

Eastman performance solvents—technical tip

A non-HAP replacement for toluene in solventborne coatings

Introduction

Eastman *n*-propyl propionate is a relatively new addition to Eastman's broad line of performance solvents. It is a low odor, medium evaporating, non-HAP ester solvent with good solvent activity and versatility. Since *n*-propyl propionate is not on EPA's HAP (Hazardous Air Pollutant) list, it is useful as a replacement for commonly used aromatic hydrocarbon solvents such as toluene.

Key attributes

- Low maximum incremental reactivity (MIR) value: Useful for formulating aerosol coatings for the California market.
- Good solvent activity: Dissolves a wide range of polymers.
- Medium evaporation rate: Provides good flow and leveling in air dry and thermoset coatings.
- Mild odor: Useful in coating applications where solvent odor is a concern.
- Low surface tension: Improves atomization, wetting, flow, and leveling.
- Low water solubility: Minimizes water pickup during storage.
- Urethane grade: Suitable for use with moisture sensitive polymers.
- High electrical resistance: Helpful when formulating electrostatically applied coatings with good transfer efficiency.
- Non-HAP under Title III of the Clean Air Act (CAA).

Application/uses

- Coatings—OEM (original equipment manufacturer) and special purpose
- Process solvent for high-solids acrylic resins
- Industrial cleaners
- Industrial printing inks
- Automotive refinishing
- Appliance coatings

The information in this technical tip was developed to assist formulators in replacing toluene with Eastman *n*-propyl propionate in selected solventborne coatings.

Table 1 Physical properties of Eastman *n*-propyl propionate vs. toluene

Properties	Eastman <i>n</i> -propyl propionate	Toluene
Evaporation rate (<i>n</i> -BuOAc = 1)	1.2	1.9
Specific gravity @ 20°/20°C	0.881	0.866
Weight/volume @ 20°C, kg/L (lb/gal)	0.88 (7.34)	0.87 (7.25)
Odor	Ester	Aromatic
Boiling range @ 760 mmHg, °C	119–124	109–112
Flash point setaflash, °F	71.6	45 (TCC)
Solubility, in water @ 20°C, weight %	0.5	Insoluble
Hansen solubility parameters		
Nonpolar	7.6	8.8
Polar	1.8	0.7
Hydrogen bonding	3.6	1.0
Total	8.6	8.9
Electrical resistance, megohms	>20	>20
MIR value (maximum incremental reactivity) ^a	0.93	3.97
HAP ^b	No	Yes

^aReference—"Regulation for Reducing the Ozone Formed from Aerosol Coating Product Emissions" (subchapter 8.6)

^bHazardous Air Pollutant—Environmental Protection Agency

Replacing toluene in a two-component polyurethane clearcoat system

Initial evaluations were conducted to determine whether the oxygenated solvent, Eastman *n*-propyl propionate, could be used to replace toluene in a two-component polyurethane clearcoat. Using Eastman's Solvent Reformulation Wizard, physical properties of the control solvent blend were generated. A replacement blend was developed by substituting *n*-propyl propionate for toluene and adjusting the overall blend composition to obtain an evaporation rate similar to the control. While developing a replacement solvent blend with a similar evaporation rate is important, it is crucial that the replacement blend also have similar activity. The solvents in the replacement blend must dissolve the resin(s) in the coating to achieve the desired application and film properties.

Table 2 Two-component polyurethane clearcoat formulations

Component	Control weight %	Reformulation weight %
Eastman cellulose acetate butyrate (CAB-551-0.2)	5.00	5.00
Solvent blend		
Eastman <i>n</i> -butyl acetate	22.90	22.90
Eastman MPK (methyl <i>n</i> -propyl ketone)	12.50	14.83
Eastman <i>n</i> -butyl propionate	10.00	7.67
Toluene	11.50	—
Eastman <i>n</i>-propyl propionate	—	11.50
Eastman EEP solvent	5.00	5.00
<i>Mix until complete solution</i>		
Acrylic resin solution (60% NV)	23.50	23.50
Catalyst	0.40	0.40
Light stabilizer	1.30	1.30
Surface additive	0.30	0.30
<i>Mix 5 minutes</i>		
Isocyanate (75% NV)	7.60	7.60

Table 3 Solvent blend properties

Component	Control	Reformulation
Evaporation rate (<i>n</i> -BuOAc = 1)	0.9	0.9
Hansen solubility parameters		
Nonpolar	7.94	7.72
Polar	1.96	2.25
Hydrogen bonding	2.59	3.05
Total	8.58	8.60
Weight volume, lb/gal	7.25	7.24

Table 4 Formulation constants

Component	Control	Reformulation
% NV weight (calculated)	25	25
NCO:OH ratio	1.1:1	1.1:1
Viscosity @ 26°C, #4 Ford cup, s ^a	17	16.5
HAP content, weight % (calculated)	21.34	9.92

^aASTM D1200—Ford cup viscosity

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A non-HAP replacement for toluene in solventborne coatings (Continued)

Table 5 Typical cured film properties

Component	Control	Reformulation
Dry-to-touch, min.	~30	~30
Dry film thickness (mils) ^a	2	2
Pendulum hardness ^b		
1-day cure	62	62
7-day cure	77	76
14-day cure	106	107
Tukon hardness ^c		
1-day cure	5	5
7-day cure	7	7
14-day cure	9	9
Gloss (60°/20°) ^d		
1-day cure	81/94	82/95
7-day cure	81/94	82/94
14-day cure	82/94	82/95
Color—L*a*b* ^e		
L*	39.3	39.3
1-day cure a*	1.78	1.77
b*	0.69	0.69
Impact—direct/reverse (in./lb) ^f		
14-day cure	87/<5	87/<5

^aETG (Electronic Thickness Gauge)—Pro Motorcar Products

^bASTM D4366—König Pendulum Hardness Tester

^cASTM D1474—Tukon Microhardness Tester

^dASTM D523—Gardco Statistical Novo-Gloss

^eMinolta CM-508d—Spectrophotometer

^fASTM D2794—Universal Impact Tester

Conclusion

When the control and replacement coatings were applied at similar film thickness and allowed to cure, the formulations yielded coatings with comparable physical properties. In-house lab evaluations show that *n*-propyl propionate can effectively replace toluene in selected solventborne coatings. With good solvent activity, Eastman *n*-propyl propionate is compatible with a wide range of polymers, yielding high-solids coatings with appropriate application viscosity. The difference in evaporation rate of *n*-propyl propionate and toluene, 1.2 and 1.9 respectively, may require the addition of a faster evaporating solvent such as Eastman MPK to achieve the desired evaporation rate characteristics.

Eastman *n*-propyl propionate is a low odor, non-HAP option for replacing aromatic hydrocarbon solvents. It provides a viable alternative for coatings formulators challenged to meet regulatory requirements. Eastman *n*-propyl propionate is one of the many formulating options offered by Eastman's broad line of performance solvents.

Table 6 Regulatory status

Regulation	Eastman <i>n</i> -propyl propionate
HAP (Hazardous Air Pollutant)	No
ODS ^a	No
SNAP Acceptable (Significant New Alternative Program)	Yes
SARA 313 (Superfund Amendments and Reauthorization Act), Title III, Section 313 ^b	No
TSCA (US Toxic Substances Control Act) ^c	Listed
DSL and CEPA (Canadian Domestic Substances List and Canadian Environmental Protection Act) ^d	Listed
EINECS Number (European Inventory of Existing Commercial Chemical Substances) ^e	203-389-7
AICS/NICNAS (Australian Inventory of Chemical Substances and National Industrial Chemicals Notification and Assessment Scheme) ^f	Listed
MITI (Japanese Handbook of Existing and New Chemical Substances) ^g	Listed
ECL (Korean Toxic Substances Control Act) ^h	Listed
PICCS (Philippines Inventory) ⁱ	Listed
IECSC (Inventory of Existing Chemical Substances in China) ^j	Listed

^aLow environmental impact-zero ODS, therefore not subject to phase-out under the Montreal Protocol as amended.

^bAlso known as Emergency Planning and Community Right-to-Know Act (EPCRA).

^cOn the TSCA inventory—Any impurities present in this product are exempt from listing.

^dOn the DSL—Any impurities present in this product are exempt from listing.

^eOn EINECS or otherwise complies with EINECS requirements—Any impurities present in this product are exempt from listing.

^fOn AICS or otherwise complies with NICNAS.

^gIn Handbook or has been approved in Japan by new substance notification.

^hOn the Korean inventory or otherwise complies.

ⁱOn the Philippine Inventory or otherwise complies with PICCS.

^jAll components of this product are listed on the inventory.



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