

An Investigation Into the Effect of *Eastman CAB* Performance Additive to a 2K Acrylic Urethane Wood Coating for Furniture

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This paper was presented at the
PRA — Fifth International Woodcoatings Congress
Prague, October 17-18, 2006

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Abstract

Whilst EU regulations are driving a change in application and coatings technologies, solvent borne systems still predominate particularly for high quality furniture coatings. The ability of the coatings applicator to combine technologies allow the continued use of 2K acrylic urethane coatings for wooden furniture to achieve desired haptic and technical performance.

A program of work was undertaken by the CTBA (Centre Technique Du Bois Et De L'Ameublement) in Paris to determine the effects of Cellulose aceto butyrate to a semigloss 2K acrylic urethane wood coating system. The work detailed in this paper identified the positive effects of CAB addition in terms of improved hardness development, surface appearance, haptic, and ease of application.

Introduction

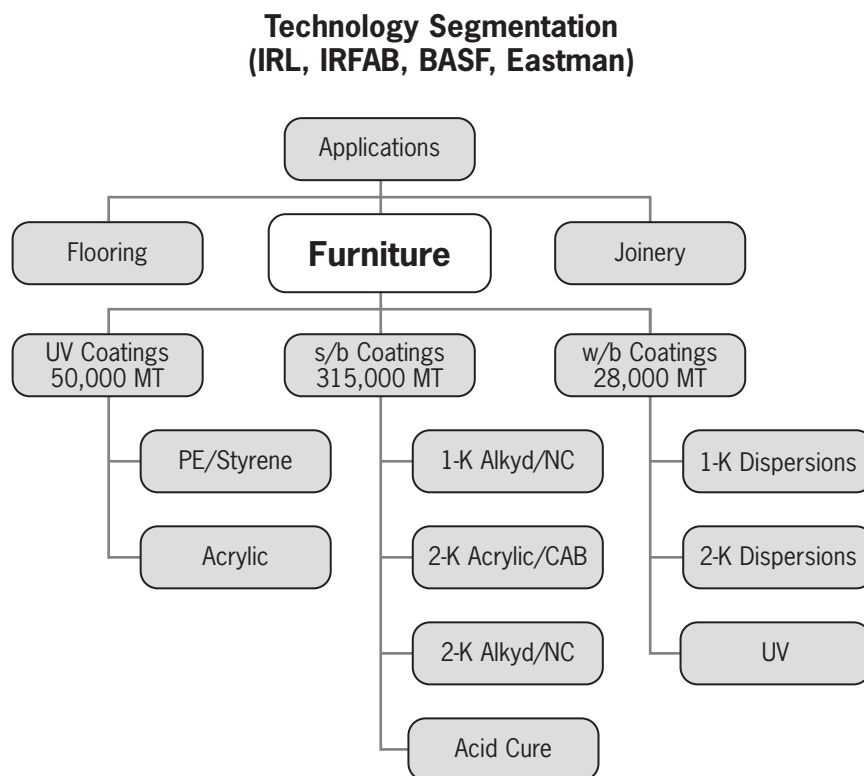
If you were to analyse and assess the current European furniture coatings industry, you would quickly reach the conclusion that the industry is relatively conservative, very much service orientated and, as a result, highly fragmented with few multinational players. The last point is also in part due to the fact that, unlike industries such as automotive OEM and electronics, there is probably only one furniture manufacturer who could be described as multinational in nature.

Wood, as a constantly changing, living substrate demands the full expert knowledge of the coatings formulator to bring out its true beauty and as a result the most cherished employee at the wood coating company is often the head formulator. The formulator must have the ability to alter his formulations to take into account changes to both

application conditions and substrate variations. Traditionally solvent borne coatings formulations have provided the ideal solution to such variability but due to the drive to lower VOC emissions, the furniture coating industry is undergoing a journey of continual change.

The current furniture coatings industry in EMEA is still dominated by the use of solvent borne coatings systems which account for over 315 KMT/year compared to UV and waterborne coatings which stand at 50 KMT and 28 KMT respectively (Figure 1). However, legislation such as the VOC directive 1999/13/EU (industrial applications) and the Decorative Paint Directive (which includes professional joinery products) are driving a change in coatings technologies.

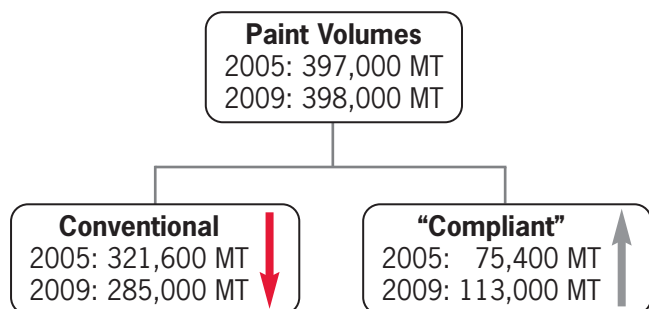
Figure 1



Although we estimate a relatively high growth rate of approximately 10% in the use of “compliant” coatings technologies such as waterborne and UV curable systems, this level of growth over the next four to five years would only provide approximately 30% of the current demand for wood furniture coatings (Figure 2).

Figure 2

Predicted Growth in “Compliant” Technologies



From this apparent imbalance it therefore seems realistic that solvent borne wood coatings systems will continue to be utilized in the coating of wood furniture for some time to come. This will be further

prolonged by the use of improved transfer efficiency, incineration, and solvent capturing technologies which are particularly of interest at large coatings applicators which ensure full compliance.

Additionally the combination of multiple technologies to apply furniture coatings is already a common practice at wood coating applicators. The particular advantages of each technology being fully utilized to provide the optimum surface finish whilst fully complying with the VOC regulations.

Coating systems such as the high quality 2K acrylic urethane furniture coatings where cellulose ester products find their main use are likely to have a prolonged life span for the following additional reasons:

- The type of furniture coated—high quality requiring high aesthetic properties
- The variety of application conditions encountered
- Open pore wood species require the correct solids content at application viscosity
- The high standards of the end user specifications
- The economic situation of the furniture manufacturer

Cellulose Esters in Wood Coatings for Furniture

Cellulose acetate butyrate (CAB) resins have been used in wood coating systems for many years. They find widespread use in high quality 2K acrylic urethane systems and the growing radiation curable systems. It is common to find CABs being employed as additives to enhance the application and performance characteristics. The main advantages cellulose esters offer in wood coating systems are:

- Fast hardness development allowing early stacking and processing of coated products
- Nonyellowing under the influence of UV light
- Excellent flow and levelling characteristics giving excellent defect reduction and appearance
- Achieving the correct balance of viscosity and solids content which allows excellent wetting, penetration, and pore-definition on “open-pore” wood species
- Superior control of silica matting aids allowing consistent gloss levels particularly at different film thickness
- Excellent atomization and application characteristics
- Improved adhesion (UV systems)

The unique structure and composition of cellulose ester materials allows us to alter key attributes of the products to alter solubility, compatibility, hydroxyl content, and molecular weight thus providing a range of products which offer the coatings formulator a wide variety of formulation options.

Many of the performance benefits of cellulose ester materials derive from the high Tg and relatively high molecular weight of the resins. Additionally the molecular structure of the cellulose ester chains is observed to provide unique rheological properties where CAB solutions are observed to have almost “Newtonian” flow behaviour at certain shear rates thus allowing excellent atomization, flow, and levelling but very shortly after application, the elastic modulus predominates over the viscous modulus resulting in fast hardness development and excellent film properties.

To demonstrate some of these performance attributes, Eastman commissioned a study at the CTBA (Centre Technique Du Bois Et De L’Ameublement) in Paris to investigate the effect of

the addition of varying levels of CAB resins to a simple solvent borne semigloss 2K acrylic urethane wood coating system. The CTBA was chosen for their expertise in the furniture coating industry and their facilities in Paris offered semi-industrial application conditions desired for such a study.

The coatings systems were prepared by Eastman and independently applied and assessed by the CTBA experts. The formulations were prepared to be virtually spray ready with only the addition of retarder solvent (PM acetate) and the aliphatic isocyanate hardener being required by the CTBA prior to application. The complete formulations are attached in Appendix 1 but were essentially as follows:

Formulations

Formulation	Theoretical % Solids at Application	Viscosity
X24441— 64A Blank No CAB	31,8	
X24441— 64B 5,8% CAB	22,3	
X24441— 64C 9,7% CAB	20,7	
X24441— 64D 2,4% CAB	21,2	

Since wood coatings typically comprise (at least) a base-coat and a topcoat, the formulation 64B (containing 5.8% CAB) was used as a common base-coat system for all panels. The coating systems were therefore as follows:

Re Systems by the Lab	Description of Applied Products	
System 1	64B—64A	A = no CAB
System 2	64B—64B	B = CAB at 5,8%
System 3	64B—64C	C = CAB at 9,7%
System 4	64B—64D	D = CAB at 2,4%

Application

The device used to apply products was Airmix[®] gun with following parameters:

- Pump 10 14—Nozzle: 06-116
- Air pressure: 1,5 bar for basecoat and 1,2 bar for topcoat. (The air pressure is adapted to the product.)
- Product pressure: 30 bar
- The aim was to apply about 100 g/m² wet on each sample

The comments of the applicator and the appearance of the coated panels were recorded as a means of comparing the application properties of each coating system.

Substrates and Preparation

The substrates chosen for the evaluation were as follows:

- Particleboard veneered beech—presanding with Abranet P180
- Solid oak and particleboard veneered oak—presanding with Abranet P180
- Particleboard veneered maple—presanding with Abranet P220

For the hardness development study, the coatings were applied directly onto glass mirror plates.

Performance Testing

After a period of conditioning, the following performance evaluations were made:

- Dry-to-touch time
- Hardness development (according to NF EN ISO 1522)
- Adhesion (according to NF EN ISO 2409)
- Gloss (according to NF EN ISO 2813)
- Chemical resistance by resistance to stains by 5 different products: water, alcohol, cleaning agent, ink, hot coffee (according to NF EN 12720)

Results and Discussion

Appearance and Application Comparison

Figure 3

Appearance on Solid Oak



The CTBA expert rated the appearance and application properties of the coating system in the following order

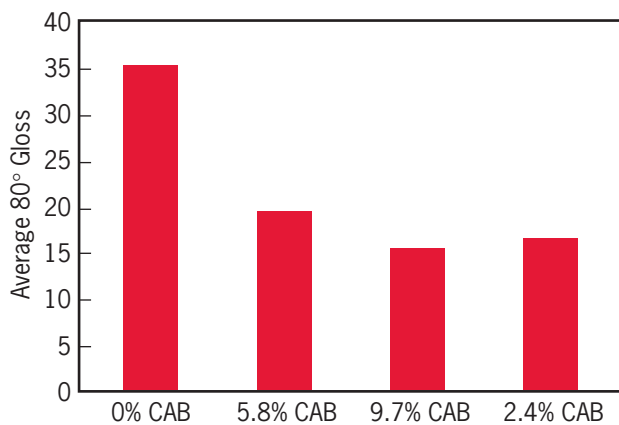
$$64B > 64C > 64D > 64A$$

Thus confirming that in all cases the addition of CAB improved the application and appearance of the coating system compared to the non-CAB containing blank.

The blank formulation 64A showed very poor flow and levelling characteristics with the coated surface described as “wrinkled” by the CTBA.

Figure 4

60°Gloss Measurements



Although the ratio of silica matting aid to binder was kept constant in the coating formulations, it was also observed that the gloss of the blank formulation was significantly higher than the CAB containing coatings. The 60° gloss values shown in Figure 4 are derived from the CTBA data. The CAB resin is effective in controlling silica matting aid because it induces a relatively high degree of film shrinkage into the coating thus ensuring the silica is present at the film surface therefore reducing gloss.

Additional work performed by Eastman looking at the appearance of an open pore wood (oak) coated with formulation 64A (blank) and 64B (5.8% CAB) indicated that the edges of the individual wood pores had a pronounced “frame” or thick edge with the non-CAB formulation but this could not be observed to the same extent with the CAB containing system. This is illustrated in the photographs shown in Figures 5 and 6 (prepared by Eastman).

Figure 5

64A No CAB

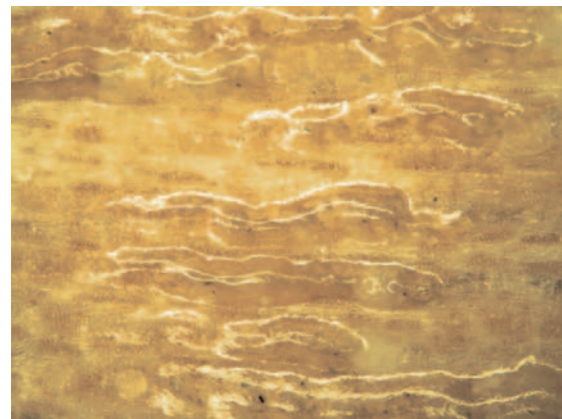
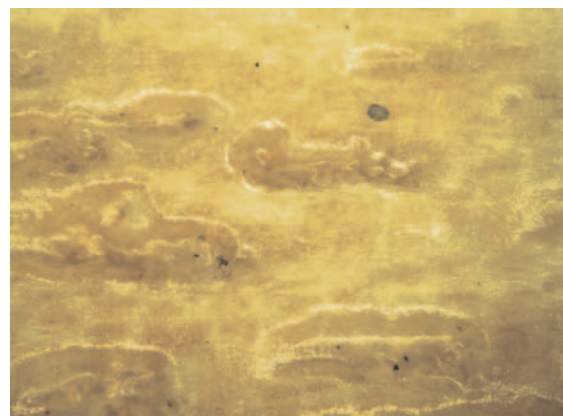


Figure 6

64B 5.8% CAB



Hardness Development

The following charts were produced from the CTBA data.

Figure 7

Hardness Development up to 24 Hours

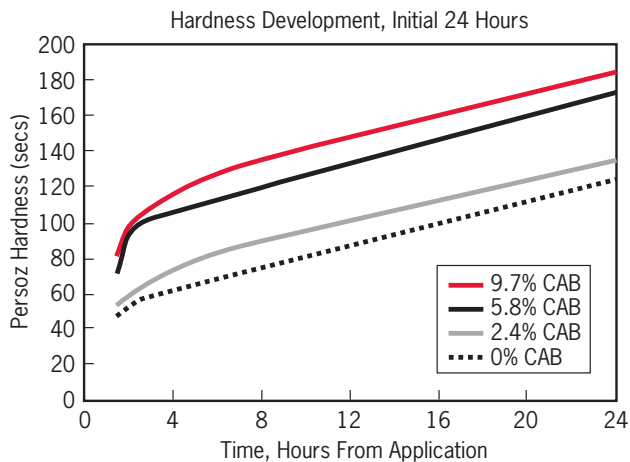
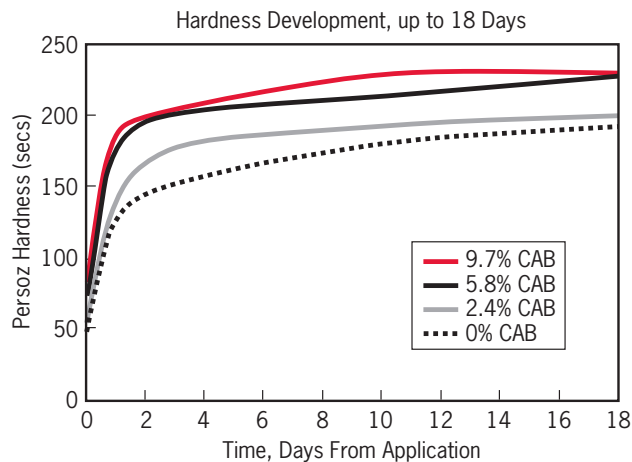


Figure 8

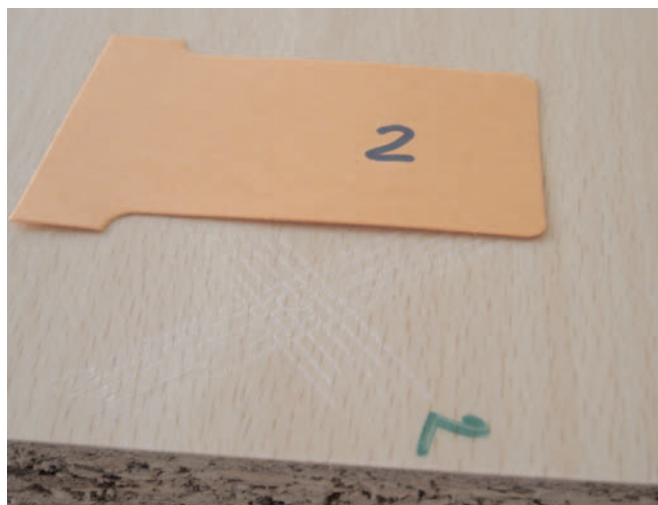
Hardness Development up to 18 Days



The data obtained clearly shows improved hardness development of the CAB containing formulations particularly in the critical early stages of the drying process. The 5.8 and 9.7% CAB containing formulations achieve hardness values after 24 hours which the blank formulation failed to reach after 18 days drying. This type of performance demonstrates another key advantage of CAB containing formulations where such rapid hardness development would allow the early processing and stacking of coated articles in an industrial environment.

Figure 9

Sample 64B Tape Adhesion Test



Adhesion

All formulations were observed to have good ISO2409 tape adhesion to the substrates used in the evaluation. A typical result is shown in Figure 9.

Chemical Resistance

The results of the chemical resistance study are detailed below:

Product	Distilled Water		Alcohol 48°		Break Up 3%		Ink		Endorsing Ink		Coffee 80°C	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
64A	5	5	1	1	5	5	1	1	1	1	5	5
64B	5	5	1	1	5	5	1	1	1	1	5	5
64C	5	5	3	3	5	5	1	1	1	1	5	5
64D	5	5	3	3	5	5	1	1	1	1	5	5

S1 = appearance in diffuse light; S2 = appearance in direct light.
 Assessment from 5 to 1 with 5 = no visible change.
 Break up is a commercial cleansing agent.

The results indicate that the formulations used had satisfactory performance in resistance to water, detergent, and coffee but were not acceptable in resistance to alcohol and inks. It should be pointed out that the formulation used for the evaluation was not fully optimized for resistance properties but

was more suitable for showing the aesthetic qualities. Nevertheless it can be stated that the CAB addition did not detract from the chemical resistance properties and indeed improved the alcohol resistance result in the case of formulation 64C and 64D.

Conclusions and Summary

The study performed by the CTBA confirmed the positive effect of CAB performance additive on the drying and hardness development of the coating—particularly in the critical early stages of the drying process. This feature allows the early handling, processing, and stackability of the coated furniture helping with throughput which is a major requirement in the industry.

The CTBA experts reported that the CAB containing coating systems had improved flow, levelling, wetting, and application characteristics compared to the control.

The study demonstrated that the CAB containing systems showed consistently lower gloss levels for

equivalent matting aid loading. Previous studies have indicated that CAB resin is effective in controlling silica matting aid because it induces a relatively high degree of film shrinkage into the coating thus ensuring the silica is present at the film surface, therefore reducing gloss. This could result in more economical use of matting aid.

The results highlighted in this report confirm the positive effect of CAB for use in furniture coatings to achieve the desired haptic and technical performance demanded in this high quality application.

Appendix 1—Formulations

INGREDIENTS	64A	64B	64C	64D
Part A				
<i>Desmophen A450 50% 1:1 BA:X</i> [Bayer]	636	347	241	390
CAB 381-20	—	—	—	24
CAB 381-0.5	—	58	97	—
MEK	110	188	214	184
Ethyl Acetate	28	96	108	96
Butyl Acetate	112	194	222	192
Xylene	31	55	61	54
Zinc Stearate 20% in Ethyl Acetate: Toluene 1:1 [Faci UK Ltd.]	58	43	40	41
<i>Acronal 4L (10% in Ethyl Acetate)</i> [BASF]	1	1	1	1
<i>Syloid ED30</i> [Grace]	17	13	12	13
<i>Lanco Wax PP 1362 D</i> [Lubrizol]	7	5	4	5
Total (g)	1,000	1,000	1,000	1,000
Part B				
<i>Desmodur N 75 BA:Ethyl</i> Acetate (1:1)	97	73	75	68
Retarder solvent to 20 seconds DIN 4	110	188	214	184

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August 2006