Compatibility of *Eastman* Cellulose Acetate Butyrate/Cellulose Acetate Propionate and European Resins

The mixed cellulose esters (cellulose acetate butyrate [CAB] and cellulose acetate propionate [CAP]) are usually modified by the addition of other resins to improve adhesion, flexibility, abrasion resistance, outdoor weathering, etc. Many compatible resins are available in Europe for this purpose. This publication presents the results of a study of the compatibility of *Eastman* lacquer-grade and ink-grade cellulose esters with a number of different European resins including acrylic, alkyd, amino, isocyanate, ketone, maleic, and polyester types.

EASTMAN

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Compatibility

It is usual to refer to cellulose ester/resin "compatibility" or "incompatibility" to denote whether the combination gives a clear or a hazy film. However, resin blends may be incompatible in a strictly thermodynamic sense and yet give clear films. Clarity is achieved when the refractive index difference and the domain size of the individual composition are sufficiently small that the eye is unable to perceive haze.

Sometimes a cellulose ester/resin combination will be reported as compatible by one laboratory and incompatible by another. The apparent discrepancy may be caused by a difference in solvents used for compatibility testing, difference in drying or stoving conditions, difference in application techniques, or difference in film thickness. Compatibility results may also vary with the technique used for evaluation. It is common practice to examine film under daylight conditions, although it can be done by projecting a strong beam of light through the film in a darkened room.

Finally, it should be noted that resin compatibility may be appreciably altered by the other components of a formulation. Compatible systems can often be obtained with three or more components when two of the individual components in the mixture are incompatible with each other. To determine the performance of a particular cellulose ester/resin composition, it should be tested in the specific formulation and under the specific conditions under consideration.

Compatibility Study

Method

Cellulose esters and modifying resins were dissolved in ethyl acetate 99 percent at 20 weight percent solids. With some resins, it was necessary to add 5–10 weight percent isobutyl alcohol, *Eastman* EEP solvent, or xylene to achieve a soluble mixture prior to testing for compatibility with the cellulosic resin. The solutions were mixed in ratios of 1:9, 1:4, 1:1, and 4:1 and coated on clear glass plates at 150–250 m dry film thickness. After air drying for 5–15 minutes, the coated glass plates were stoved in an air oven for 30 minutes at 115°C. When cooled to room temperature, the coatings were examined for clarity in diffused light with a black background and also in direct sunlight. Assessments on compatibility were made on the following basis:

Compatible (completely clear film)

Very Slightly Incompatible

Slightly Incompatible

Incompatible (translucent to opaque film)

Cellulose Esters Studied

The following *Eastman* CAB and CAP esters were tested for compatibility with a wide variety of European resins:

CAB-381-0.5 and CAB-551-0.2
CAB-553-0.4
CAP-504-0.2
CAP-482-0.5
CAB-551-0.01

The compatibility of CAB-551-0.2 is normally similar to CAB-381-0.5. In those cases where it is not the same, data for CAB-551-0.2 is reported following a diagonal (/) mark. Thus, "C/VSI" indicates that CAB-381-0.5 is compatible and CAB-551-0.2 is very slightly incompatible with the modifying resin. A glance at the chart shows where the compatibility differences are between the two resins. Compatibility of the lower-viscosity and higher-viscosity CAB-381 esters (CAB-381-0.1, CAB-381-2 and CAB-381-20) can be assumed to be the same as that reported for CAB-381-0.5.

Two alcohol-soluble cellulose esters were included in the study: CAB-553-0.4 and CAP-504-0.2. The former is soluble in anhydrous ethyl alcohol, but the latter requires at least 5 percent water or a low percentage of an active solvent such as ethyl acetate to achieve a clear solution. Both are also soluble in conventional lacquer solvent compositions.

Except for CAB-551-0.01, the study does not indicate compatibility at very high levels of resin modification (1:9). CAB is often used as an additive in other coating compositions. For example, a small amount of the cellulosic can be added to thermoplastic or thermosetting finishes to improve application and performance properties. The most notable improvements are reduced cratering, quicker dust-free time, and better pigment control. CAB-551-0.01 is a low-molecular-weight cellulose ester that is used primarily as an additive or as a polyol reactant. It provides the usual benefits of improved flow control, pigment control, and solvent release.

Formulating Techniques

Formulating techniques for *Eastman* lacquer-grade cellulose esters may vary from those used with nitrocellulose lacquer compositions.

The chief differences are as follows:

1. Films of mixed cellulose esters soften more readily when modified with resin or plasticizer than do nitrocellulose films. Thus, to avoid softening of the film, coatings containing *Eastman* CAB and CAP should be formulated with less plasticizer than is used with nitrocellulose.

2. A slight haze may result from using medium-evaporating or slow-evaporating esters or ketones. This occurs if they are the last solvents to evaporate from films containing alkyd or maleic resins modified with CAB. If haze occurs, a change to an aromatic hydrocarbon as the slowest-evaporating solvent may yield a clear film.

3. The density difference between mixed cellulose esters and nitrocellulose must be considered. The density of *Eastman* CAB and CAP is approximately 1,200 grams per litre, as compared with approximately 1,600 grams per litre for nitrocellulose. A CAB wood lacquer formulated at 19.5 weight percent nonvolatile would give approximately the same coverage in microns per square meter as would a nitrocellulose lacquer at 21.5 weight percent nonvolatile. The density difference is particularly important in pigmented coatings or inks. To convert a pigmented nitrocellulose ink formulation to a CAP or CAB formulation, it must be done on a volume basis, not on a weight basis, to maintain the pigment-to-binder ratio and therefore the color strength of the reformulated ink.

ACRYLIC RESINS

Thermoplastic	Supplier	CAB-381-0.5/ CAB-551-0.2 CAB:Resin Ratio 1:4	1:1	4:1	CAB-553-0.4 CAB:Resin Ratio 1:4	1:1	4:1	CAP-504-0.2 CAP:Resin Ratio 1:4	1:1	4:1	CAP-482-0.5 CAP:Resin Ratio 1:4	1:1	4:1	CAB-551-0.01 CAB:Resin Ratio 1:9	1:4	1:1	4:1
Neocryl B-723	Neo Resins, Netherlands	C	C	C	C	VSI	VSI	SI	SI	SI	C	SI	SI	C	C	C	C
Neocryl B-728	Neo Resins, Netherlands	VSI/SI	I	VSI/SI	I	I	I	VSI	VSI	VSI	C	VSI	VSI	—	—	—	—
Neocryl B-735	Neo Resins, Netherlands	C	C	C	C	VSI	VSI	C	SI	VSI	C	VSI	VSI	C	C	C	C
Neocryl B-736	Neo Resins, Netherlands	C	C	C	C	C	SI	C	I	I	VSI	VSI	VSI	C	C	C	C
Neocryl B-805	Neo Resins, Netherlands	C	C	C	C	VSI	VSI	VSI	SI	SI	C	C	C	C	C	C	C
Neocryl B-810	Neo Resins, Netherlands	C	C	C	C	C	C	I	I	I	I	I	C	—	—	—	—
Neocryl B-813	Neo Resins, Netherlands	SI/C	SI/C	SI/C	C	I	SI	SI	SI	C	C	I	VSI	C	C	C	C
Neocryl B-814	Neo Resins, Netherlands	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Degalan M 345	Roehm, Germany	C	C/I	C/VSI	SI	SI	VSI	—	—	—	—	—	—	—	—	—	—
Degalan M 920	Roehm, Germany	C	C	C	—	—	—	—	—	—	—	—	—	—	—	—	—
Degalan MB 319	Roehm, Germany	C	C	C	C	I	C	—	—	—	—	—	—	C	C	C	C
Degalan N 80	Roehm, Germany	C	C	C	C	SI	C	C	C	C	C	C	C	C	C	C	C
Degalan N 742	Roehm, Germany	C	C	C	SI	I	C	C	C	C	C	C	C	C	C	C	C
Degalan P 675	Roehm, Germany	SI/C	SI/C	VSI/C	SI	SI	SI	—	—	—	—	—	—	C	C	C	C
Degalan PM 381	Roehm, Germany	C	C	C	SI	I	C	I	I	I	I	I	C	C	C	C	C
Degalan PM 685	Roehm, Germany	C	C	C	C	SI	SI	SI	SI	C	C	SI	SI	C	C	C	C
Surcol 836	Ciba Specialty Chemicals, UK	C/VSI	VSI	C/VSI	VSI	VSI	C	SI	VSI	VSI	C	C	C	—	—	—	—
Thermoset																	
Degalan LP 62/03	Roehm, Germany	C	VSI/C	C	SI	SI	VSI	—	—	—	—	—	—	C	C	C	C
Degalan LP 68/04	Roehm, Germany	C/SI	C	C	C	C	C	—	—	—	—	—	—	—	—	—	—
Jagotex F 232	Eastman Chemical Jaeger, Germany	I/C	I/C	I/C	I	I	SI	—	—	—	—	—	—	C	C	C	C
Jagotex F 256	Eastman Chemical Jaeger, Germany	I/VSI	SI	C	I	I	VSI	—	—	—	—	—	—	—	—	—	—
Macrynal SM 500	Solutia, Germany	I/I	I/SI	I/C	I	I	I	—	—	—	—	—	—	—	—	—	—
Macrynal SM 540	Solutia, Germany	I/SI	I/VSI	I/VSI	I	I	I	—	—	—	—	—	—	—	—	—	—
Setalux 1151 XX-51	Akzo Nobel Resins, Netherlands	I/VSI	I/VSI	I/C	I	SI	SI	—	—	—	—	—	—	—	—	—	—
Setalux 1385 BX-51	Akzo Nobel Resins, Netherlands	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C

C = Compatible
VSI = Very Slightly Incompatible
SI = Slightly Incompatible
I = Incompatible

ACRYLIC RESINS *(Continued)*

Thermoset	Supplier	CAB-381-0.5/ CAB-551-0.2 CAB:Resin Ratio 1:4	1:1	4:1	CAB-553-0.4 CAB:Resin Ratio 1:4	1:1	4:1	CAP-504-0.2 CAP:Resin Ratio 1:4	1:1	4:1	CAP-482-0.5 CAP:Resin Ratio 1:4	1:1	4:1	CAB-551-0.01 CAB:Resin Ratio 1:9	1:4	1:1	4:1
Synocure 867 S	Cray Valley, UK	I/SI	I	C/I	I	I	SI	I	I	SI	I	SI	C	—	—	—	—
Synocure 869 SD	Cray Valley, UK	C	C	C	C	VSI	SI	C	SI	C	C	C	C	C	C	C	C
Uracron CS 104 M	DSM Resins, Netherlands	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Uracron CY 451 XE	DSM Resins, Netherlands	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Uracron CR201 SI	DSM Resins, Netherlands	SI/C	VSI/C	C	I	VSI	VSI	—	—	—	—	—	—	C	C	C	C

ALKYD RESINS

	Supplier	CAB-381-0.5/ CAB-551-0.2 CAB:Resin Ratio 1:4	1:1	4:1	CAB-553-0.4 CAB:Resin Ratio 1:4	1:1	4:1	CAP-504-0.2 CAP:Resin Ratio 1:4	1:1	4:1	CAP-482-0.5 CAP:Resin Ratio 1:4	1:1	4:1	CAB-551-0.01 CAB:Resin Ratio 1:9	1:4	1:1	4:1
Vialkyd AC 421	Solutia, Germany	I/VSI	I/SI	SI/VSI	VSI	SI	VSI	—	—	—	—	—	—	C	C	C	C
Vialkyd AF 360	Solutia, Germany	I/VSI	I	SI/I	VSI	I	SI	—	—	—	—	—	—	—	—	—	—
Vialkyd AN 950	Solutia, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Cardura E10	Resolution Performance Products, Netherlands	C	C	C	C	C	C	C	SI	I	C	C	C	C	C	C	C
Duramac 307-1382	Eastman Chemical Company, UK	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Duramac 307-2009	Eastman Chemical, Italy	C	C	C	—	—	—	—	—	—	—	—	—	—	—	—	—
Uralac P810 S2G3-60	DSM Resins, Netherlands	—	—	—	—	—	—	—	—	—	—	—	—	C	C	C	C
Uralac AM181 X-60	DSM Resins, Netherlands	C	C	C	—	—	—	—	—	—	—	—	—	—	—	—	—
Uralac AN621 S2	DSM Resins, Netherlands	—	—	—	I	C	C	—	—	—	—	—	—	—	—	—	—
Uralac AK424 X-60	DSM Resins, Netherlands	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Uralac AD525 X-60	DSM Resins, Netherlands	I/SI	I	SI	I	I	I	—	—	—	—	—	—	—	—	—	—
Uralac AD152 W-50	DSM Resins, Netherlands	VSI/I	VSI/I	VSI/I	I	I	I	—	—	—	—	—	—	—	—	—	—
Uralac AN582 X-70	DSM Resins, Netherlands	I/VSI	I/VSI	I/VSI	I	I	VSI	—	—	—	—	—	—	—	—	—	—

AMINO RESINS

Benzoguanamine	Supplier	CAB-381-0.5/ CAB-551-0.2 CAB:Resin Ratio 1:4	1:1	4:1	CAB-553-0.4 CAB:Resin Ratio 1:4	1:1	4:1	CAP-504-0.2 CAP:Resin Ratio 1:4	1:1	4:1	CAP-482-0.5 CAP:Resin Ratio 1:4	1:1	4:1	CAB-551-0.01 CAB:Resin Ratio 1:9	1:4	1:1	4:1
Cymel 659	Cytec, UK	C	C	—	C	C	—	I	VSI	—	—	—	—	—	—	—	—
Melamine																	
Cymel 9370	Cytec, UK	C	C	—	C	C	—	C	C	—	—	—	—	—	C	C	—
Cymel 615	Cytec, UK	I	I	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymel 681	Cytec, UK	I/SI	I	VSI	SI	SI	C	I	I	I	I	I	SI	—	—	—	—
Cymel 688	Cytec, UK	I	VSI	—	VSI	C	—	I	SI	—	—	—	—	—	—	—	—
COD 4494	Duco, Italy	SI	I	I	I	I	C	—	—	—	—	—	—	—	—	—	—
Cymel MI 11	Cytec, Norway	I/SI	I/VSI	SI/VSI	I	SI	C	—	—	—	—	—	—	—	—	—	—
Luwipal 010	BASF, Germany	I	I	I	SI	I	I	I	I	I	I	I	I	—	—	—	—
Luwipal 012	BASF, Germany	SI	I	I	SI	I	VSI	—	—	—	—	—	—	—	—	—	—
Luwipal 013	BASF, Germany	I	I	SI	SI	SI	VSI	—	—	—	—	—	—	—	—	—	—
Luwipal 014	BASF, Germany	I	I/SI	I	SI	I	I	I	I	I	I	I	I	—	—	—	—
Luwipal 015	BASF, Germany	I	I	I	VSI	C	C	—	—	—	—	—	—	—	—	—	—
Luwipal 016	BASF, Germany	VSI/C	SI/C	VSI/C	C	C	C	C	I	I	VSI	SI	I	C	C	C	C
Luwipal 062	BASF, Germany	C	I/C	VSI/C	C	C	VSI	C	C	C	C	C	C	C	C	C	C
Luwipal 066	BASF, Germany	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Luwipal 068	BASF, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Maprenal MF 590	Solutia, Germany	I/VSI	I/C	C	SI	C	C	—	—	—	—	—	—	—	—	—	—
Maprenal MF 600	Solutia, Germany	I/SI	I/VSI	I/VSI	SI	C	C	—	—	—	—	—	—	—	—	—	—
Maprenal MF 650	Solutia, Germany	I/SI	I/SI	I/VSI	SI	VSI	C	—	—	—	—	—	—	—	—	—	—
Maprenal MF 800	Solutia, Germany	I/SI	I/C	C	SI	VSI	C	—	—	—	—	—	—	—	—	—	—
Melamac 318-1194	Eastman Chemical, Italy	I	I	SI/C	SI	SI	C	—	—	—	—	—	—	—	—	—	—
Melamac 318-1188	Eastman Chemical, Italy	I/SI	I	VSI/C	VSI	VSI	C	—	—	—	—	—	—	—	—	—	—
Setamine US 132	Akzo Nobel Resins, Netherlands	I	I	I/SI	I	I	SI	—	—	—	—	—	—	—	—	—	—
Setamine US 133	Akzo Nobel Resins, Netherlands	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Setamine US 135	Akzo Nobel Resins, Netherlands	I/SI	I/VSI	SI/C	VSI	VSI	C	—	—	—	—	—	—	—	—	—	—
Setamine US 136	Akzo Nobel Resins, Netherlands	I/SI	I	VSI/C	VSI	VSI	C	—	—	—	—	—	—	—	—	—	—

AMINO RESINS
(Continued)

Urea	Supplier	CAB-381-0.5/ CAB-551-0.2			CAB-553-0.4			CAP-504-0.2			CAP-482-0.5			CAB-551-0.01			
		CAB:Resin Ratio			CAB:Resin Ratio			CAP:Resin Ratio			CAP:Resin Ratio			CAB:Resin Ratio			
		1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:9	1:4	1:1	4:1
Cymel U 610	Cytec, UK	I	SI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymel U 640	Cytec, UK	SI	C	—	C	C	—	C	C	—	—	—	—	—	—	—	—
Cymel U 646	Cytec, UK	SI	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymel U 656	Cytec, UK	SI	VSI	—	C	C	—	C	C	—	—	—	—	—	—	—	—
Setamine US 8 BX50	Akzo Nobel Resins, Netherlands	I/C	I/C	SI/C	—	—	—	—	—	—	—	—	—	—	—	—	—
Setamine US 11 BX68	Akzo Nobel Resins, Netherlands	C	C	C	—	—	—	—	—	—	—	—	—	—	—	—	—
Uramex U460 BI	DSM Resins, Netherlands	VSI/C	VSI/C	C	C	C	C	—	—	—	—	—	—	C	C	C	C

ISOCYANATE RESINS

	Supplier	CAB-551-0.2			CAB-381-0.5/ CAB-553-0.4			CAP-504-0.2			CAP-482-0.5			CAB-551-0.01			
		CAB:Resin Ratio			CAB:Resin Ratio			CAP:Resin Ratio			CAP:Resin Ratio			CAB:Resin Ratio			
		1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:9	1:4	1:1	4:1
Desmodur HL	Bayer, Germany	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Desmodur IL	Bayer, Germany	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Desmodur L 67	Bayer, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Desmodur L 75	Bayer, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Desmodur N 75	Bayer, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Desmodur N 3390	Bayer, Germany	C	C	C	C	I	I	C	I	I	C	I	I	C	C	C	C

MALEIC RESINS

	Supplier	CAB-381-0.5/ CAB-551-0.2			CAB-553-0.4			CAP-504-0.2			CAP-482-0.5			CAB-551-0.01			
		CAB:Resin Ratio			CAB:Resin Ratio			CAP:Resin Ratio			CAP:Resin Ratio			CAB:Resin Ratio			
		1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:9	1:4	1:1	4:1
Alresat KM 400	Akzo Nobel Resins, Netherlands	I	I	I	I	I	SI	—	—	—	—	—	—	—	—	—	—
Granolite K10	DRT, France	—	—	—	—	—	—	I	I	I	I	I	I	—	—	—	—
Polygral	Granel, France	—	—	—	—	—	—	I	I	VSI	I	I	SI	—	—	—	—
Worleesin GM 201	Worlee, Germany	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—
Worleesin MK 223	Worlee, Germany	I/VSI	I/SI	I/SI	SI	I	I	—	—	—	—	—	—	—	—	—	—
Worleesin PM 202	Worlee, Germany	I	I	I	I	I	I	—	—	—	—	—	—	—	—	—	—

POLYESTER RESINS

		CAB-551-0.2			CAB-381-0.5/ CAB-553-0.4			CAP-504-0.2			CAP-482-0.5			CAB-551-0.01			
		CAB:Resin Ratio			CAB:Resin Ratio			CAP:Resin Ratio			CAP:Resin Ratio			CAB:Resin Ratio			
	Supplier	1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:4	1:1	4:1	1:9	1:4	1:1	4:1
Desmophen RD181	Bayer, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Desmophen 651	Bayer, Germany	VSI	VSI	SI	VSI	SI	SI	—	—	—	—	—	—	—	—	—	—
Desmophen 800	Bayer, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Desmophen 1100	Bayer, Germany	C	C	C	C	C	C	—	—	—	—	—	—	C	C	C	C
Desmophen 1300	Bayer, Germany	SI/C	SI/C	SI/C	VSI	VSI	C	—	—	—	—	—	—	C	C	C	C
Polymac 323-2028	Eastman Chemical, Italy	C*	C*	C*	—	—	—	—	—	—	—	—	—	—	—	—	—
Duramac 307-1352	Eastman Chemical, Italy	C*	C*	C*	—	—	—	—	—	—	—	—	—	—	—	—	—
Synolac 9109XA	CVP, UK	SI/VSI	I/SI	I/VSI	VSI	SI	I	SI	I	I	SI	I	I	—	—	—	—
Synolac 9585X	CVP, UK	I/VSI	I/SI	I/SI	I	I	I	I	I	I	VSI	I	I	—	—	—	—

**80:20 MEK:Toluene at 10 Wt %*

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

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Publication E-309B
September 2002

Printed in U.S.A.