

Formulating Decopaint-compliant 2K industrial wood-coating formulations with Eastman Solus™ 2100 performance additive and Eastman EP solvent

EC directive 2004/42/EC was implemented on January 1, 2007. This directive introduced 12 categories of coatings for architectural systems, with each category demanding a maximum allowable volatile organic compounds (VOC) content. Phase 2 of this implementation took place on January 1, 2010, with a corresponding change to the maximum allowable VOC content for some product types.

Some professionally applied wood-coating formulations are applied *in situ* and are regulated by this EC directive. In particular, the product category j (two-pack reactive performance coatings for specific end uses such as floors) designated a maximum VOC limit of 550 g/L for solventborne coatings in 2007, reducing to 500 g/L in 2010. It has been reported that some customers are reducing the VOC content of such coatings by adding water to the solventborne coating systems, since water would not be included in the VOC calculation.

This technical tip describes how Eastman Solus™ 2100 performance additive in combination with Eastman EP solvent can be used to modify a noncompliant test formulation to reduce the VOC to below the allowable level for a coating of this category. Eastman EP solvent performs as a coupling solvent and allows the addition of water to a solventborne coating, while the Eastman Solus 2100 performance additive maintains the appearance and physical properties of the final coating film without compromising the performance of the system.

Eastman Solus™ 2100 performance additive

Solus 2100 derives from natural and renewable cellulose material, has a relatively high T_g , and is designed for today's high-solids topcoat systems, featuring improved productivity from reduced dry-to-touch time while maintaining the excellent rheology profile for which the traditional Eastman cellulose esters are known.

Eastman EP solvent

Eastman EP (ethylene glycol monopropyl ether) solvent is a colorless, water-miscible solvent that provides a slow evaporation rate, good viscosity control in waterborne resins, and high flash point. Eastman EP solvent has a milder, less detectable odor than most other glycol ethers, enhancing its use in coatings when mild odor is desirable. Eastman EP solvent is completely water miscible over a wide range of temperatures. The water miscibility characteristics of Eastman EP solvent result in excellent coupling performance where the solvent can solubilize or stabilize normally immiscible materials.

Experimental

Table 1 shows a typical starting point formulation for a two-pack acrylic urethane coating system used for furniture applications. The VOC content of this formulation was calculated at 626 g/L in the ready-to-use form. Therefore, this formulation would not be suitable for use in applications such as professionally applied *in situ* type applications which would be regulated by the Decopaint directive 2004/42/EC. The formulation was modified (Table 2) by substituting the relatively high-molecular-weight CAB with the lower-viscosity Solus 2100 and Eastman EP solvent together with deionized water.

Table 1. Starting point formulation standard product

Ingredient	Weight (g)
Part A	
Desmophen™ A450 (50%) (Covestro)	50.0
<i>n</i> -Butyl acetate	13.0
Baysilone™ OL31 (Borchers)	0.3
CAB 381-2 (25% in <i>n</i> -butyl acetate)	11.1
MEK (methyl ethyl ketone)	18.2
Part B	
Desmodur™ N75BA (Covestro)	7.4
Total	100.0
Viscosity (DIN 4)	32.0 sec
Solids content	33.4%
Specific gravity (23°C)	0.94
VOC g/L ready to use	626

Table 2. Revised formulation with Eastman EP solvent, water, and Eastman Solus™ 2100 performance additive

Ingredient	Weight (g)
Part A	
Desmophen™ A450 (50%) (Covestro)	49.8
Eastman EP Solvent	9.0
Paint additive 3468 (Borchers)	0.3
BYK™ 065 (BYK Chemie)	0.2
Eastman Solus 2100 (60% in <i>n</i> -butyl acetate)	11.0
<i>n</i> -Butyl acetate	8.8
Deionized water	12.9
Part B	
Desmodur™ N75BA (Covestro)	8.0
Total	100.0
Viscosity (DIN 4)	35.0 sec
Solids content	37.5%
Specific gravity (23°C)	0.98
VOC g/L ready to use	486

The formulations were prepared by gentle mixing using a laboratory stirrer. Part B (isocyanate hardener) was added to part A immediately prior to application. The EP solvent/water mixture formulated a slight excess of isocyanate to account for reduced cross-linking due to possible side reactions between the isocyanate and water.

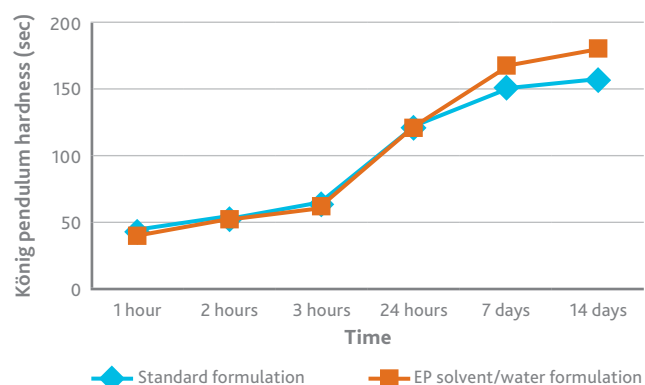
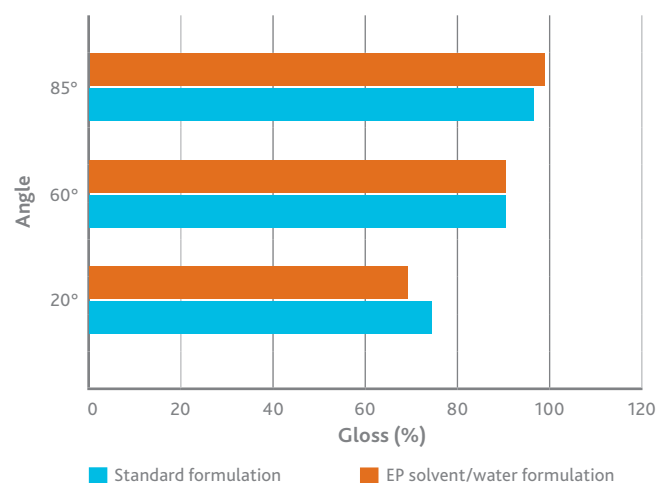
The calculated VOC content for the Eastman EP solvent/ Solus 2100 modified formulation was 486 g/L, thus indicating that this formulation is in compliance with the relevant product category limit stipulated in EC directive 2004/42/EC.

Coating performance

The physical properties of both formulations are illustrated in Table 3, and the test methods are detailed in the "Test methods" section.

Table 3. Comparison of properties

	Standard formulation	EP solvent/ water formulation
1. Dry-to-touch time (min)	10.0	14.0
2. Hardness development (sec)		
1 hour	36.4	30.8
2 hours	47.8	44.8
3 hours	60.2	54.6
24 hours	116.2	116.2
7 days	149.8	166.6
14 days	155.4	179.2
3. Gloss (%)		
20°	75.6	71.4
60°	89.4	89.1
85°	96.9	98.6
4. Alcohol and water resistance (DIN 68861)		
48% ethanol (1 hour)	0	0
Deionized water (16 hours)	0	0

Figure 1. Hardness development**Figure 2. Gloss**

Incorporation of water into the Eastman EP solvent-containing formulation resulted in the formation of an opaque mixture. After standing for 48 hours, this mixture separated into two layers but could easily be homogenized with stirring or shaking.

The pot life of the standard formulation was observed to be in excess of 8 hours, whereas the water-containing formulation was observed to increase in viscosity after approximately 5 hours. No evidence of excessive foam generation was observed with the EP solvent/water formulation.

Discussion

The results of our evaluation indicated that it was possible to formulate a Decopaint-compliant wood coating formulation by adding water to a standard solventborne wood coating formulation using Eastman EP solvent as a coupling solvent to homogenize the aqueous and nonaqueous phases and Eastman Solus™ 2100 performance additive to adjust the viscosity of the formulation. Although these phases will separate on standing, the mixture became homogeneous with moderate agitation.

The physical properties of the EP solvent/water-containing coating compared favorably with the standard formulation. The main difference was an increase in dry-to-touch time and a corresponding slight reduction in hardness development in the initial 3 hours of the drying process. After 7 and 14 days, the hardness of the water-containing system was actually higher than the standard system.

The gloss and chemical (alcohol and water) resistance of the EP solvent/water-containing formulation remained generally unchanged compared to the standard formulation.

EC directive 2004/42/EC allows calculation of VOC content in the ready-to-use coating but does not require that any water in the formulation be discounted. Thus adding water to a solventborne coating can result in lower VOC content in the ready-to-use state. The VOC is calculated as follows: $\text{VOC g/L} = (100 - \text{NVC}) \times \text{SG (specific gravity)} \times 10$.

Test methods

Dry-to-touch time

Films of both formulations were drawn down onto sheen-sealed, sag-resistance test charts to give a target approximate dry-film thickness of 40 µm. The drying films were assessed by touching with a finger, and the time was taken until this action resulted in no marking of the surface.

Hardness development

Films of both formulations were drawn down onto glass panels to give a target dry-film thickness of approximately 40 µm. The coated plates were stored at room temperature. Hardness development was measured using a König pendulum hardness tester at 1, 2, 3, and 24 hours, followed by 7-day and 14-day drying.

Gloss

Films of both formulations were drawn down onto sheen-sealed, sag-resistance test charts to a target dry film thickness of 40 µm. The coated panels were allowed to dry for 24 hours before gloss measurements were recorded using a Sheen Tri-Microgloss multiangle glossmeter.

Alcohol and water resistance

The resistance of dried films of both materials was assessed after 24 hours drying at room temperature (DIN 68861). The assessment was made with deionized water (16 hours) and 48% ethanol (weight/weight) aqueous solution (1 hour). A 1.5-cm square of cotton wool was soaked with the test material, placed on the coating surface, and covered for the required time period. Following the time period, the surface was wiped and the coating assessed against the criteria listed. The coatings were reassessed after 72 hours to establish if the effects noted were permanent.

- 0** = No sign of damage
- 1** = Surface is slightly changed in color or gloss (change disappears within 10 minutes)
- 2** = Surface is slightly changed in color or gloss (change disappears within 1 hour)
- 3** = Visible and durable changes to the surface
- 4** = Changes in the structure of the film
- 5** = Test film is destroyed



Eastman Corporate Headquarters
P.O. Box 431
Kingsport, TN 37662-5280 U.S.A.

U.S.A. and Canada, 800-EASTMAN (800-327-8626)
Other Locations, +(1) 423-229-2000

www.eastman.com/locations

Although the information and recommendations set forth herein are presented in good faith, Eastman Chemical Company ("Eastman") and its subsidiaries make no representations or warranties as to the completeness or accuracy thereof. You must make your own determination of its suitability and completeness for your own use, for the protection of the environment, and for the health and safety of your employees and purchasers of your products. Nothing contained herein is to be construed as a recommendation to use any product, process, equipment, or formulation in conflict with any patent, and we make no representations or warranties, express or implied, that the use thereof will not infringe any patent. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS AND NOTHING HEREIN WAIVES ANY OF THE SELLER'S CONDITIONS OF SALE.

Safety Data Sheets providing safety precautions that should be observed when handling and storing our products are available online or by request. You should obtain and review available material safety information before handling our products. If any materials mentioned are not our products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be observed.

© 2019 Eastman. Eastman brands referenced herein are trademarks of Eastman or one of its subsidiaries or are being used under license. The ® symbol denotes registered trademark status in the U.S.; marks may also be registered internationally. Non-Eastman brands referenced herein are trademarks of their respective owners.