Solvents

Eastman EP solvent for:

Solventborne coatings

- Lacquers
- Enamels
- High solids

Waterborne coatings

- Solution
- Dispersions
- Emulsions

Eastman EP solvent in solventborne coatings

An effective and proven substitute for ethylene glycol ethyl ether (EGEE) solvent

Features

- Low odor
- High flash point
- Good activity
- Complete water miscibility
- Excellent aqueous coupling for polar organic phases
- Rapid viscosity reduction of waterborne resins

Eastman EP solvent has a unique balance of properties not found in EGEE solvent or propylene glycol alkyl ethers. It is a slow-evaporating (0.2), colorless, low-odor, water-miscible solvent. It has a milder, less detectable odor than most other glycol ethers, which is particularly important in trade sales paints and ink applications.

In many coating formulations, Eastman EP solvent can easily be substituted for EGEE solvent with little or no adjustment because of the similarity in their evaporation rate and solvent activity. Formulators appreciate the simplicity of a single substitution rather than detailed blend replacements.

Some key features of Eastman EP solvent in solventborne coatings follow.

Eastman EP solvent has a flash point greater than 38°C (100°F) and does not require a red label.

The flash point of Eastman EP solvent is 49°C (120°F) (TCC). Solvents with flash points at or above 38°C (100°F) and below 93°C (200°F) give finished products which can be classified as combustible rather than flammable for shipping and handling under DOT guidelines.

Solvent	Flash point °C (°F) (TCC)
Ethylene glycol ethyl ether (EGEE)	43 (110)
Eastman EP	49 (120)
Eastman PM	34 (94)

Eastman EP solvent is an effective retarder solvent with good blush resistance in lacquer systems.

It is superior in moisture blush resistance to both EGEE solvent and Eastman PM, which is an important property in the successful application of lacquer coatings under high humidity conditions.

Solvent	Blush resistance, % RH at 27°C (80°F)
EGEE	59
Eastman EP	90
Eastman PM	56

Eastman EP solvent has a linear evaporation rate, which promotes good paint rheology with satisfactory drying rates.

Eastman EP solvent is slightly slower in evaporation than EGEE solvent. When replacing EGEE solvent in coatings that are applied by brush, roller, or spray, the slower evaporation rate of Eastman EP will provide consistently smooth coatings with excellent leveling and gloss.

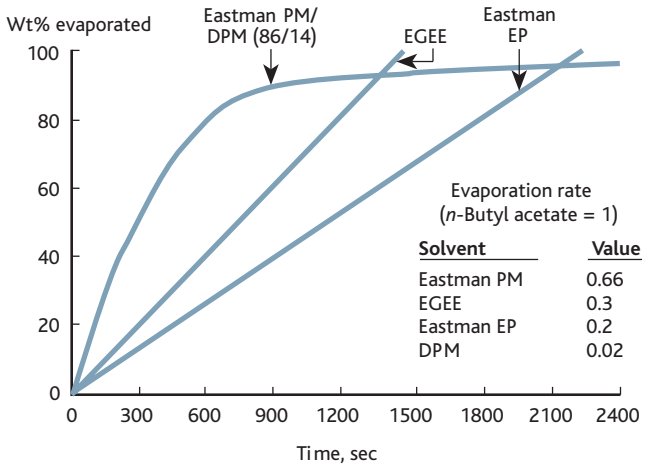
The use of a considerably faster-evaporating glycol ether (Eastman PM solvent) than EGEE solvent can produce brush marks, blistering, and inferior flow and leveling in a solventborne coating. Blends of Eastman PM and a slower-evaporating glycol ether such as dipropylene glycol monomethyl ether (DPM) can be selected to match the evaporation rate of EGEE solvent, but the blend does not evaporate at a constant rate (Figure 1). The PM/DPM blend (86/14) matches the 90 wt% loss evaporation time of EGEE solvent, but the curve also reveals that 85 wt% of the PM/DPM blend has evaporated in the same time as only 50 wt% of the EGEE solvent. This difference in solvent loss versus time would have a significant effect on the rheology and handling characteristics of the coating.

The slow release of DPM from the film, as noted by the slope of the curve, could affect the hardening rate, water sensitivity, and weathering properties of the coatings (see section on solvent release).

Eastman EP solvent is an active solvent for a broad range of coating resins.

Glycol ethers, because of their dual functionality, are effective solvents for nitrocellulose, acrylic, epoxy, polyamide, polyester, and alkyd resins. Shown here is the solubility of various resins in three glycol ethers.

Figure 1 **Comparison of evaporation rates of glycol ethers**



Polymer solubility

Resin	% NV	EGEE	Eastman EP	Eastman PM
Nitrocellulose, ½ sec	10	S	S	S
Nitrocellulose, ¼ sec	10	S	S	S
CAB-553-0.4	10	S	S	S
CAB-381-0.5	10	S	I	S
Vinyl chloride/ vinyl acetate	10	I	I	I
Epoxy	50	S	S	S
Polyamide	50	S	S	S
Acrylic	30	S	S	S

Legend: S = Soluble, I = Insoluble

All of these solvents exhibit good activity for epoxy and polyamide resins, which normally require glycol ethers for satisfactory paint stability and application properties.

With most resin systems, Eastman EP will produce a slightly higher solution viscosity than EGEE solvent. Normally in coating systems, higher-molecular-weight solvents in the same homologous series give higher solution viscosities than lower-molecular-weight solvents. The viscosity differences between the ethyl and propyl derivatives are not unexpected.

Solution viscosity (cP) of epoxy resin in glycol ethers

% NV	EGEE	Eastman EP	Eastman PM
50	190	247	190
40	61	78	58
30	23	31	20

In a complete coating formulation, the replacement of EGEE solvent with Eastman EP solvent may yield little or no increase in solution viscosity. Minor solvent adjustments are easily made to compensate for any viscosity differences.

Eastman EP solvent offers outstanding aliphatic hydrocarbon tolerance.

A high nitrocellulose dilution ratio can result in considerable cost savings to the paint formulator. Eastman EP solvent has a higher VM&P naphtha dilution ratio than either EGEE solvent or Eastman PM. Dilution ratios for each glycol ether follow:

	Dilution ratio	
Solvent	Toluene	VM&P naphtha
EGEE	5.0	1.1
Eastman EP	4.0	2.0
Eastman PM	5.2	0.9

Eastman EP solvent has a good balance of properties for coating plastic substrates.

Glycol ethers are very useful in coating plastic substrates because of their:

- Good activity for many synthetic coating resins.
- Minimal solvent attack (crazing) on the surfaces of sensitive plastics such as polystyrene and polycarbonate.

Glycol ethers offer a good balance of high activity and low crazing tendencies, while the use of ketone, ester, and aromatic hydrocarbon solvents can cause crazing on solvent-sensitive plastic surfaces. Alcohols and aliphatic hydrocarbons are a good choice to avoid solvent crazing, but they have limited activity for synthetic coating resins.

A lacquer retarder solvent in coatings for plastic parts should also have:

- High aliphatic hydrocarbon dilution ratio.
- Good blush resistance.
- Slow evaporation rate.

Eastman EP solvent meets all of these requirements and can be used as a replacement for EGEE in a number of coatings systems. A comparison of the use of Eastman EP solvent and EGEE as the glycol ether component in a barrier coating for high-impact polystyrene follows:

Component	Wt%
CAB-381-0.5	1.92
Acrylic resin	8.40
SAIB-90T	1.87
TiO_2/CAB-381-0.5 (60/40) pigment grind	12.00
Acetone	30.20
Isopropyl alcohol	14.81
Glycol ether[a]	14.60
Toluene	13.20
Eastman EEP solvent[b]	3.00
	100.00

[a] *EGEE or Eastman EP.*

[b] *Ethyl 3-ethoxypropionate.*

Eastman EP solvent is an effective replacement for EGEE solvent in epoxy coatings.

Eastman EP solvent has demonstrated satisfactory performance as a substitute for EGEE solvent in two-component epoxy formulations for metal and maintenance finishes. The evaporation rate, solubility parameters, and water miscibility of both products are similar; therefore, Eastman EP solvent can often be used as a direct replacement for EGEE solvent. Added benefits when making the change are higher flash point, superior blush resistance, and improved VM&P naphtha tolerance.

Eastman EP has a higher boiling range than EGEE solvent or Eastman PM.

The high boiling point of Eastman EP solvent allows potentially safer handling of the solvent during the thinning of hot synthetic resins. Another potential safety advantage during the thinning process is the higher flash point of Eastman EP solvent compared with both EGEE and Eastman PM solvents.

Solvent	Boiling range, °C (°F)
EGEE	134–136 (273–277)
Eastman EP	149–154 (300–390)
Eastman PM	117–125 (243–257)

Lower density is an advantage in complying with air pollution regulations which restrict the VOC (volatile organic compound) emitted to the atmosphere. VOC guidelines limit the maximum weight of a solvent for a given volume of coating. Lower density means a formulator can use more volume of solvent for a given weight of solvent in the final paint. Also, lower density is beneficial where solvent is purchased by the pound and the coating is sold by the gallon.

Solvent	Wt/gal (lb)
EGEE	7.75
Eastman EP	7.59
Eastman PM	7.69

Eastman EP solvent features fast solvent release.

Excess solvent retention in a film can result in poor rubbing and sanding characteristics, slow film hardness development, and inferior physical properties. The linear structure of Eastman EP solvent allows it to diffuse through a film rapidly, thus aiding the handling and packaging of the painted article.

Comparison of film-hardening rates of DER684[a] epoxy resin (24 h drying)

Solvent	Tukon hardness, Knoops
EGEE	6.4
Eastman EP	5.2
Eastman PM	4.4
PM/DPM (86/14)	3.3

[a]*Product of Dow Chemical (40% NV in MEK)—reduced to 20% NV with appropriate glycol ether prior to evaluation.*

Eastman EP solvent in waterborne coatings

Extra pluses as a coupling solvent and coalescing aid in aqueous coatings

In the manufacture of waterborne coatings, it is often necessary to incorporate a glycol ether to:

- Provide a homogeneous resin/water solution or coupling and confer good application and film formation rheology.
- Coalesce or fuse the polymer particles of an emulsion into a smooth, continuous paint film.

The good hydrolytic stability, complete water miscibility over a wide temperature range, and good coupling efficiency of Eastman EP make it of special interest in waterborne coatings and inks. Many of these advantages are reviewed in the following sections.

Eastman EP solvent, when combined with slower-evaporating solvents, is an effective coalescing aid for high T_g acrylic emulsions when fast dry and rapid hardness are required.

High T_g acrylic emulsions require coalescing aids for satisfactory film formation. Eastman EB solvent is the most widely used coalescing aid in high T_g acrylic emulsions; however, the type and level of coalescent are determined by drying conditions (temperature, humidity), polymer hardness, and stability requirements. For low relative humidity conditions (<50%), blending Eastman EP solvent with Eastman EB solvent will enhance the drying speed and hardening rate of the film. If relative humidity conditions are high (60% to 90%), the addition of a higher-boiling solvent such as Eastman DB glycol ether or Texanol™ ester alcohol is needed to ensure good film formation. Normal coalescing aid levels for high T_g acrylic emulsion are 20–35 wt% based on emulsion solids.

Eastman EP solvent is a good coupling agent for combining water-insoluble polar materials with water.

Eastman EP solvent has demonstrated good coupling activity for water-insoluble polar organic phases, important for maintaining good solution homogeneity. When Eastman EP is added to a multiphase system, it will selectively partition between the organic and aqueous phases, thus coupling the multiphase system into a homogeneous phase. For polar phases, Eastman EP solvent is a more efficient coupling solvent than Eastman™ PM solvent.

Eastman EP solvent exhibits complete water miscibility at elevated temperatures.

Most glycol ethers used in waterborne coatings are completely miscible in water, but some revert to a heterogeneous phase with increasing temperature. This inverse solubility with temperature could cause aqueous paint stability problems at elevated temperatures during storage, or poor film appearance under certain baking conditions. As shown below, Eastman EB solvent and propylene glycol monopropyl ether are completely miscible with water at room temperatures, but they are immiscible at elevated temperatures. Eastman EP solvent is completely miscible with water over the temperature range shown.

Miscibility[a] vs. temperature, °F

Temperature	Eastman EP	Eastman EB	PG monopropyl ether
80	M[b]	M	M
100	M	M	30
120	M	M	20
140	M	10	16
160	M	6	13

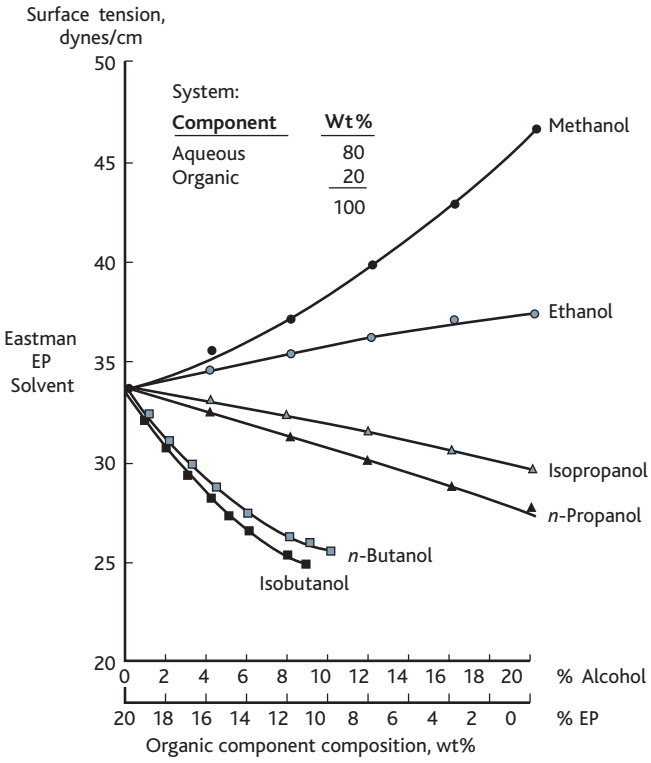
[a] *Solubility or organic phase in water, volume %.*

[b] *M = completely miscible.*

Eastman EP solvent helps reduce the surface tension of aqueous systems for improved surface-wetting properties.

Surface tension values of liquid coatings are largely determined by the solvents in the coating. Water has a very high surface tension (72 dynes/cm), so aqueous coatings are more prone to surface-wetting defects than solventborne coatings. Adding a glycol ether will reduce the surface tension of an aqueous coating, thereby improving application characteristics. An 80/20 mixture of water/Eastman EP solvent has a surface tension value of approximately 33.7 dynes/cm at 25°C. Further reduction in surface tension can be obtained by adding selected alcohols (Figure 2).

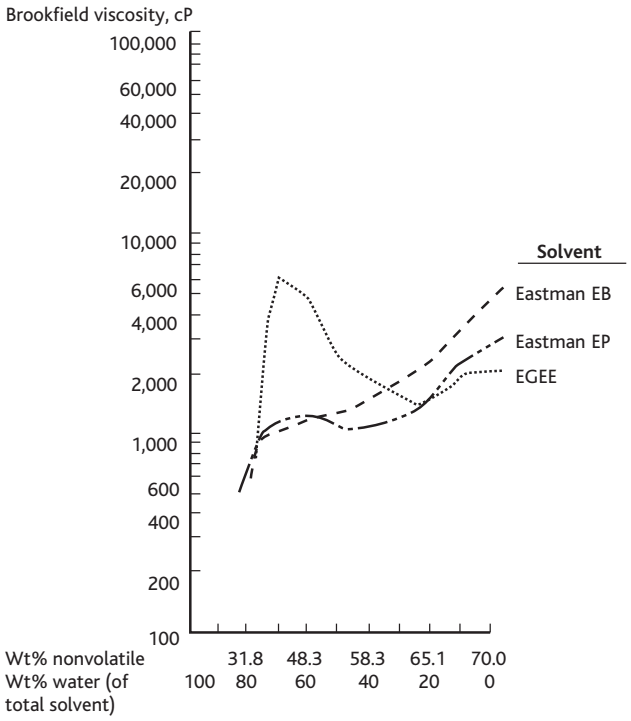
Figure 2 Surface tension vs. solution composition



Eastman EP solvent provides favorable handling characteristics for processing waterborne resins.

As a solvent for "cutting" waterborne resins, Eastman EP solvent is more active (gives lower viscosity) than Eastman EB solvent and Eastman PM. During aqueous thinning of the neutralized resin, Eastman EP provides a smooth viscosity reduction profile. With lower-molecular-weight glycol ethers (EGEE), substantial viscosity increases can occur during the aqueous dilution process, creating materials handling problems (Figure 3).

Figure 3 **Aqueous viscosity dilution curve for polyester resin dissolved in ethylene glycol monoether solvents**



Eastman EP solvent provides a good balance of activity during the resin "cut" and imparts organic character to the aqueous reduction process.

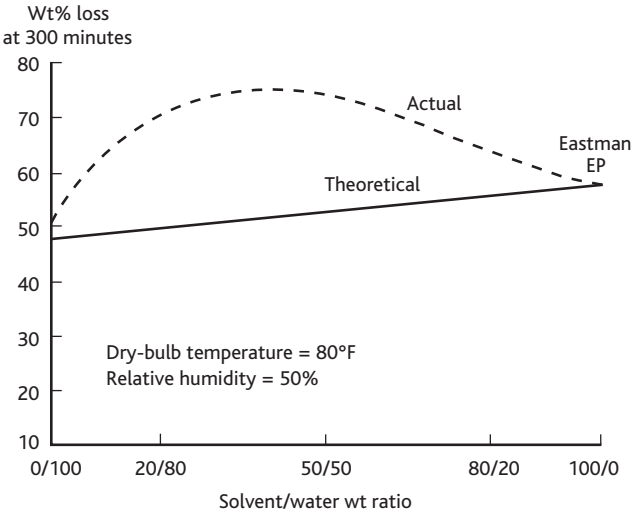
Solvent	Viscosity of polyester[a] resin, cP (80% NV)	Viscosity on water dilution, cP (35% NV)
Eastman EP	17,500	1,070
Eastman EB	29,000	1,830
Eastman PM	37,000	1,780

[a]*Polyester resin; organic solvent only, no water present.*

Eastman EP solvent provides evaporation rate control in waterborne coatings.

The evaporation of water from a film is not easily accomplished, particularly under high-humidity conditions. Eastman EP solvent evaporates at about the same rate as water at 50% relative humidity and 80°F dry-bulb temperature. However, mixtures of Eastman EP solvent and water, under the same conditions, evaporate faster than predicted. Acceleration in water removal will provide faster-drying coatings, which will minimize undesirable printing and blocking problems (Figure 4).

Figure 4 **Acceleration of evaporation rate (water/glycol ether mixtures)**



Eastman EP solvent has an exceptionally mild odor.

Aqueous inks can be prepared with a very low degree of odor using Eastman EP solvent. It has a milder odor than propylene glycol alkyl ethers and can be used effectively as a replacement for alkyl alcohols to retard the drying rate of an ink without introducing objectionable residual odors.

Other applications for Eastman EP solvent

- In dampening solutions for offset lithography, Eastman EP solvent can be blended with other solvents to replace isopropyl alcohol, providing higher flash point and lower volatile emissions.
- Eastman EP solvent provides good coupling, penetration and cleaning ability, and evaporation rate control in various cleaning formulations.
- Improved penetration and evaporation control are possible using Eastman EP solvent in leather dyes, wood stains, and textile dyeing.
- Eastman EP solvent is an effective substitute for EGEE solvent in duplicating fluid formulations.
- As a reactive intermediate, Eastman EP solvent can be used in many reactions that are typical of alcohols.
- Eastman EP solvent is useful as an extraction and crystallization solvent.

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