Eastman Optifilm™ enhancer 400

Making very low-odor and low-emission formulating easy

Eastman **OPTIFILM**™
enhancer 400

Eastman Optifilm™ enhancer 400 is a nonvolatile coalescent with very low odor that makes formulating eco-friendly paint easier.

Efficient and effective, Optifilm 400 coalesces a variety of latex types while maximizing performance and minimizing emissions. Optifilm 400 allows formulators the opportunity to continue to use high-T_g resin systems and meet any new emission regulations with minimum hassles.

Optifilm 400 is appropriate for all types of architectural coatings. It can be used as the sole coalescent in products such as ultralow-odor, very low-emission paints and is easy to use in the manufacturing environment.

Key attributes

- Enables hypoallergenic paint
- Extremely low odor
- Good coalescing efficiency
- Insignificant VOC contribution to paint
- Non-HAP (hazardous air pollutant)[a] and non-SARA[b]
- Nonyellowing
- REACH compliant[c]
- Readily biodegradable
- Stable in low to high pH coatings
- Zero contribution to VOC emission from dried paint

Zero contribution to TVOC[d]

Emitted TVOC can be contributed by many paint components from different raw materials, such as latex, coalescents, cosolvents, and other materials. Optifilm 400, as the novel coalescent, contributes zero to TVOC.

Independent emissions testing conducted at an external, accredited laboratory[e] confirms that Optifilm 400 has zero contribution to emitted TVOC. See Appendix II for test method.

Table 1. TVOC contribution

Formula—emulsion type	Formula—coalescing aid type	Emission VOC (µg/m³)		Emission label
		Coalescing aid's contribution	TVOC	
High-T_g styrene acrylic (DC420V)	Optifilm 400	0	185 ~ 384	A+
Low-T_g styrene acrylic (Eco559)	Optifilm 400	0	149 ~ 310	A+
Low-T_g pure acrylic (SF500)	Optifilm 400	0	52 ~ 109	A+
VAE (E1608)	Optifilm 400	0	56 ~ 117	A+

[a]U.S. hazardous air pollutants [b]U.S. Superfund Amendments and Reauthorization Act of 1986 [c]Registration, Evaluation, Authorisation, and Restriction of Chemicals [d]Total volatile organic compounds with retention time between C_6 and C_{16} as defined in JG/T 481-2015 [e]Eurofins testing laboratory, Shenzhen, P.R. China

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. A temperature-gradient bar (also known as an MFFT bar) is used to determine the approximate level of coalescent required to form a film at an appropriate application temperature for the paint in which the coalescent will be used. The test results from this instrument provide the appropriate amount of coalescent needed for a particular latex. Coalescent levels can be further optimized in the paint by testing key paint properties at several coalescent levels.

Calculating the coalescent dosage from MFFT data is a suggested starting point for the determination of coalescent dosage in paint. Adjusting the dosage according to the paint film performance requirements is also suggested. For example, delivering good low-temperature film formation (LTFF) may require additional coalescent when formulating the final paint.

Minimum film-forming temperature

Optifilm 400 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 400 on the MFFT of four commonly used latexes are shown in Figures 1–4.

Figure 1. Efficiency of Optifilm 400 and Eastman Texanol™ ester alcohol in a pure acrylic polymer

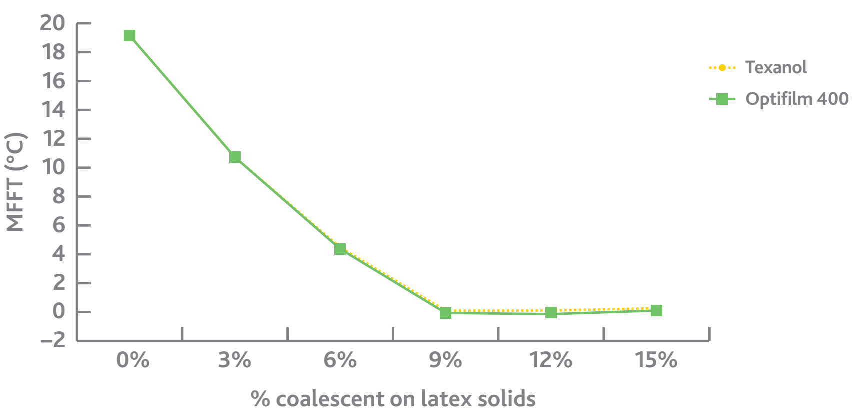


Figure 2. Efficiency of Optifilm 400 and Texanol in a styrene acrylic polymer

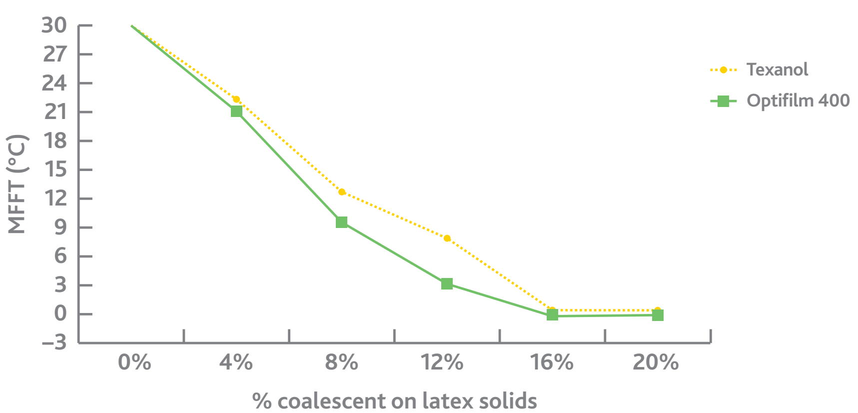


Figure 3. Efficiency of Optifilm 400 and Texanol in a vinyl acrylic polymer

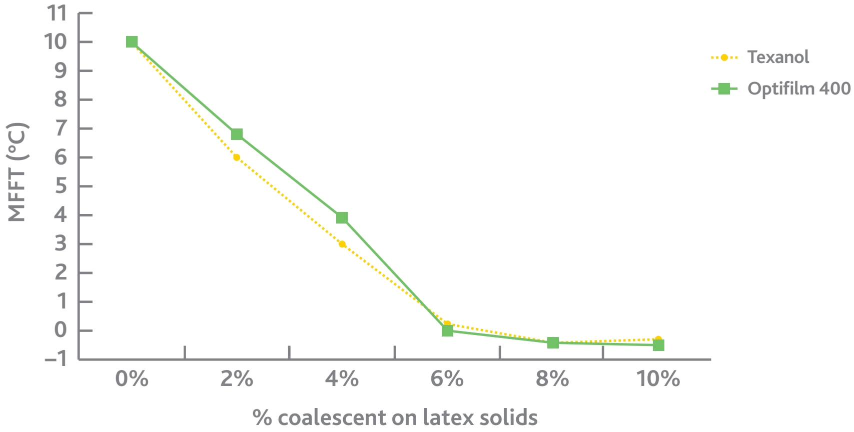
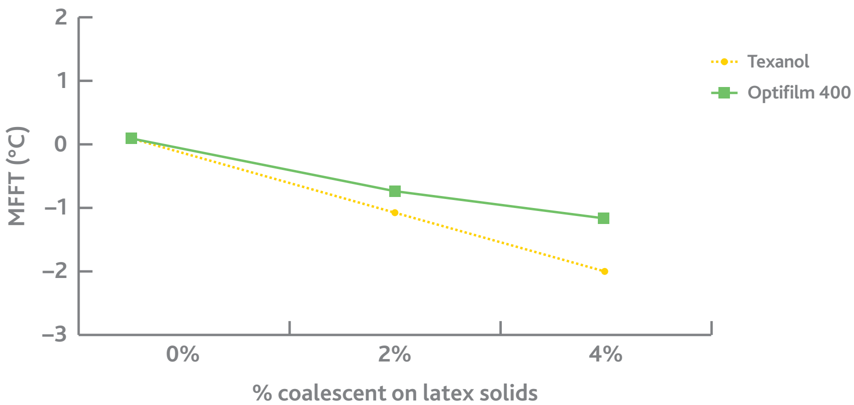


Figure 4. Efficiency of Optifilm 400 and Texanol in vinyl acetate/ethylene (VAE)



Paint performance

Optifilm 400 has excellent performance in a variety of formulation types, which allows minimum reformulating effort to achieve nonvolatile status. A variety of performance properties are summarized in the following section. See Appendix IV for emulsions commonly used in the coatings industry.

Table 2. Coalescent dosage[a] in the testing formulations

Formulation / Coalescent	High-T_g styrene acrylic (DC420V)	Low-T_g styrene acrylic (Eco559)	Low-T_g pure acrylic (SF500)	Vinyl acetate/ ethylene (E1608)
Texanol	3.0%	—	—	—
Optifilm 400	3.0%	0.5%	0.5%	0.7%

[a]*Coalescent dosage based on total wet paint weight*

Low odor

Optifilm 400 is ideal for applications where odor is a concern. Our testing has demonstrated that it has lower in-can odor and dry-film odor than conventional coalescents used in architectural paints. The odor of paints with Optifilm 400 is comparable to paints that do not contain coalescent.

Figure 5. Odor evaluation—in can

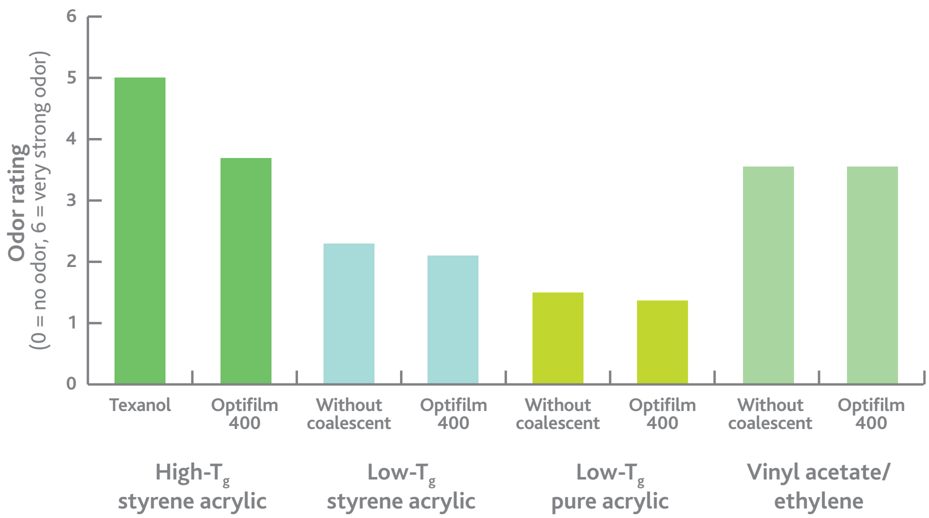
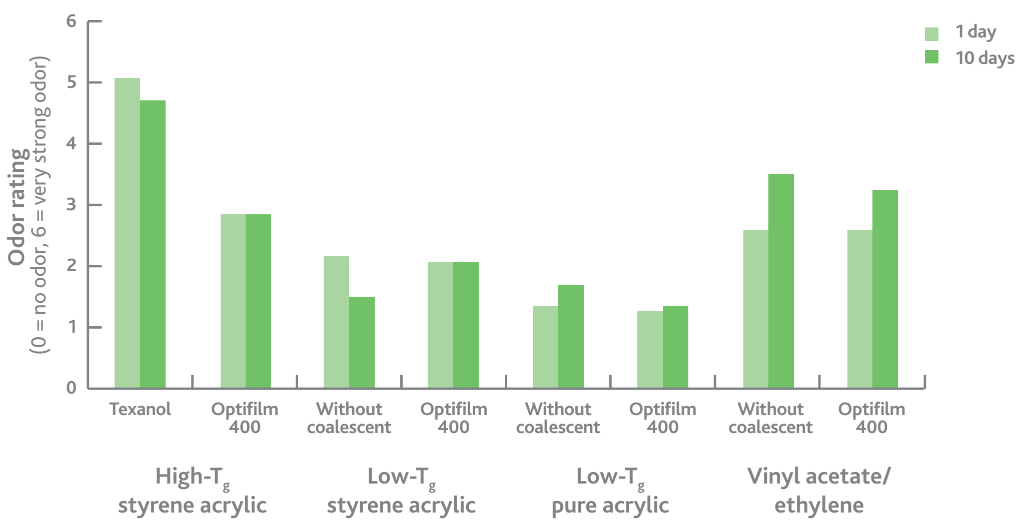


Figure 6. Odor evaluation—dry film



Test method: *Internal test method. As defined, 5 g of paint applied on a 5-L can inner wall is dried 2 hours and then sealed with lid.*
Judgment criteria: *Invited 10 people to do blind test and report the order of samples' odor from least to most (1 = least odor)*

Storage stability

Optifilm 400 has good storage stability across a wide range of polymer types. At normal usage levels, Optifilm 400 has minimal impact on the shelf or freeze-thaw stability of a formulated paint. With high-T_g latex, Optifilm 400 delivers the same excellent storage stability performance the industry expects with Texanol.

Table 3. Storage stability

Formula—emulsion type	Formula—coalescing aid type	Viscosity (KU, ICI)	pH	Gloss (20°, 60°, 80°)	Opacity
High-T_g styrene acrylic (DC420V)	Texanol	Good	Good	Good	Good
	Optifilm 400				
Low-T_g styrene acrylic (Eco559)	Without coalescent	Good	Good	Good	Good
	Optifilm 400				
Low-T_g pure acrylic (SF500)	Without coalescent	Good	Good	Good	Good
	Optifilm 400				
Vinyl acetate/ethylene (E1608)	Without coalescent	Good	Good	Good	Good
	Optifilm 400				

Test method: *GB/T 9756-2001. As defined, store in 50°C oven for 10 days and check variation of viscosity, pH, gloss, and opacity.*
Judgment criteria: *Variation comparison*

Washability

Optifilm 400 has a positive impact on washability in high-T_g styrene acrylic and low-T_g styrene acrylic systems and can significantly improve washability of low-T_g pure acrylic formulations. With high-T_g latex, Optifilm 400 delivers the same great washability the industry expects with Texanol.

Table 4. Washability

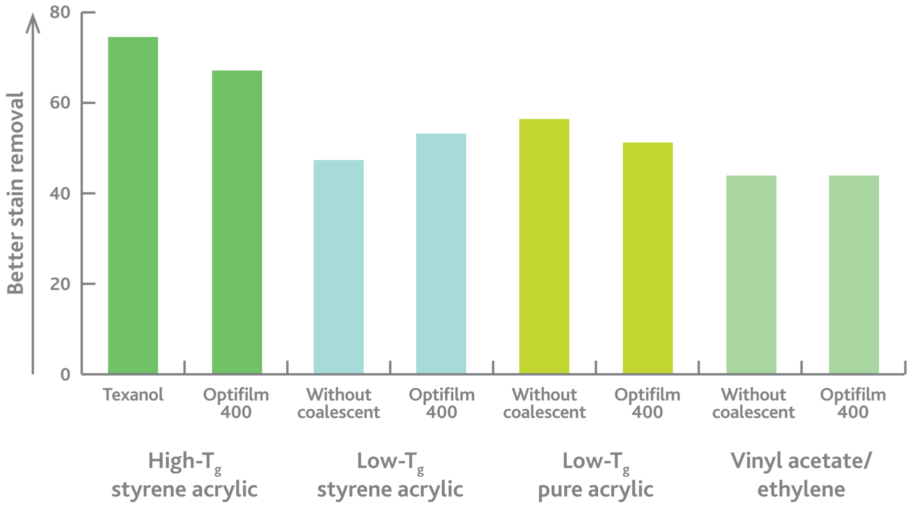
Formula—binder type	Formula—coalescing aid type	Cycles
High-T_g styrene acrylic (DC420V)	Texanol	> 30,000
	Optifilm 400	> 30,000
Low-T_g styrene acrylic (Eco559)	Without coalescent	> 30,000
	Optifilm 400	> 30,000
Low-T_g pure acrylic (SF500)	Without coalescent	4,094
	Optifilm 400	8,225
Vinyl acetate/ethylene (E1608)	Without coalescent	7,251
	Optifilm 400	7,561

Test method: *GB 9266-88. As defined, 120-µm WFT + 80-µm WFT in 2 coats, curing at 23°C for 7 days, and scrubbed with 0.5% detergent solution.*
Judgment criteria: *Failed cycles recorded*

Stain removal

Optifilm 400 gives slight impact while resin is the critical factor in stain-removal performance. With high-T_g latex, Optifilm 400 delivers the same stain-removal performance as Texanol.

Figure 7. Stain removal



Stains: *Vaseline, vinegar, black tea, WB black, SB black, blue ink*
Test method: *GB/T 9780-2013. As defined, 150-µm WFT applied on black vinyl chart is cured at 23°C for 7 days, covered by different stains for 2 hours, and cleaned with water.*
Judgment criteria: *Scored according to GB method*

Leaching

Optifilm 400 gives no impact to leaching performance.

Table 5. Leaching

Formula		Leaching		
		4 hours	1 day	4 days
High-T_g styrene acrylic (DC420V)	Texanol	Good	Good	Good
	Optifilm 400			
Low-T_g styrene acrylic (Eco559)	Without coalescent	Slight water streaking	Slight water streaking	Slight water streaking
	Optifilm 400			
Low-T_g pure acrylic (SF500)	Without coalescent	Water streaking	Water streaking	Water streaking
	Optifilm 400			
Vinyl acetate/ethylene (E1608)	Without coalescent	Slight water streaking	Slight water streaking	Slight water streaking
	Optifilm 400			

Test method: *ASTM D7190-10 (2011). As defined, 100-µm WFT applied on black vinyl chart is cured at 23°C for 4 hours. A row of four droplets of di-water was placed at room temperature across the top of the first designated section of each paint film with approximately 0.1 cc in volume and allowed to stand for 10 minutes. They were then lifted into a vertical position, allowing the water droplets to run down the section of the paint film being evaluated.*
Judgment criteria: *The visual appearance of film (checked for each test interval)*

Conclusion

Optifilm 400 is an efficient and effective option when a lower-odor profile is desired. It has lower in-can and dry-film odor than conventional coalescents, and it does not contribute to TVOC. By choosing Optifilm 400, formulators can gain low odor and emissions benefits without compromising performance attributes. Whether the need is to address regulatory legislation, voluntary labels, or customer demand, choosing Optifilm 400 can give you a competitive edge in a dynamic market.

For more information, visit **www.eastman.com/optifilm400**.

Appendix I. Typical properties of Optifilm 400

Property	Typical value, units
Assay	97.0 wt% min.
Autoignition temperature	385°C
Boiling point @ 760 mm Hg	374°–381°C (705°–718°F)
Color (Pt-Co)	100 max.
Evaporation rate (*n*-butyl acetate = 1)	0.000017
Flash point (Pensky-Martens closed cup)	199°C (390°F)
Freezing point	–50°C (–58°F)
Liquid viscosity @ 20°C	15.8 cP (mPa•s)
Refractive index @ 20°C	1.4436
Solubility In water, @ 20°C Water in, @ 20°C	 0.0 wt% 0.9 wt%
Specific gravity @ 20°C/20°C	0.967
Vapor pressure @ 20°C	< 0.0001 mm Hg
% VOC (250°C)[a]	Zero VOC

[a]*China national standard GB18582-2008, Singapore national standard SS150:2015, and Korea standard Eco-Label EL241. Paints [EL241-1998/10/2014-53]*

Appendix II. Test method

Eurofins' emission test apparatus

In this study, emission was determined by Eurofins China according to JG/T 481-2015 methodology. A 119-L cubic-shaped stainless steel chamber is used for emissions testing in a Eurofins China lab. The chamber is capable of precision control of air temperature, relative humidity, air velocity, and exchange rate. Emission air was collected after 3 days using Tenax® TA thermal sorbent tubes. Prior to each sampling use, conditioning the precleaned sorbent tubes is required to remove trace organic volatiles possibly trapped on the tube. A thoroughly cleaned chamber is also required to ensure blank VOC is lower than 2 μg/m^3. Analysis of the thermal desorption tube is by thermal desorption and gas chromatography-mass spectrometry (GC-MS) using an HP-5 chromatography column. Detailed GC-MS parameters were not shared by Eurofins lab, with the exception of its detection limit (5 μg/m^3). Data variation between ± 35% was valid.

Sample preparation and test parameters

A 30-g specimen of each formula was brushed evenly on a glass panel with a surface area of 0.12 m^2. The freshly coated panel was then loaded into the chamber immediately. The time when tested panel entered into the chamber was set as 0, and the emission time length was 72 h ± 1 h before chamber air sampling. Air temperature in the test chamber was controlled at 23°C ± 1°C. Relative humidity was 50% ± 5%. Air velocity was 0.1 m/s ~ 0.3 m/s. Air was exchanged at the rate of 0.5 h-1 ± 0.01 h-1. Parallel air sampling was conducted to check test reproducibility and get the average data.

Test method summary

Method	Principle	Parameter	Detection limit	Uncertainty
Water-based interior wall coating with low-emission TVOC	TDS GC/MS	TVOCs	5 µg/m^3	17.5% (RSD) U = 2 × RSD = 35%

Test chamber parameter

Chamber volume (L): 119
Air change rate (per hour): 0.5

Temperature (°C): 23
Loading ratio (m^2/m^3): 1

Relative humidity (%): 50

Test condition

Sample stayed in test chamber during the whole 3-day testing period.

Sample preparation

The application is 30 g per test specimen.

Appendix III. Key elements of starting point formulation

Adjust items	Supplier	Formulation (50% PVC, 36% VS)			
		High-T_g styrene acrylic (DC420V)	Low-T_g styrene acrylic (Eco559)	Low-T_g pure acrylic (SF500)	Vinyl acetate/ ethylene (E1608)
Emulsion	—	300.00 Solid % = 48	288.00 Solid % = 50 ± 1	303.10 Solid % = 47.5	262.00 Solid % = 55
Optifilm 400	Eastman	30.20	5.00	5.00	7.00
Acrysol™ TT-935	The Dow Chemical Company	0.00	6.00	6.30	7.60
AMP-95™	ANGUS Chemical Company	0.00	0.30	0.00	3.30
Water	—	86.30	117.20	102.10	136.60

Appendix IV. Emulsions commonly used in the coatings industry

Emulsion grade	Supplier	Type	MFFT (°C)	T_g (°C)
PRIMAL™ DC-420V	The Dow Chemical Company	Styrene acrylic	29	30
Acronal® Eco559	BASF	Styrene acrylic	0	5
PRIMAL™ SF-500	The Dow Chemical Company	Pure acrylic	2	11
EcoVAE® 1608	Celanese Corporation	Vinyl acetate/ethylene	0	10

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