

Eastman Optifilm™ enhancer 300:
A low-odor, non-VOC coalescent
for latex paint

Eastman OPTIFILM™

300 enhancer

Building on our technical expertise and market understanding, our growing coalescent portfolio helps deliver the right balance of performance and regulatory compliance to meet today's needs and tomorrow's challenges. Eastman Optifilm™ enhancer 300 is an efficient, low-odor, non-VOC coalescent for interior and exterior latex paints. It performs effectively in a variety of latex types, has the added benefit of low odor, and is appropriate for use in many architectural applications. Typical properties are included in Appendix II.

With a boiling point of 281°C, Optifilm 300 is a non-VOC (volatile organic compound) by most definitions, including:

- European Union Council Directive 2004/42/EC, commonly referred to as the Decopaint directive
- China National Standard GB 18582-2008
- China Environmental Protection Standard HJ2537-2014
- Green Seal GS-11
- APAS—Australian Paint Approval Scheme D181
- Singapore Green Label

Optifilm 300 has also been awarded the **Green Label II** certificate in China.

Optifilm 300 optimizes paint performance in several key areas:

- Low-odor properties
- Improves film formation over a wide range of temperature and relative humidity conditions
- Reduces formulated cost by allowing substantial reductions in associative thickeners without compromising performance
- Improves film and application properties such as touch-up and scrub resistance
- Improves durability

Desired properties

Coalescents should possess certain properties to be widely effective. These properties include:

- **Low water solubility**—Water-miscible coalescents distribute themselves between the polymer and water phases. The more hydrophilic the coalescent, the greater the tendency of the coalescent to partition itself within the water phase. As the paint film dries, the water evaporates from the film and any coalescent present in the water phase will be lost to the surroundings, resulting in a reduction in the efficiency of the coalescent. More water-insoluble coalescents partition themselves within the polymer particles; therefore, the loss during water evaporation is minimized. Furthermore, water-insoluble coalescents are less likely to migrate through into porous substrates.
- **Appropriate evaporation rate for application**—The evaporation rate must be matched to the particular application. Using a coalescent with too slow an evaporation rate in a low-PVC formulation may lead to problems of blocking, etc. Conversely, too fast an evaporation rate may lead to problems in high-humidity conditions where the release of the water from the paint film is retarded. In this instance, the evaporation of the solvent is relatively unaffected by the humidity; thus the solvent could evaporate faster than the water, preventing eventual coalescence.
- **Excellent hydrolytic stability**—Hydrolytic stability is a measure of how stable the coalescent is with respect to pH—particularly high pH. Hydrolysis can lead to poor in-can stability, odor, and even antifouling properties, since many biocides only function within a narrow pH range.
- **Excellent coalescing efficiencies with a wide variety of latex emulsions**

For more information on coalescents and why they are used, see Appendix I.

Table 1. Performance properties of Eastman Optifilm™ enhancer 300

Performance in low-odor interior formulated paints		Legend
VOC (GB & Deco directive)	No	+ Good performance
Low odor	Yes	++ Very good performance
Coalescing efficiency	+++	+++ Excellent performance
Storage stability	+++	
Freeze-thaw stability*	++	
Open time	++	
Influence on AT efficiency	+++	
LTFF	+++	
Wet scrub resistance	+++	
Blocking resistance	++	
Water/alkali resistance	+++	
Robustness	+++	

*Formulation dependent

Level of addition

Guidelines for use

The minimum film-forming temperature (MFFT) of the latex is the most important consideration in determining the optimum level of coalescent. Harder polymers have higher MFFTs and, to achieve the same level of coalescence, require more coalescent than softer polymers. To determine the initial level of coalescent addition, test the response of the particular latex to the addition of coalescent using an MFFT bar. Coalescent levels can be further optimized in the paint by testing key paint properties at several coalescent levels.

Incorporation

Optifilm 300 is a slow-evaporating, water-immiscible coalescent. The most effective coalescents are water immiscible because they penetrate the polymer particle and effectively soften the particle from the inside out. On lab scale, water-immiscible coalescents may take slightly longer to incorporate than more water-miscible types. Table 2 shows the incorporation time of Optifilm 300 compared to a more water-miscible coalescent in a fully formulated styrene-acrylic dispersion architectural wall paint. Good mixing is also required. When mixing speeds of 750 rpm were used, laminar flow was created and the mixing time was greatly reduced. Below 750 rpm, there is no laminar flow; the coalescent flows to the outer edge of the vessel. Therefore, longer mixing times are required.

Table 2. Incorporation time of Eastman Optifilm™ enhancer 300

Incorporation time		
Mixing speed	Optifilm 300	Water-miscible coalescent
100 rpm	1 hour 12 minutes	45 minutes 12 seconds
250 rpm	40 minutes 33 seconds	20 minutes 28 seconds
500 rpm	18 minutes 28 seconds	11 minutes 20 seconds
750 rpm	1 minute 34 seconds	43 seconds

Minimum film-forming temperature

Eastman Optifilm™ enhancer 300 is an efficient coalescent for all latex types used in architectural paint formulations. This is illustrated by the degree to which it lowers the MFFT of latexes. The effects of various concentrations of Optifilm 300 on the MFFT of three commonly used latexes are shown in Figures 1, 2, and 3.

Figure 1. Efficiency of Eastman Optifilm™ enhancer 300 and Eastman Texanol™ ester alcohol in a pure acrylic polymer

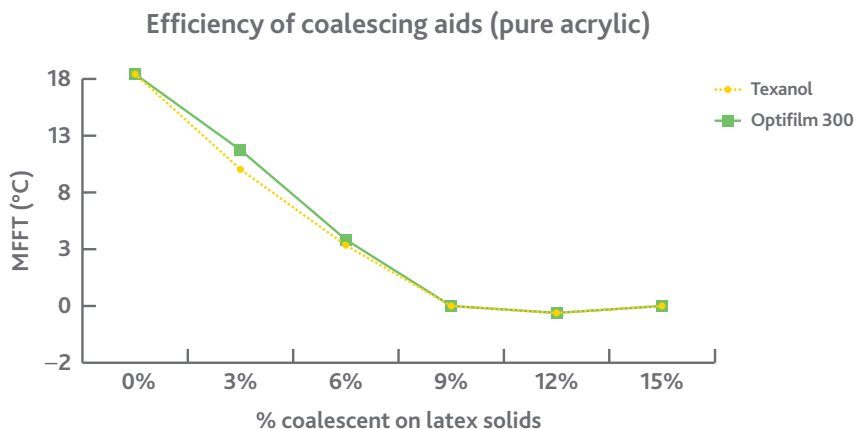


Figure 2. Efficiency of Eastman Optifilm™ enhancer 300 and Eastman Texanol™ ester alcohol in a vinyl acrylic polymer

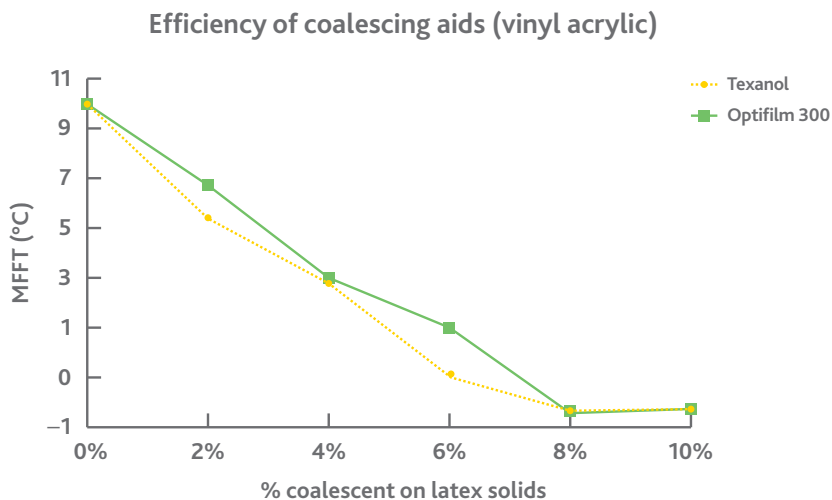
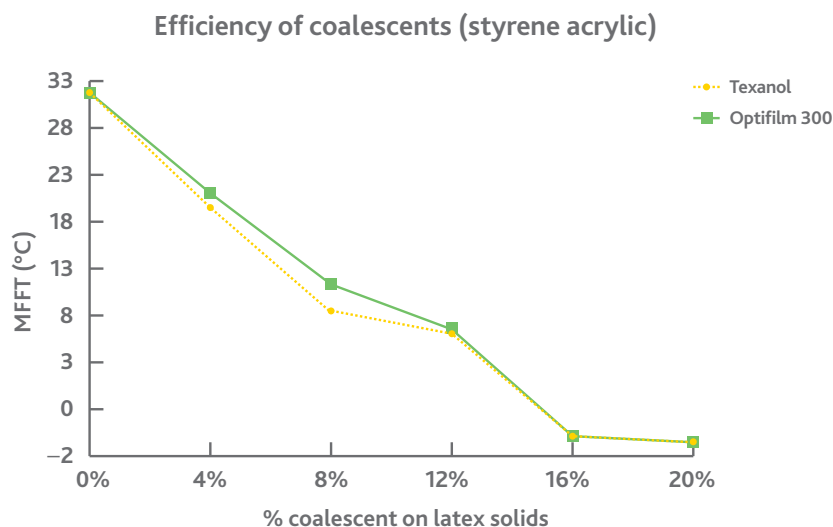


Figure 3. Efficiency of Eastman Optifilm™ enhancer 300 and Eastman Texanol™ ester alcohol in a styrene acrylic polymer



Figures 1, 2, and 3 show virtually no difference in efficiency between Texanol and Optifilm 300.

The optimum coalescent level is strongly dependent on the composition of the latex. Therefore, confirm the efficiency of Optifilm 300 in a specific latex system before use.

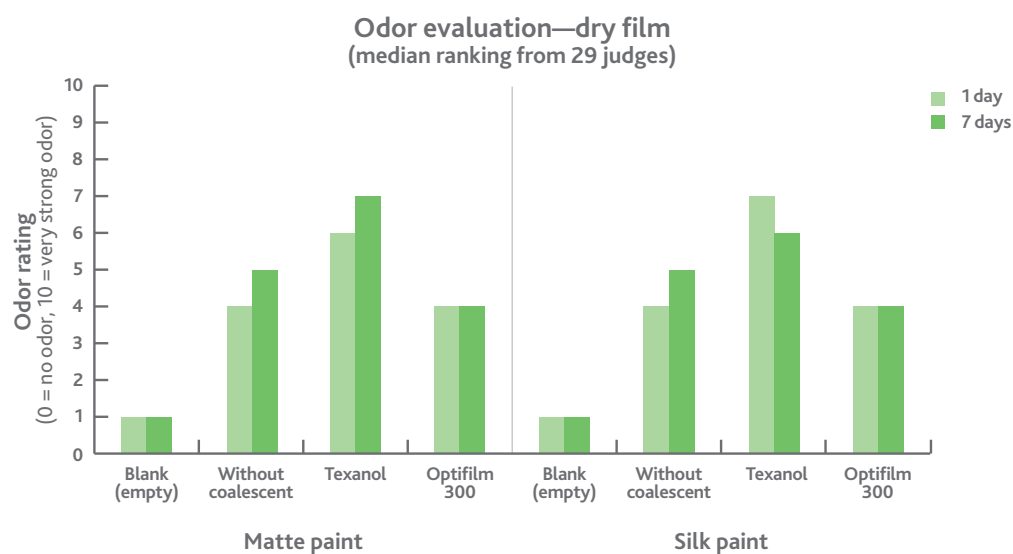
Paint performance

Optifilm 300 has excellent performance in a variety of formulation types. A variety of performance properties are summarized in the following section. See Appendix III for the detailed formulations.

Low odor

Optifilm 300 is ideal for applications where odor is a concern. Our testing has demonstrated that it has a lower odor profile than many traditional coalescents used in architectural paints. Statistically designed experiments were used to evaluate the odor characteristics of paints containing Optifilm 300. Results of odor panel tests carried out after 1 and 7 days are summarized in Figure 4. See Appendix IV for test method.

Figure 4. Odor rating of paint films formulated with and without coalescent



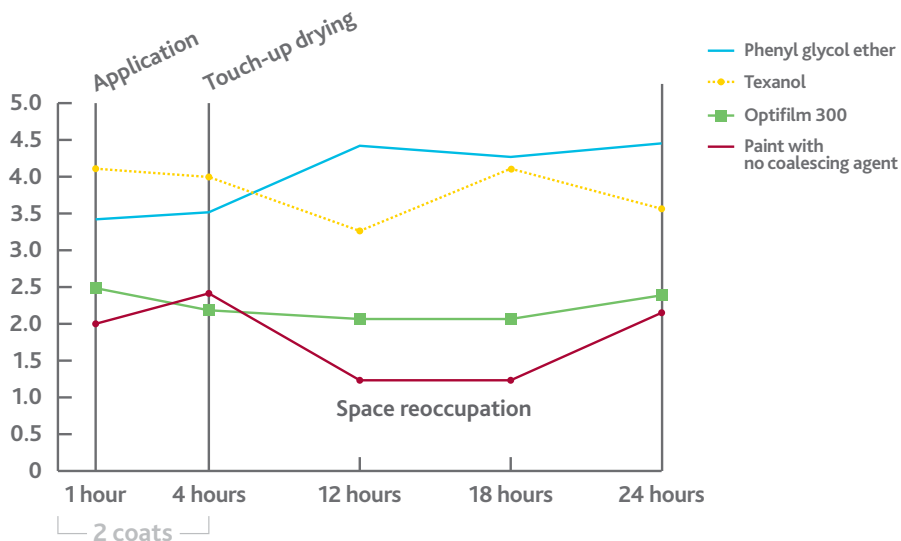
The odor of paints containing Eastman Optifilm™ enhancer 300 is equivalent to the odor of a paint without coalescent.

Odor profile changes with time

Paints based on Optifilm 300 have low odor throughout the drying process. Our testing has demonstrated that architectural paints formulated with Optifilm 300 have a similar odor profile to those without coalescents. Odor at both the time of application and in the early stages of drying can affect applicators and occupants, so sensory testing was completed to evaluate odor during these early stages. Odor perception within the first 24 hours has the most significance for the end user, but testing is often focused only on the initial drying time shortly after application. This study provides a more holistic analysis, with evaluations conducted at intervals throughout the whole drying process.

Statistically designed experiments were used to evaluate the odor characteristics of paints containing Optifilm 300, Eastman Texanol™ ester alcohol, and a competitive glycol ether. Results of odor panel tests carried out after 1, 4, 12, 18, and 24 hours gave additional insight into odor trends. These results are summarized in Figure 5. The paint with Optifilm 300 has low odor throughout the first 24 hours, similar to the same paint without coalescent, and has statistically improved from the odor with the other coalescents. This testing also demonstrated that relative odor is different in the 0 to 4 hours after application than it is 4 to 24 hours after application, with relative odor ratings reversing. See Appendix V for test method.

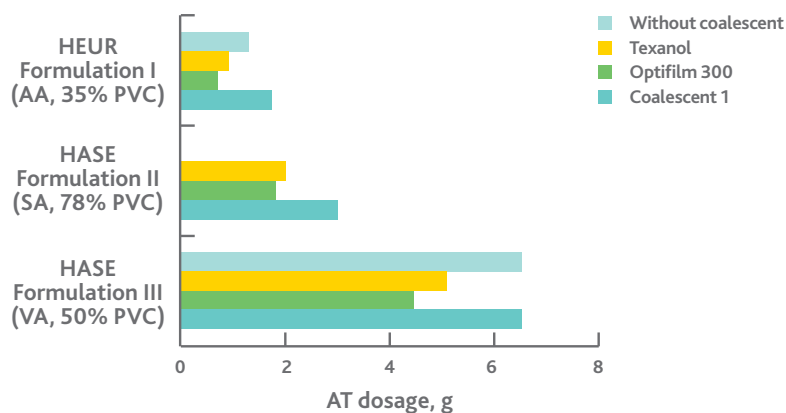
Figure 5. Results of odor panel tests over time



Associative thickener efficiency

Optifilm 300 reduces formulated cost by allowing substantial reductions in associative thickeners. Greater than 25% reduction in associative thickener levels can be obtained without compromising rheology characteristics, as shown in Figure 6.

Figure 6. Differences in associative thickener usage with various paints formulated with and without coalescents



To develop the same rheological characteristics, paint containing Eastman Optifilm™ enhancer 300 requires less associative thickener than paint without coalescent.

Storage stability

Optifilm 300 has excellent storage stability. At normal use levels, Optifilm 300 has minimal impact on the shelf or freeze-thaw stability of a formulated paint. The pH stability upon storage is illustrated in Figure 7 and the KU stability upon storage in Figure 8.

Figure 7. pH stability of various paints formulated with different coalescents

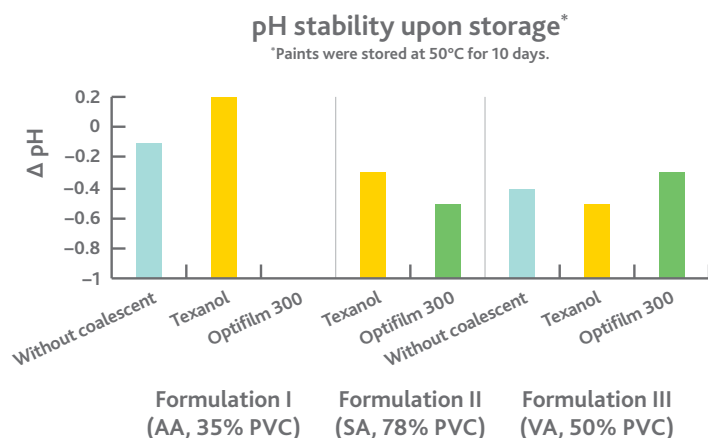
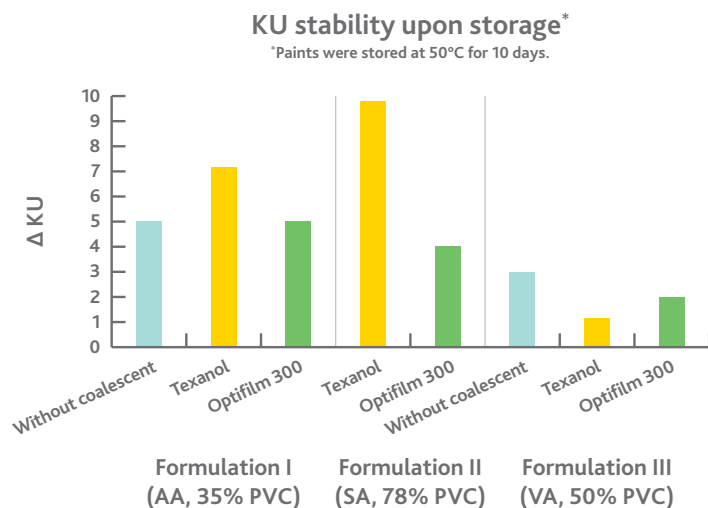


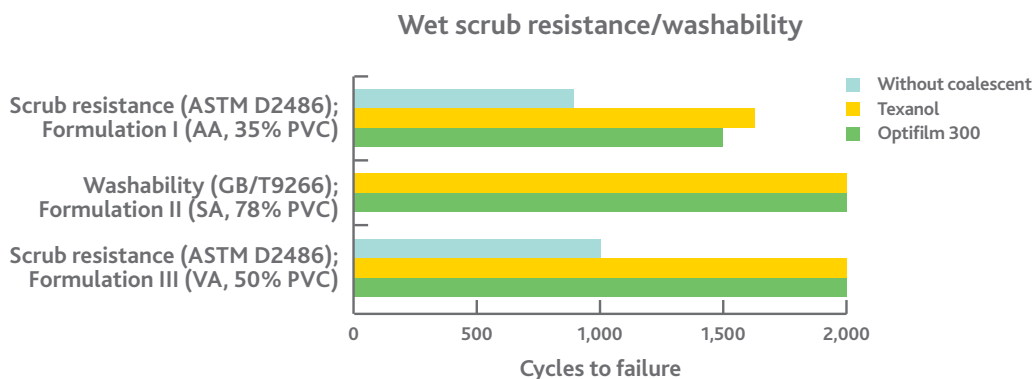
Figure 8. KU stability of various paints formulated with different coalescents



Scrub resistance

Eastman Optifilm™ enhancer 300 boosts the wet scrub resistance/washability of a paint film because it improves film integrity. Scrub resistance is dependent on the coalescent level and formulation ingredients of the paints. Results in matte paints based on the latex resins are illustrated in Figure 9.

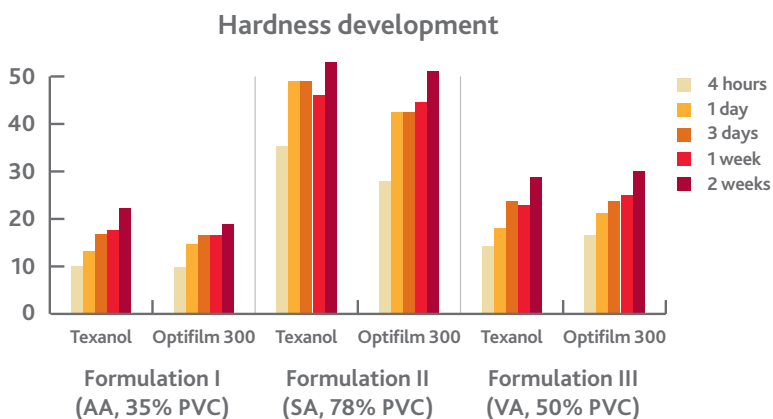
Figure 9. Wet scrub resistance/washability of matte paints formulated with various coalescents



Hardness development

Optifilm 300 allows for good hardness development in a span of 4 hours to 2 weeks. Test results displayed in Figure 10 show that Optifilm 300 gives relatively similar hardness development compared with Eastman Texanol™ ester alcohol.

Figure 10. Hardness development of various films formulated with Eastman Texanol™ ester alcohol and Eastman Optifilm™ enhancer 300



Low-temperature color development

When properly coalesced, color differences under different application conditions are minimized. Testing in two different types of latex paints shows that Optifilm 300, like Texanol, improves the consistency of color development under low-temperature conditions. Optifilm 300 provides a significant improvement in low-temperature color development, as shown in Figures 11 and 12. See Appendix VI for test method.

Figure 11. Low-temperature color development on addition of Eastman Optifilm™ enhancer 300 and Eastman Texanol™ ester alcohol

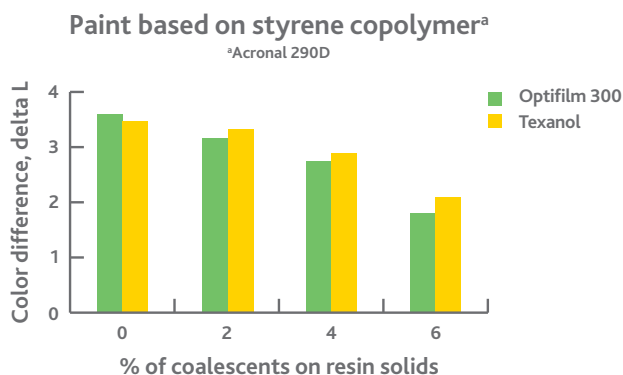
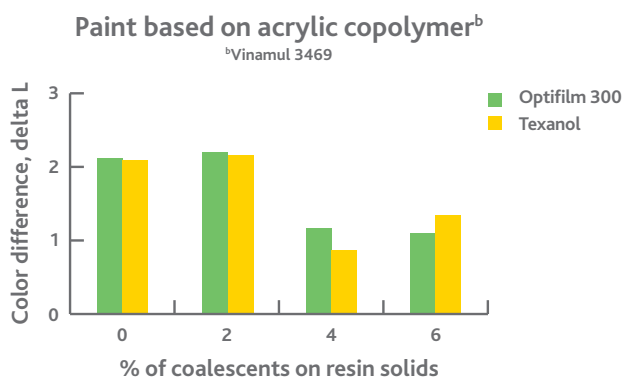


Figure 12. Low-temperature color development on addition of Eastman Optifilm™ enhancer 300 and Eastman Texanol™ ester alcohol



Low-temperature film formation

Optifilm 300 helps to form integrated films across a broad range of temperatures.

Paint films were applied on vinyl chart and cured at temperatures of 3°C. The film surfaces were visually assessed for any cracks or visible chalking, as illustrated in Table 3.

Table 3. Low-temperature (3°C) film formation of Optifilm 300 and Texanol-containing paint films

	Formulation I: Pure acrylic/35% PVC			Formulation II: Styrene acrylic/78% PVC			Formulation III: Vinyl acrylic/50% PVC		
	Film formation	Cracking	Chalking	Film formation	Cracking	Chalking	Film formation	Cracking	Chalking
Texanol	Good	No	No	Good	No	No	Good	No	No
Optifilm 300	Good	No	No	Good	No	No	Good	No	No

Both Optifilm 300 and Texanol help film formation even under adverse conditions.

Summary

For applications that demand low-odor or higher-boiling-point coalescents, Eastman Optifilm™ enhancer 300 offers the perfect balance of compliance and performance. Optifilm 300 will reduce the odor of your paint while maintaining performance and eliminating the need for extensive reformulation. See what Optifilm 300 can bring to your formulations today.

For more information, visit www.eastman.com/optifilm300.

General guide to coalescents

Appendix I

What are coalescents?

Coalescents assist film formation in latex paints. Coalescents temporarily soften the polymer particles, allowing them to fuse into a continuous film. After the film is formed, the coalescent evaporates, allowing the paint to form a hard surface. Good coalescence improves the overall performance of the paint, decreasing porosity and improving film properties such as scrub resistance, washability, and gloss. Coalescents allow good film formation under adverse conditions, such as low temperatures or high humidity.

The most efficient coalescents are water immiscible. Water-immiscible coalescents penetrate the polymer particle and most effectively soften the particle. More water-soluble coalescents stay in the water phase of the paint and soften the polymer particle surface from the outside. Preferably, coalescents evaporate slower than water so that they stay in the film longer than the water. Other important properties of coalescents include hydrolytic stability, compatibility with a wide range of latex types and paint additives, and ease of use.

Common coalescents include ester alcohols and glycol ethers.

Why is the evaporation rate of the coalescent important to the coating?

Coalescent selection can be critical to achieving a successful coating. If the coalescent chosen has an evaporation rate (E.R.) that is too slow, poor block and print resistance and slow drying can result. If the coalescent has an E.R. that is too fast, the paint could have poor flow and leveling properties.

Why is the hydrolytic stability of a coalescent important?

Paints can remain on a dealer's shelves for months or even more than a year. If the coalescent is not hydrolytically stable during that time, the paint performance may deteriorate. Latex paint is usually at a high pH, and a 2-year shelf life is desirable.

Why should a coalescent have low water solubility?

Water-miscible coalescents distribute themselves between the polymer and water phases. The more hydrophilic (water loving) the coalescent, the more it will stay in the water phase of the paint. A more water-insoluble coalescent will partition to the polymer particles. This partitioning preference could affect coalescing efficiency and performance under high humidity/low-temperature conditions. Because hydrophilic coalescents are in the water phase, some of the coalescent will evaporate with the water and its ability to coalesce the suspended particles into a continuous film will be decreased. With a more water-insoluble coalescent, this loss during water evaporation is minimized. More water-insoluble coalescents are also less likely to migrate into a porous substrate.

Can gelling occur?

Gelling is uncommon but may be more likely to occur with glycol ethers. To minimize the risk of gelling, premix the coalescent with water and/or surfactant prior to addition in the letdown stage.

If paint is applied at temperatures below those recommended on the can or label, what problems can be expected?

Potential problems include cracking, poor color development, poor weatherability, and lower gloss levels. Coalescents extend the range of temperatures under which coatings can be applied.

If the same paint is applied in 2 successive days in the winter, but the color appears differently on the second day, what could be the source of the difference?

One possibility is color development under different drying conditions. For example, a contractor paints several rooms of the house, shuts off the space heaters, and the temperature in the dwelling drops below 32°F. The painter comes in the following day and paints the remaining rooms using the same paint. If the paint films in the separate rooms do not coalesce equally well, the color will not match exactly. That is a difference in color development. The effect on the film can change the light-scattering effect. The amount and the type of coalescent in the paint are very important. If the paint contains sufficient coalescent to provide proper coalescence at low temperatures, the color will be the same.

What happens if too much or too little coalescent is used in latex paint?

If too little coalescent is used, a good homogeneous film may not form, especially at colder temperatures. This deficiency can result in suboptimal film integrity and lower paint performance (i.e., scrub resistance, exterior durability, low-temperature color development and touch-up, etc.). If too much coalescent is used, it may affect key paint performance properties such as dry time and stability (shelf/freeze-thaw) and, with VOC coalescents, make the paint exceed environmental regulations.

Why can't any solvent work as a coalescent?

Some water-soluble materials, such as hydrocarbon solvents, are not effective coalescents. These materials are not compatible with some latex. An efficient coalescent will be water insoluble to minimize coalescent loss during water evaporation and water migration into a porous substrate. It will also have good plasticizing efficiency for all types of latexes.

Appendix II

Typical physical and chemical properties of Eastman Optifilm™ enhancer 300

Typical properties	Typical value, units
Appearance	Free from insoluble matter and haze
Boiling point @ 760 mm Hg	281°C (537.8°F)
Specific gravity @ 20°C/20°C	0.942–0.948
Solubility in water, @ 20°C	0.42 g/L
Evaporation rate (<i>n</i> -butyl acetate = 1)	0.0004
Refractive index @ 20°C	1.43 <i>n</i> (25°C/D)
Vapor pressure @ 20°C	4.4 × 10 ⁻⁹ mm Hg
Freezing point	–70°C (–94°F)
Autoignition temperature	424°C (795°F)
Viscosity, Brookfield @ 25°C	9 cP
Surface tension @ 25°C	27.56 dynes/cm
Molecular weight	286.4
Density wt/vol @ 20°C	0.94 kg/L (7.86 lb/gal)

Appendix III

Starting-point formulations

Formulation I—Primal™ AC-361V (35% PVC)

Raw material trade name	Raw material type	Raw material supplier	Weight (g)
Grind			
Water	Solvent	—	87.00
Natrosol™ 250 HBR	Thickener	Ashland Inc.	1.50
AMP-95™	pH regulator	The Dow Chemical Company	1.30
Propylene glycol	Solvent	The Dow Chemical Company	20.00
Orotan™ 731A	Dispersant	The Dow Chemical Company	7.00
Kathon™ LXE	Biocide	The Dow Chemical Company	1.00
Triton™ DF-16	Surfactant	The Dow Chemical Company	2.00
Nopco™ NXZ	Defoamer	San Nopco, Korea	0.70
Ti-Pure™ R-706	Titanium dioxide	DuPont™	180.00
CC-700	Extender	Guangfu Construction Materials (Jiaoling) Fine Chemical Co. Ltd., China	40.00
Letdown			
Primal™ AC-361V	Binder	The Dow Chemical Company	485.00
Ropaque™ Ultra E	Opaque polymer	The Dow Chemical Company	100.00
Texanol/Optifilm 300	Coalescent	Eastman Chemical Company	Adjust
Nopco™ NXZ	Defoamer	San Nopco, Korea	0.50
Acrysol™ RM-2020 NPR	Thickener	The Dow Chemical Company	6.00
Acrysol™ RM-8W	Thickener	The Dow Chemical Company	Adjust
Water	Solvent	—	Adjust
Total			1,000.00

Property	Value (without additives)
Total PVC	34.8%
Volume solids	37.8%
Weight solids	47.9%
Density	1.2488 kg/L
Dry density	1.5177 kg/L
Total dispersant	0.78%
Total coalescent	9.09%
VOC generic water excl.	130 g/L

Coalescent	CAs level, % based on binder solid	CAs dosage, g/1000-g paint	RM (acrysol RM-8W) dosage, g/1000-g paint
Without coalescent	0	0.00	1.40
Texanol	10	25.00	1.00
Optifilm 300	10	25.00	0.60

Formulation II—Primal™ DC-420V (78% PVC)

Raw material trade name	Raw material type	Raw material supplier	Weight (g)
Grind			
Water	Solvent	—	250.00
Propylene glycol	Solvent	The Dow Chemical Company	10.00
Natrosol™ 250 HBR	Thickener	Ashland Inc.	4.00
AMP-95™	pH regulator	The Dow Chemical Company	0.50
Orotan™ 1288	Dispersant	The Dow Chemical Company	7.00
Triton™ CF-10	Surfactant	The Dow Chemical Company	1.00
Dispelair™ CF-246	Defoamer	Blackburn Chemicals Ltd., U.K.	1.00
Kathon™ LXE	Biocide	The Dow Chemical Company	1.00
Ti-Pure™ R-706	Titanium dioxide	DuPont™	40.00
CC 700	Extender	Guangfu Construction Materials (Jiaoling) Fine Chemical Co. Ltd., China	390.00
Kaolin™ DB-80	Extender	Guangfu Construction Materials (Jiaoling) Fine Chemical Co. Ltd., China	60.00
Letdown			
Primal™ DC-420	Binder	The Dow Chemical Company	110.00
Dispelair™ CF-246	Defoamer	Blackburn Chemicals Ltd., U.K.	0.30
Texanol/Optifilm 300	Coalescent	Eastman Chemical Company	Adjust
Acrysol™ AP-10	Thickener	The Dow Chemical Company	Adjust
Water	Solvent	—	Adjust
Total			1,000.00

Property	Value (without additives)
Total PVC	78.9%
Volume solids	33.1%
Weight solids	54.3%
Density	1.4705 kg/L
Dry density	2.3670 kg/L
Total dispersant	0.64%
Total coalescent	18.18%
VOC generic water excl.	79 g/L

Coalescent	CAs level, % based on binder solid	CAs dosage, g/1000-g paint	RM (acrysol RM-8W) dosage, g/1000-g paint
Texanol	18	9.50	2.00
Optifilm 300	18	9.50	1.80

Formulation III—Rovace™ 662 (50% PVC)

Raw material trade name	Raw material type	Raw material supplier	Weight (g)
Grind			
Water	Solvent	—	180.00
Natrosol™ 250HBR	Thickener	Ashland Inc.	2.00
Propylene glycol	Solvent	The Dow Chemical Company	15.00
Orotan™ 1288	Dispersant	The Dow Chemical Company	5.00
Triton™ DF-16	Surfactant	The Dow Chemical Company	1.00
Dispelair™ CF-246	Defoamer	Blackburn Chemicals Ltd., U.K.	0.50
AMP-95™	pH regulator	The Dow Chemical Company	4.50
Ti-Pure™ R-706	Titanium dioxide	DuPont™	180.00
CC 700	Extender	Guangfu Construction Materials (Jiaoling) Fine Chemical Co. Ltd., China	130.00
Kaolin DB-80	Extender	Guangfu Construction Materials (Jiaoling) Fine Chemical Co. Ltd., China	90.00
Letdown			
Rovace™ 662	Binder	The Dow Chemical Company	267.00
Texanol/Optifilm 300	Coalescent	Eastman Chemical Company	Adjust
Dispelair™ CF-246	Defoamer	Blackburn Chemicals Ltd., U.K.	1.50
Acrysol™ RM-7	Thickener	The Dow Chemical Company	5
Acrysol™ DR-72	Thickener	The Dow Chemical Company	Adjust
Water	Solvent	—	Adjust
Total			1,000.0

Property	Value (without additives)
Total PVC	50.1%
Volume solids	36.0%
Weight solids	54.7%
Density	1.4152 kg/L
Dry density	2.1169 kg/L
Total dispersant	0.56%
Total coalescent	8.17%
VOC generic water excl.	121 g/L

Coalescent	Coalescents level, % based on binder solid	CAs dosage, g/1000-g paint	RM (acrysol RM-8W) dosage, g/1000-g paint
Without coalescent	0	0.00	6.51
Texanol	8	12.00	5.19
Optifilm 300	8	12.00	4.60

Appendix IV

Test method—Analysis of paint odor

The following procedure was used to determine paint odor profiles.

1. Five grams of each paint type was applied to the interior of a lacquer-lined 5-liter tin using a sponge. A fresh sponge was used for each formulation to avoid cross-contamination of samples.
2. The paints were allowed to dry for 1 hour until touch dry before sealing with lids.
3. The tins were stored at 23°C throughout the duration of the experiment.
4. Twenty-four hours after the initial application, the paints were opened and the judges were asked to evaluate the paints' odor, ranking the samples from least odor to most odor.
5. The tins were then resealed and stored at 23°C until day 7, when the same judges repeated the evaluation.
6. Each paint sample was tested in duplicate to provide an average rank for each judge and each paint type.
7. The data gathered from the experiment was statistically analyzed.

Appendix V

Test method—Odor profile changes

The following procedure was used to determine paint odor profile changes over time.

1. The samples were drawn down onto Leneta form 2A test panels using a No. 8 K-bar (100- μ m WFT).
2. The paints were allowed to dry for 1 hour before storing in open containers (unlidded 5-liter paint cans) throughout the test period. The painted panels were stored at 23°C/30% relative humidity throughout the experiment.
3. The 12- and 15-hour panels were applied and stored overnight at 17°C/48% relative humidity.
4. To obtain 12- and 15-hour results, the paints had to be applied outside of office working hours/off site.
5. A maximum of 15 judges were asked to evaluate the paints' odor, ranking the samples from least to most odor at each test interval (1 hour, 4 hours, 12 hours, 15 hours, 18 hours, 24 hours, 48 hours, and 7 days).
6. Data was statistically analyzed.

Appendix VI

Test method—Low-temperature color development

The following procedure was used to determine the low-temperature color development.

1. Paint was tinted to pale blue color with water-based tinting aid.
2. A strip of the test panel was painted with the tinted paint and allowed to dry at 23°C for 24 hours.
3. Both the panel and the paint were divided in two. A sample of each was placed in a refrigerator at 5°C and allowed to stabilize.
4. A patch of the paint started at 5°C was applied onto the painted panel that was stored at 5°C. This second coat was allowed to dry for 24 hours at 5°C.
5. A similar patch was applied to the sample stored at 23°C using the paint that was also stored at that temperature.
6. Once the paint films were dry, the color of the second coats dried at 23° or 5°C were compared and any color difference between them was measured using a Sheen Instruments Micromatch color difference meter employing the lightness scale (delta L).
7. The lower the color difference, the better the paint film was coalesced.



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