In recent years voluntary and mandatory schemes have been put in place to improve indoor air quality as explained by **Carlo Testa*, Louise Taylor** and **Ralf Taube**, Eastman Chemical Company

Meeting current and future legislations

Over the past few years, several global voluntary and mandatory schemes have been introduced to improve indoor air quality by limiting emissions from materials. In many cases it is not feasible or desirable to lower the overall emissions of a coating by simply reducing or completely removing the coalescents present in the formulation as this will have a negative effect on the application, performance and quality of the paint.

Eastman is now offering an enhanced coalescent portfolio to provide the coatings formulator with more options for designing a range of formulations from traditional coalesced coating systems to the latest low emission coatings. While many paints that meet the highest emission standards can be formulated with traditional coalescents, adding a low emission coalescent to Eastman's portfolio allows formulators options for transitioning away from volatile to non-volatile coalescents when required. Rather than spending resources and time re-formulating paints based on low Tg binders, traditional volatile coalescents can simply be replaced or used in combination with, new low- or non-emitting coalescents.

The poor reproducibility of emission testing is well known within the industry[1]. Formulators often choose to send their samples to more than one external laboratory to validate their emission results. The poor reproducibility can lead to unnecessary reformulation work and further costs associated with re-testing paint samples at more than one accredited test laboratory. No matter how poor the reproducibility of the testing, formulators who opt to formulate with Optifilm enhancer 400, have the reassurance that the contribution of this low emitting coalescent to the emission profile of the paint is always negligible.

Improving indoor air quality and lowering emissions from indoor paints, particularly wall and ceiling paints, is a major challenge for the coatings industry and designing a paint system that can conform to these schemes has become increasingly challenging.

Eastman Optifilm™ enhancer 400 is the Trademark of the Eastman Company

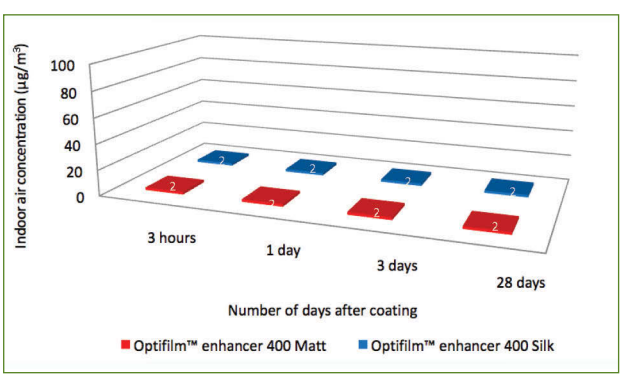


Fig 1. Emissions of Optifilm enhancer 400 in a matte and silk paint at 23°C

EVALUATION OF OPTIFILM ENHANCER 400

Emissions: Emission evaluations were carried out in-house and at an external accredited laboratory[2] in accordance with the ISO 16000 method[3]. The data in **figure 1** shows that the amount of Eastman Optifilm enhancer 400 emitted from a matte and silk wall paint formulation over a 28-day period is negligible.

To determine the amount of coalescent remaining in the paint films, dried paint was scraped off glass panels at regular intervals and analysed for residual coalescent by extraction into acetone. The amount of the coalescent in the extract was then determined by gas chromatography with flame ionisation detection.

The data presented in **figures 2** and **3** demonstrate that, even after six months of testing, 100% of low emitting coalescent remains in the coating, whereas the two conventional coalescents emit from the paint film during the 168 day testing period.

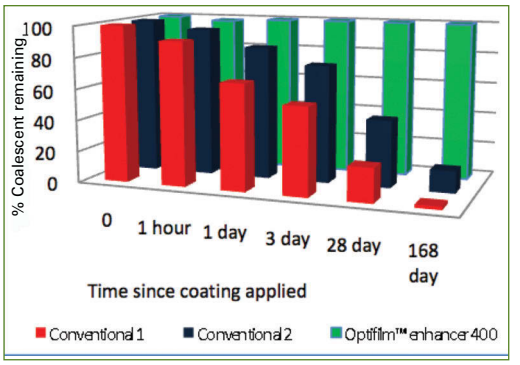
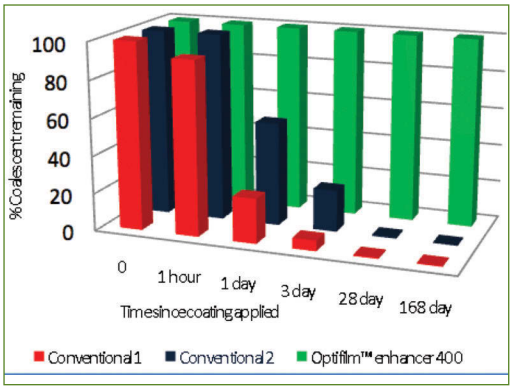


Fig 2. Silk paints. Coalescent loss over a six month period

Fig 3. Matte paints. Coalescent loss over a six month period



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3. 16000-6:2011, Indoor Air – Part 6: Determination of Volatile Organic Compounds in Indoor and Test Chamber Air by Active Sampling on Tenax TA Sorbent, Thermal Desorption and Gas Chromatography Using MS or MS-FID, December 2011.
4. A copy of TT-28C 'Reduce emulsion wall paint odour using Eastman Optifilm enhancer 300' can be found on www.eastman.com

Odour: Odour evaluations (**Table 1**) are subjective and perceived differently in different regions.

In all three test regions, matte and silk paints containing OE400 were found to have comparable odour to VAE-based paints.

For further details on how these paints were tested for odour see Eastman's coatings film technologies – technical tip TT-28C – '*Reduce emulsion wall paint odour using Eastman Optifilm enhancer 300*' [4].

Table 1. Right: Odour rating of low emission coalescents in matte paints after 24hr

Coalescent sample	China	UK	Asia
Conventional 1	6	8	6
Conventional 2	4	4	4
Optifilm enhancer 400	3	5	4
VAE	5	4	4

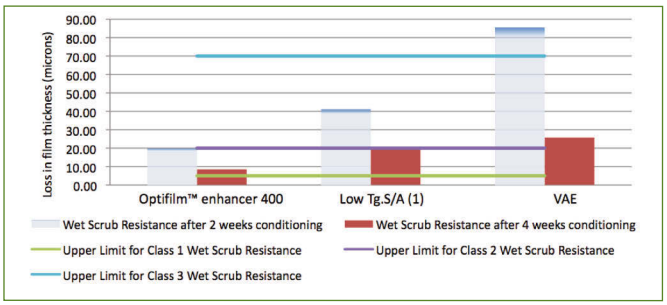

Fig 4. Low temperature scrub resistance of matte paint

Table 2. Performance of a matte paint formulated with OE400 against coalescent-free matte paints

Matte paints	Optifilm enhancer 400	Low Tg. S/A (1)	Low Tg. S/A (2)	VAE
Opacity (ASTM D-2805)	●	●	□	●
Gloss 85° (BS EN ISO 2813)	●	●	●	□
Cold temp integration (ASTM D-7489)	●	□	○	○
Colourant acceptance Blue tint	●	●	○	●
(ASTM D-2244/E-308) Black tint	●	●	●	●
Mud-cracking on Minerit board	●	●	●	●
Mud-cracking (low temp) on Minerit board	●	●	●	●
Block Resistance (day 7)	●	●	●	●
Burnish resistance	●	○	●	●
Wet scrub resistance room temp	Class 2	Class 2	Class 2	Class 3
(EN ISO 11998) low temperature	Class 2	Class 3	Class 1	Class 3
Water resistance (day 7) ●	●	●		□
Leach test (ASTM D7190-10(2011)	●	●	●	○

Legend: ● Comparable or slightly improved performance ●● Significant improvement in performance
□ Reduction in performance ○ Significant decrease in performance

Table 3. Performance of a silk paint formulated with OE400 against coalescent-free silk paints

Silk paints	Optifilm enhancer 400	Low Tg S/A (1)	Low Tg S/A (2)	VAE
Opacity (ASTM D-2805)	●	●	●	●
Gloss 85° (BS EN ISO 2813)	●	●	●	□
Cold temp integration (ASTM D-7489)	●	●	●	○
Colourant acceptance Blue tint	●	●	●	●
(ASTM D-2244/E-308 Black tint	●	●	●	●
Mud-cracking on Minerit board	●	●	●	●
Mud-cracking (low temp) on Minerit board	●	□	○	○
Hardness development (day 7)	□	●	●	●●
Block resistance (day 7)	□	●	●	●
Wet scrub resistance room temp	Class 1	Class 1	Class 1	Class 1
(EN ISO 11998) low temperature	Class 1	Class 1	Class 1	Class 2
Water resistance (day 7)	□	●	□	●
Leach test (ASTM D7190-10(2011)	●	□	○	○

Legend: ● Comparable or slightly improved performance ●● Significant improvement in performance
□ Reduction in performance ○ Significant decrease in performance

Performance: Matte and silk paints were formulated at PVCs of 70% and 25%.

The performance of the traditional polymer system formulated with Optifilm enhancer 400 was compared against the latest coalescent-free polymer technologies. The following matte and silk paint systems were prepared based on the following polymers:

1. A conventional styrene acrylic (S/A) polymer formulated with Optifilm enhancer 400.
a. S/A – Tg = 23°C
2. Two Low Tg coalescent-free styrene acrylic polymers that do not require a coalescing aid.
a. Low Tg S/A 1 Tg = 0°C
b. Low Tg S/A 2 Tg = 7°C
3. Two ethylene vinyl acetate (VAE) polymers that do not require a coalescing aid.
a. VAE Tg = 11°C for the matte test paint
b. VAE Tg = 21°C for the silk test paint

The results show that paints formulated with Optifilm enhancer 400 have very similar performance to the latest coalescent-free resin technologies. Performance improvements with Eastman's low emitting coalescent were observed in the colour acceptance, mud cracking, cold temperature integration (coalescence), water resistance and leaching tests.

Not all new regulations and labelling schemes take into consideration the 'life cycle' aspects of coatings, which include performance factors such as coverage and service life. The durability of a coating is one of the key properties of a paint film and one of the ways to measure the durability of a coating is via the EN-ISO11998 method, which is used to determine the wet scrub resistance of a film. The test involves conditioning the paint films for four weeks at 23°C before evaluating the wet scrub resistance. Eastman's internal low temperature wet scrub resistance test is much more severe and simulates applying the paint in cold, humid conditions before conditioning the film under ambient conditions (eg a professional decorator painting a new build, which is not heated). The test involves applying the paints, immediately drying them for two days at 5°C and 65-75% RH, followed by a 26-day conditioning at 23°C. **Figure 4** shows the comparison in low temperature wet scrub resistance of matte paints formulated with two different coalescent-free polymers compared against a traditional coalesced system based on Optifilm enhancer 400. The results show that the VAE-based paint had the greatest loss in film thickness (>20µm – Class III), followed by the low Tg coalescent-free polymer (~20µm – Class II/III). The matte paint formulated with the low emitting coalescent demonstrated the best wet scrub resistance with a loss in film thickness <10µm (Class II).

Formulating with this coalescent will enable formulators to meet the increasing demand for durable paint solutions with lower odour and near-zero emissions.

CONCLUSION

Formulating with Eastman's Optifilm enhancer 400 eliminates the need for the extensive re-formulation that is often required when switching to coalescent-free polymers, thus providing a simple, cost competitive way to create low-odour, near-zero emission coatings that comply with the most stringent voluntary and compulsory global regulations.