK and MIAK are useful as polymerization solvents for high-solids acrylic resins. The high boiling point of MAK (150°C) and MIAK (144°C) aids in the production of low molecular weight acrylic resins with narrow molecular weight distribution. Other important properties are good solvent activity for the resin and chemical processing stability.

Acrylic resins prepared in MAK and MIAK are useful for formulating high-solids coatings that meet demanding performance standards yet satisfy lower VOC emissions guidelines. MAK and MIAK are also useful as let-down solvents for high-solids alkyd and polyester resins because of their high boiling point, high solvent activity, and chemical stability.

Table 4 lists some commercial acrylic, alkyd, and polyester high-solids resins which, as supplied, contain either Eastman MAK or MIAK.

Table 4 Commercial resins supplied in Eastman™ MAK or MIAK

Resin	Supplier	Eastman™ solvent
Paraloid™ AT-400 ^a	Rohm and Haas	MAK
Paraloid™ AT-410 ^a	Rohm and Haas	MAK
Coroc™ resin A-3866-M ^a	CCP/Polymer Products Inc.	MAK/xylene
Coroc™ resin A-4069-K3 ^a	CCP/Polymer Products Inc.	MAK
Acrylamac™ HS 2980 ^a	Eastman	MAK
Joncryl™ 500 ^a	SC Johnson	MAK
Beckosol™ 12-501 ^b	Reichold, Inc.	MAK
Macopol™ HS 2758 ^b	Eastman	MAK
Duramac™ HS 5797 ^b	Eastman	MIAK/ <i>n</i> -BuOAc
Rezamac™ HS 5747 ^c	Eastman	MAK/ <i>n</i> -BuOAc
Duramac™ 7784 ^d	Eastman	MAK

^aHigh-solids acrylic

^bHigh-solids alkyd

^cSilicone-modified polyester

^dConventional alkyd



**Eastman Chemical Company
Corporate Headquarters**

P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

Telephone:
U.S.A. and Canada, 800-EASTMAN (800-327-8626)
Other Locations, (1) 423-229-2000
Fax: (1) 423-229-1193

Eastman Chemical Latin America

9155 South Dadeland Blvd.
Suite 1116
Miami, FL 33156 U.S.A.

Telephone: (1) 305-671-2800
Fax: (1) 305-671-2805

Eastman Chemical B.V.

Fascinatio Boulevard 602-614
2909 VA Capelle aan den IJssel
The Netherlands

Telephone: (31) 10 2402 111
Fax: (31) 10 2402 100

**Eastman (Shanghai) Chemical
Commercial Company, Ltd. Jingan Branch**

1206, CITIC Square
No. 1168 Nanjing Road (W)
Shanghai 200041, P.R. China

Telephone: (86) 21 6120-8700
Fax: (86) 21 5213-5255

Eastman Chemical Japan Ltd.

MetLife Aoyama Building 5F
2-11-16 Minami Aoyama
Minato-ku, Tokyo 107-0062 Japan

Telephone: (81) 3-3475-9510
Fax: (81) 3-3475-9515

Eastman Chemical Asia Pacific Pte. Ltd.

#05-04 Winsland House
3 Killiney Road
Singapore 239519

Telephone: (65) 6831-3100
Fax: (65) 6732-4930

www.eastman.com

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