Eastman products for architectural coatings

Optimizing VOC and performance in paint

Introduction

Today's most significant driver for reformulation in the architectural paint market is the regulatory requirements on volatile organic compound (VOC) content. In many cases, some performance compromise has already been accepted to meet existing VOC regulations. Additional regulations continue to reduce the allowable VOC level, potentially causing more performance compromise. In typical architectural formulations, glycols and coalescents represent the two most significant contributors to VOC content. One way to reach targeted VOC levels would be to remove the glycol, although this could have a negative effect on freeze/thaw stability and open time. There are three techniques for reducing the VOC contribution from the coalescent: use a more efficient coalescent, use a lower or zero VOC coalescent, or reduce the overall amount of coalescent in a formulation. This technical tip illustrates how Eastman coalescents (Eastman Texanol™ ester alcohol, Eastman EEH solvent, and Eastman Optifilm™ enhancer 400) can help maintain the best possible performance when it is necessary to further reduce paint VOC.

Data

Paints containing moderate levels of VOC were reformulated to future regulatory limits by altering both the level of glycol and the level and type of coalescent. Paints included an interior flat (formulated to 50 g/L), an exterior flat (formulated to 50 g/L and 100 g/L), an interior/exterior semigloss (formulated to 50 g/L and 150 g/L), and an interior high-gloss (formulated to 150 g/L). The control formulas were made with Texanol as the sole coalescent. When reformulating to meet lower VOC targets, the coalescent was reduced to the minimum level necessary to maintain adequate low temperature coalescence (LTC) properties. In most cases, lowering the amount of coalescent alone was insufficient to reach VOC targets, so the amount of glycol was also reduced. In some cases, the targeted VOC levels could not be obtained with a given coalescent because the LTC requirements were higher than the targeted VOC levels allowed. Examples of the VOC content resulting from the coalescent and glycols in these formulations are shown in Table 1. One point of interest is that the low level of VOC contributed from other additives becomes more significant as overall levels of VOC continue to be reduced.

Table 1. **Interior/exterior semigloss formulations**[a]

Description	VOC (g/L)	phr[b] coalescent	phr EG	VOC from coalescent (g/L)	VOC from glycol (g/L)
Texanol control	178	8.29	15.78	56.60	108.40
Texanol	152	8.24	11.44	58.50	80.90
Eastman EEH	142	6.70	12.33	69.60	62.30
Optifilm 400	123	8.36	16.08	Trace	109.80
Texanol/Optifilm 400	148	3.86/each	15.76	25.60	108.60
Texanol/Optifilm 400	50	3.73/each	0.93	28.30	7.20
Optifilm 400	50	8.36	4.82	Trace	36.30
Eastman EEH/Optifilm 400	145	3.80/each	15.40	22.00	101.00
Eastman EEH/Optifilm 400	47	3.80/each	0.50	28.00	3.00

[a]*Based on Rhoplex™ SG-10 from Dow Chemicals*

[b]*Parts per hundred parts of resin*

The lower VOC paints and controls were subjected to a wide range of testing, including weathering to fully assess the impact of reducing the VOC. Testing included ICI and Stormer viscosity, heat stability, gloss, freeze/thaw stability, contrast ratio, scrub resistance, block and print resistance, low-temperature porosity, room-temperature porosity, low-temperature touch-up, color development, Zapon™ tack-free time, mudcracking, sag and leveling, stain resistance, open time, crosshatch adhesion, and low-temperature coalescence. Weathering data for the exterior paints included grain cracking, color retention, adhesion, and gloss retention. A portion of the data is summarized in this technical tip to demonstrate ways of obtaining the best balance of performance properties. Some differences were seen in the relative efficiency of the different coalescent systems tested. Figure 1 shows the relative coalescent efficiencies in each of the four paint types. Regardless of the paint type, Eastman EEH solvent was the most efficient coalescent.

Some differences were seen in the relative efficiency of the different coalescent systems tested. Figure 1 shows the relative coalescent efficiencies in each of the four paint types. Regardless of the paint type, Eastman EEH solvent was the most efficient coalescent.

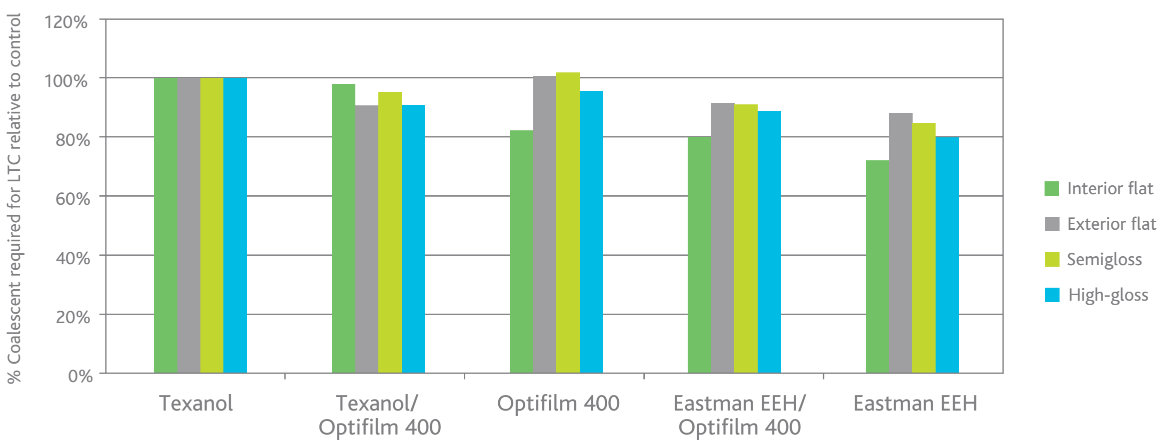
Table 2. **Formulations and coalescents tested**

Coalescent(s)	Paint type	Control PVC level	Control vol. % solids	Latex	VOC target
Texanol control	Interior flat	65	29	UCAR 379[a]	<50 g/L
Texanol/Optifilm 400	Exterior flat	40	32	Rhoplex ML-200[b]	<100 g/L; <50 g/L
Optifilm 400	Interior/exterior semigloss	21	34	Rhoplex SG-10[b]	<150 g/L; <50 g/L
Eastman EEH					
Eastman EEH/Optifilm 400	Interior gloss	17	37	Rhoplex HG-74[b]	<150 g/L

[a]*Arkema Chemicals*

[b]*Dow Chemicals*

Figure 1. **Coalescent requirements**



Interior flat paint results

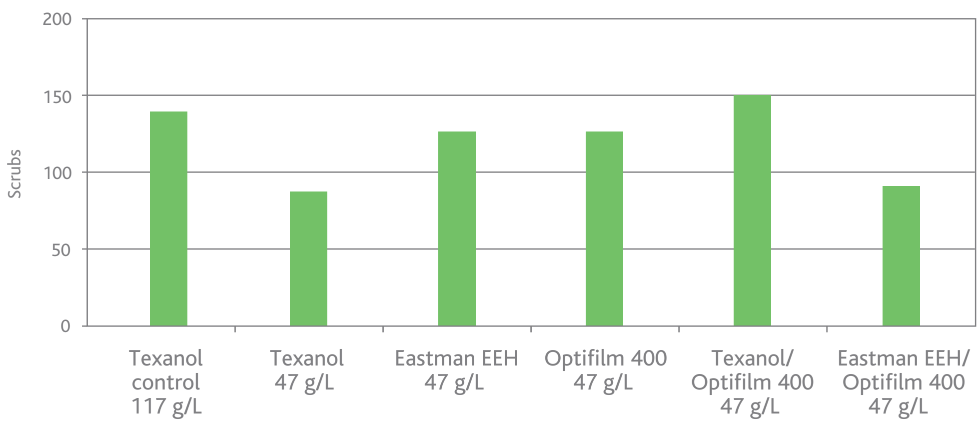
In this formulation, several of the paints formulated to 50 g/L VOC had performance comparable to the control paint which was formulated at 117 g/L. Regardless of the coalescent system used, no significant differences were seen between the 50 g/L paints and the higher VOC paint in many properties, including heat-age stability, contrast ratio, porosity at room temperature and low temperature (40°F), color development, mudcracking, or stain resistance. The Stormer viscosity of all the lower VOC paints was slightly lower than the higher VOC control.

Coalescent system did not seem to have a significant impact on the Stormer viscosity. This formulation did not have freeze/thaw stability, so no differences could be seen.

Scrub resistance results are summarized in Figure 2. This testing indicated some small differences in the different 50 g/L paints when compared to the control paint at 117 g/L VOC. Several systems, however, maintained the initial scrub resistance. While reducing the Texanol ester alcohol level caused a slight drop in scrub resistance, a blend of Texanol with Optifilm 400 had scrub resistance equal to the control.

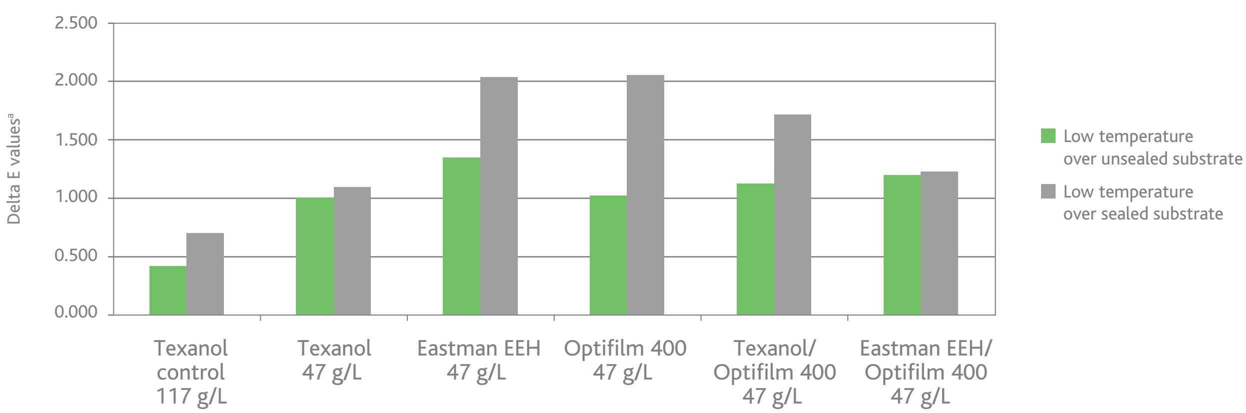
Lower VOC paints do show performance decreases in low-temperature touch-up properties. The best low-VOC results were seen with Eastman Texanol™ ester alcohol (See Figure 3).

Figure 2. **One week room-temperature scrubs**



Paints based on Ucar 379; tested by ASTM D2486, 7-day dry.

Figure 3. **Interior flat low-temperature touch-up**



[a]Delta E values relative to unsealed room temperature control panels; Paints based on Ucar 379.

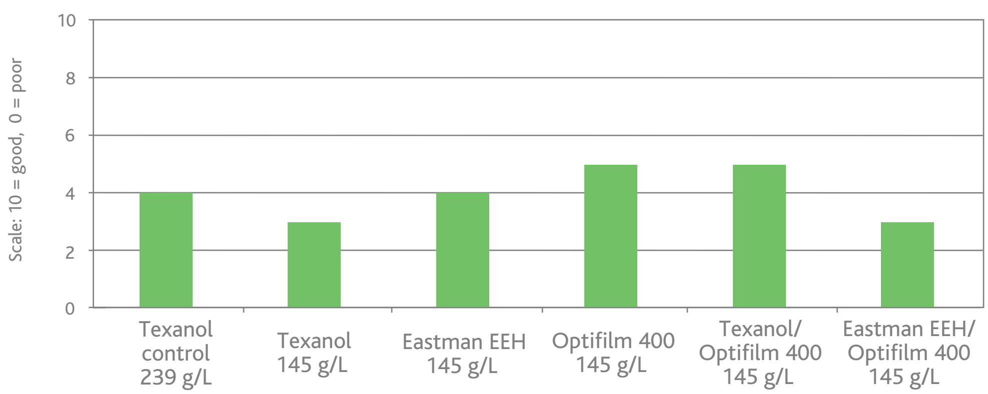
Interior high-gloss paint results

A good balance of performance was maintained in high-gloss paints formulated to 150 g/L VOC. All of the lower VOC paints required higher levels of associative thickener than the 239 g/L VOC control paint. The paints containing Texanol ester alcohol required the lowest thickener levels. Regardless of the coalescent system used, no significant differences were seen between the 150 g/L paints and the higher VOC paint in many properties, including heat-age stability, contrast ratio, color development, adhesion to gloss alkyd, or stain resistance. In this paint system, using Optifilm enhancer 400 as the sole coalescent increased the tack-free time relative to the control paint. This increase was minimized if Optifilm 400 was blended with Texanol ester alcohol or Eastman EEH solvent. Because Optifilm 400 does not contribute a significant amount of VOC to the paint, more glycol could be maintained in those paints. Keeping the higher glycol level helped these paints maintain the freeze/thaw resistance.

As seen in Figure 4, there were no significant differences in block resistance with the different coalescent systems in this formulation. Because the latex choice has a significant effect on block resistance, different trends may be seen in other formulations.

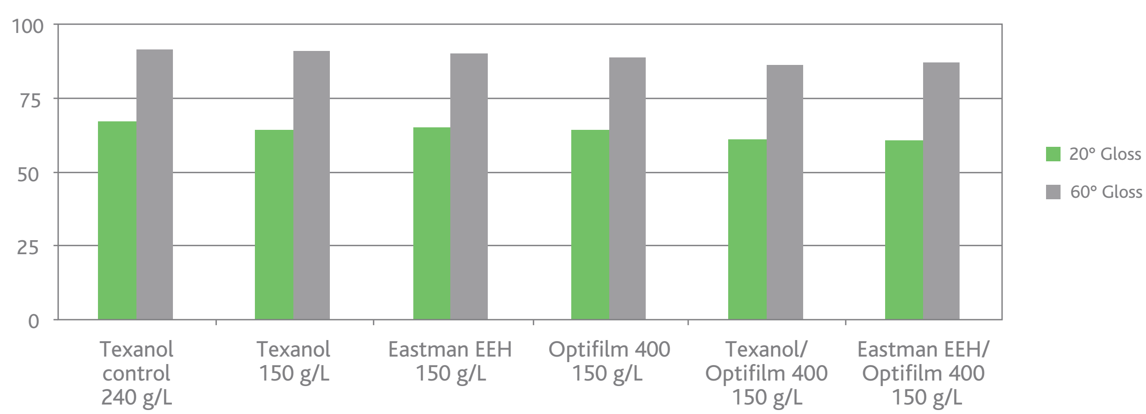
As seen in Figure 5, gloss development was consistent, regardless of the coalescent system used.

Figure 4. **Room-temperature block resistance**



Paints based on Rhoplex *HG-74; tested by ASTM D4946.*

Figure 5. **Gloss development for interior high gloss**



Paints based on Rhoplex HG-74; tested by ASTM D523-89.

Exterior flat paint results

As in the interior paints, a good balance of performance was maintained in exterior flat paints formulated to 100 or 50 g/L. Regardless of the coalescent system used, no significant differences were seen between the lower VOC paints and the 140 g/L control paint in many properties including viscosity, heat-age stability, contrast ratio, porosity at room temperature and low temperature (40°F), color development, or stain resistance. The freeze/thaw resistance of the lower VOC paints passed the same number of cycles as the higher VOC control, but the viscosity increases were slightly higher in the 50 g/L paints.

The exterior paints have been exposed in Kingsport, Tennessee, and Miami, Florida. After long-term exposure, overall performance for the lower VOC paints is very similar to the control paints. There are no clear trends due to the coalescent system (See Figures 6–9).

Figure 6. **Rhoplex™ ML-200 exterior flat paint**
Performance ratings after 3-year exposure
Two coats on beveled yellow pine exposed at 45° S in Kingsport, Tennessee

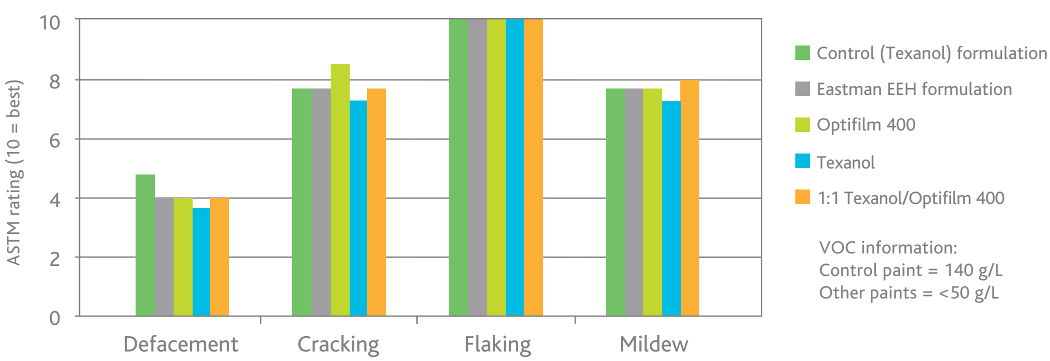


Figure 7. **Rhoplex™ ML-200 exterior flat paint**
Performance ratings after 3-year exposure
Two coats on beveled yellow pine exposed at 45° S in Miami, Florida

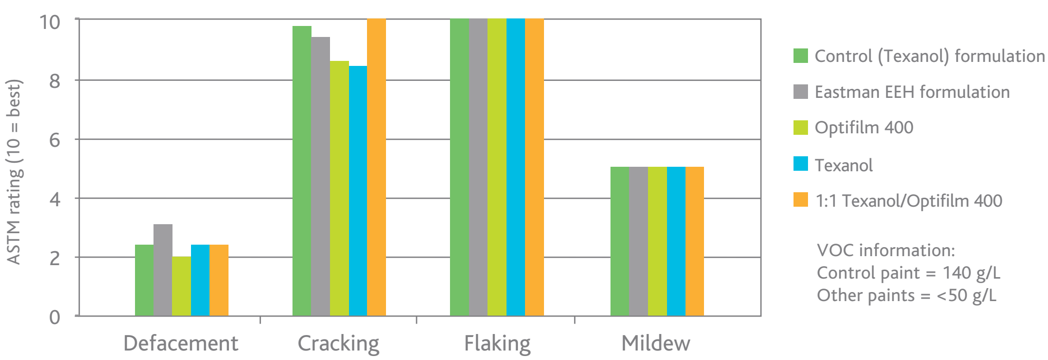


Figure 8. **Rhoplex™ ML-200 exterior flat paint**
Performance ratings after 3-year exposure
Two coats on western red cedar exposed at 45° S in Kingsport, Tennessee

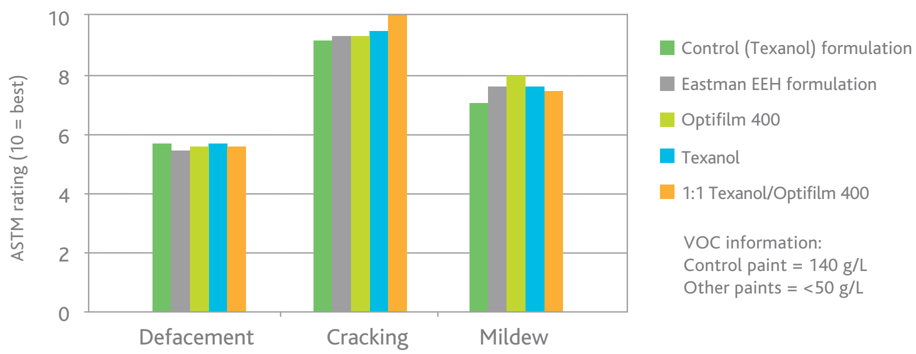
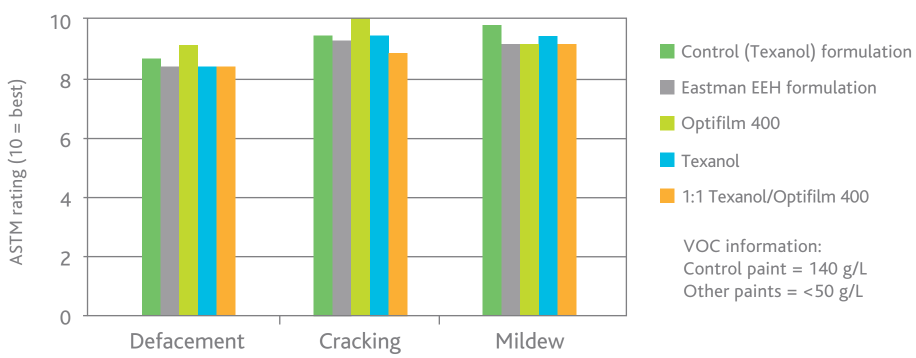


Figure 9. **Rhoplex™ ML-200 exterior flat paint**
Performance ratings after 3-year exposure
Two coats on western red cedar exposed at 45° S in Miami, Florida



Interior/exterior semigloss paint results

Interior/exterior semigloss paints were formulated to 150 g/L and, with some systems, 50 g/L. The 50 g/L paints could only be formulated if the coalescent package contained Eastman Optifilm™ enhancer 400. Optifilm 400 was tested as the sole coalescent and in blends with both Eastman Texanol™ ester alcohol and Eastman EEH solvent. As in the other paint types, a good balance of performance was maintained in the semigloss paints. Regardless of the coalescent system used, no significant differences were seen between the lower VOC paints and the 178 g/L VOC control paint in many properties including heat-age and freeze/thaw stability, contrast ratio, color development, adhesion to gloss alkyd, gloss development, and block or stain resistance. There were some differences in thickener efficiency, with the paints containing Eastman EEH requiring additional thickener.

These paints have also been exposed in Kingsport, Tennessee, and Miami, Florida, for more than a year. After long-term exposure, overall performance for the lower VOC paints is very similar to the control paints. As with the flat paints, there are no clear trends related to the coalescent system. Performance of the semigloss paints is summarized in Figures 10–13.

Figure 10. **Rhoplex™ SG-10M exterior semigloss paint**
Performance rating after 5-year exposure
Two coats on beveled yellow pine exposed at 45° S, Kingsport, Tennessee

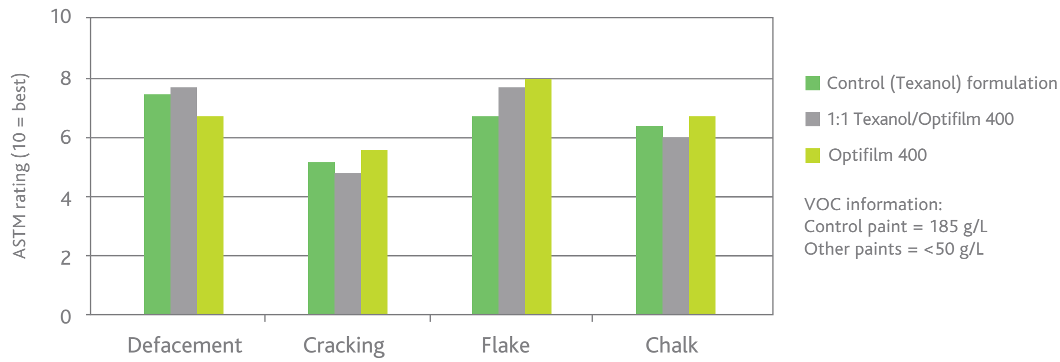


Figure 11. **Rhoplex™ SG-10M exterior semigloss paint**
Performance rating after 5-year exposure
Two coats on beveled yellow pine exposed at 45° S, Miami, Florida

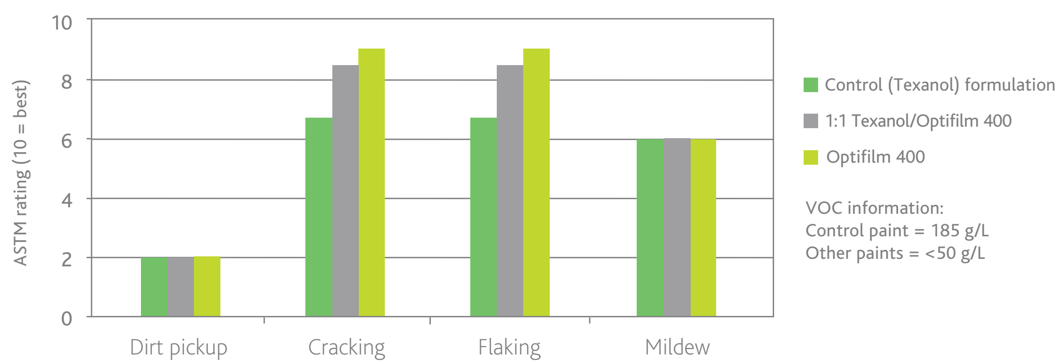


Figure 12. **Rhoplex™ SG-10M exterior semigloss paint**
Performance rating after 5-year exposure
Two coats on western red cedar exposed at 45° S, Kingsport, Tennessee

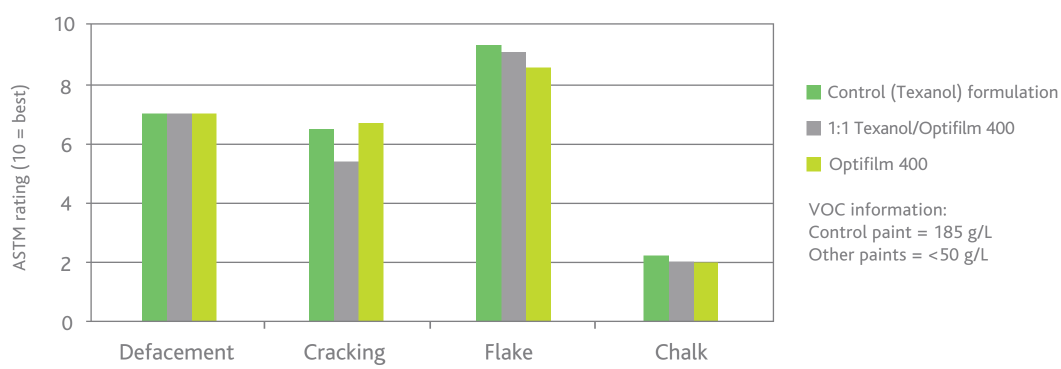
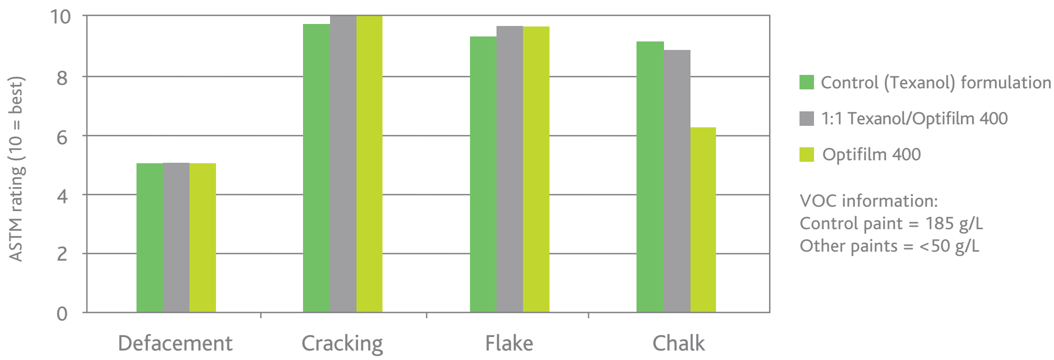


Figure 13. **Rhoplex™ SG-10M exterior semigloss paint**
Performance rating after 5-year exposure
Two coats on western red cedar exposed at 45° S, Miami, Florida



Conclusion

By choosing the right coalescent system, it is possible to formulate low-VOC paints with a good balance of performance. Different coalescents and blends of coalescents offer a variety of options for formulating low-VOC paints. By choosing coalescents that are effective at low levels such as Texanol ester alcohol, Eastman EEH solvent with improved efficiency, or Optifilm enhancer 400 which contributes lower levels of VOC, different balances of performance properties are possible.

Let us help you balance VOC compliance and paint performance. Call Eastman today or visit www.eastman.com/filmtechnologies.

Test methods

Scrub resistance of wall paint: ASTM D2486-00—Test method A with 3-mil bird bar.

Gloss: ASTM D523-89—Draw down the test paint with a 3-mil bird bar on a 3B chart. For a semigloss paint, measure gloss at 20°, 60°, and 85° after 1- and 7-day dry. For gloss paints, measure gloss at 20° and 60° after 1- and 7-day dry. For flat, eggshell, or satin paints, measure 60° and 85° after 1-day dry. Take at least 3 measurements at each appropriate angle. Record the average gloss and the standard deviation of the readings.

Room temperature block resistance: Cast films of the test paints with a 3-mil bird bar on 3B Leneta charts. Dry films for 1 day. For room temperature block, cut and place the 1-in. stripes together (paint film against paint film) and place a 1-lb weight on each strip. After 24 hours, remove the weight and separate the strips. Evaluate the block resistance by ASTM D4946 ratings. Report the average of the three tests. ASTM ratings are:

Block rating	Type of separation	Performance
0	75% to 100% seal	Very poor
1	50% to 75% seal	Very poor
2	25% to 50% seal	Poor
3	5% to 25% seal	Poor
4	Very tacky; no seal	Poor to fair
5	Moderate tack	Fair
6	Slight tack	Good
7	Very slight to slight tack	Good to very good
8	Very slight tack; slight pressure required	Very good
9	Trace tack; falls apart if shaken	Excellent
10	No tack; falls apart	Perfect

Low temperature touch-up: Paint one half of an upson board with the tinted paint. Dry 24 hours at room temperature. Place paints, boards, and brushes at 40°F for at least 4 hours to allow temperatures to equilibrate. Paint the perpendicular section of the panel and immediately return to the refrigerator. Dry for 24 hours. Evaluate each of the 3 sections of the panel (room temperature, cold temperature sealed, cold temperature unsealed) for any cracking. Record as excellent, poor, etc. Measure delta E values relative to the room temperature section to determine whether there are any differences in color.

EASTMAN

The results of insight™

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.
Building 3, Yaxin Science & Technology Park
Lane 399 Shengxia Road,
Pudong New District
201210, Shanghai, P.R. China

Telephone: (86) 21 6120-8700
Fax: (86) 21 5027-9229

Eastman Chemical Japan Ltd.
Anzen Building 16F
1-6-6 Moto Akasaka
Minato-ku, Tokyo 107-0051 Japan

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

Eastman Chemical Asia Pacific Pte. Ltd.
9 North Buona Vista Drive
#05-01 The Metropolis Tower 1
Singapore 138588

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

www.eastman.com