EASTMAN

Eastman
cellulose esters

Pigmentation of **Eastman cellulose esters** for use in printing inks

Eastman cellulose acetate propionate (CAP) and cellulose acetate butyrate (CAB) esters can be readily pigmented by conventional methods such as ball, shot, and two-roll milling. A well-dispersed pigment is essential to produce good hiding, high gloss, and maximum color strength. The alcohol-soluble cellulose esters, CAP-504-0.2 and CAB-553-0.4, can also be pigmented from high solids with 50 wt% pigment or greater and as wet-press cakes. Flexographic and gravure inks are applied in thin films from low-viscosity solutions. A high level of finely ground pigment is essential for desirable appearance properties. Achieving a finely ground particle is also important to minimize damage to the printing cylinders.

Features and benefits of CAB and CAP

- Low density
- Fast solvent release
- Stability to ultraviolet light
- Easy handling and storage
- Low flammability
- Ease of storage
- Metallic pigment compatibility
- Good integration via diverse dispersion techniques

Milling equipment

Equipment that can be used to produce pigment dispersions in CAP and/or CAB esters is listed in Table 1.

Table 1. Milling equipment

Viscosity requirement (shear rate)	Physical form of dispersion	Mill type
Low	Fluid	Kady Mill,[a] Attritor, sand mill, shot mill, ball/pebble mill
Intermediate	Paste	High-speed disperser, three-roll mill
High	Chip	Banbury[b] (sigma blade), two-roll mill

[a]*Kinetic Dispersion Corporation* [b]*Farrell Company*

Dispersion formulations

The formulations presented here are intended only as suggested starting points. Since solvents, resins, pigments, and mechanical techniques affect rheology and dispersion rate, each system must be optimized according to the components and technique chosen.

Fluid dispersions

It is important to control the viscosity of fluid dispersions to obtain optimum shear rate during processing. The cellulose ester/pigment dispersions should be formulated to a Stormer viscosity of 50–75 Krebs units for ball-mill and sand-mill operations.

Pigment dispersion for use in fluid inks may be made according to the formulations given in Tables 2 and 3. All of these dispersions may be prepared in ball/pebble mills, sand mills, or shot mills. Formulation 4, which contains some titanium dioxide pigment, may also be prepared in a high-speed disperser (cold cut).

Table 2. CAP-482-0.5 pigment dispersions[a]

	Wt%				
Product	**1**	**2**	**3**	**4**	**5**
Potomac red 215-2360 pigment	20	—	—	—	—
Sunbrite™ yellow 274-0042 pigment	—	18	—	—	—
Sunfast™ blue 249-3450 pigment	—	—	20	—	—
Raven® 1020 black pigment	—	—	—	20	—
Unitane OR-580 white pigment	—	—	—	—	50
CAP-482-0.5	8	5	8	8	5
Ethanol, anhydrous	43	54	43	43	27
Ethyl acetate (99%)	18	23	18	18	11
n-Propyl acetate	11	—	11	11	7
Total	**100**	**100**	**100**	**100**	**100**
Stormer viscosity, Krebs units	62	76	64	68	69

[a] *Pigment dispersion can be prepared with CAB-553-0.4 instead of CAP-482-0.5 in the formulation. Adjustment of the solids content may be required to obtain the viscosity needed for optimum shear rate.*

Table 3. CAP-504-0.2 pigment dispersions[a]

	Wt%				
Product	**1**	**2**	**3**	**4**	**5**
Potomac red 215-2360 pigment	20	—	—	—	—
Sunbrite™ yellow 274-0042 pigment	—	20	—	—	—
Sunfast™ blue 249-3450 pigment	—	—	20	—	—
Raven® 1020 black pigment	—	—	—	20	—
Unitane OR-580 white pigment	—	—	—	—	50
CAP-504-0.2	10	10	10	10	8
Ethanol, anhydrous	59	59	59	59	36
Ethyl acetate (99%)	11	11	11	11	6
Total	**100**	**100**	**100**	**100**	**100**
Stormer viscosity, Krebs units	59	61	54	59	63

[a] *Pigment dispersion can be prepared with CAB-553-0.4 instead of CAP-504-0.2 for this ester in the formulation. Adjustment of the solids content may be required to obtain the viscosity needed for optimum shear rate.*

Guidelines for dispersing pigments with cellulose esters in fluid mills

1. The pigment should be dispersed into solutions of cellulose esters without the presence of modifying resins or plasticizers. Because of high hydroxyl content, the alcohol-soluble-type cellulose esters wet and disperse most pigments more effectively than other cellulose esters.
2. Aromatic hydrocarbon solvents (e.g., toluene and xylene) should be excluded from the mill during the dispersion process. These solvents can be added during the letdown phase.
3. The presence of alcohols during the milling process improves color development and gloss of the pigment dispersions in the final formulations.
4. Dispersants and wetting aids may be used to improve pigment dispersion, but these additives can be highly specific and may not be satisfactory in all dispersions.
5. A processing viscosity of 50–75 Krebs units is desirable for either a sand mill or ball mill. In formulations that have poor rheology characteristics, the best pigment dispersions are obtained at the lower end of this viscosity range. However, a viscosity lower than 50 Krebs units may cause excessive wear on the milling equipment.
6. A pigment/cellulose ester ratio of 2:1 or 3:1 by weight is generally optimum when dispersing organic pigments and carbon black. With inorganic pigments, a 5:1 to 10:1 weight ratio is more desirable.
7. Cellulose ester/pigment dispersions can be prepared in a sand mill or ball mill at 25–35 wt% solids when using organic pigments and at 55–65 wt% solids when using inorganic pigments. This does not apply to cellulose esters, CAP-482-20 or CAB-381-20, since these products produce much higher solution viscosities.

Pigment chips

Two-roll milling is an effective dispersion method for obtaining full color development, transparency, tinting strength, and gloss of a pigment. A pigment/cellulose ester/plasticizer mixture is heated on the two-roll mill until banding occurs. The high viscosity of the melt obtained with these resins gives good shear in the nip of the rolls, thus producing excellent pigment dispersions in sheet form, which is then granulated into pigment chips for more rapid dissolution in use.

Due to their low flammability, CAP and CAB esters can be more safely handled on milling equipment than flammable film formers such as nitrocellulose. Table 4 contains starting point formulations for CAP and CAB pigment dispersions prepared on a two-roll mill.

Table 4. Pigment dispersions prepared on a two-roll mill

Product	Wt%		
	1	2	3
CAP-482-0.5 or CAB-381-0.5	56	—	—
CAP-504-0.2 or CAB-553-0.4	—	28	50
Benzidine yellow pigment	30	—	—
Red lake C pigment	—	55	—
Phthalo blue pigment	—	—	40
Sucrose acetate isobutyrate (SAIB)	14	5	—
Eastman 168™ non-phthalate plasticizer	—	12	10
Total	**100**	**100**	**100**

Raw material suppliers

Product	Description	Supplier
CAP-482-0.5	Cellulose acetate propionate	Eastman Chemical Company
CAB-381-0.5	Cellulose acetate butyrate	Eastman Chemical Company
CAP-504-0.2	Cellulose acetate propionate	Eastman Chemical Company
CAB-553-0.4	Cellulose acetate butyrate	Eastman Chemical Company
Ethanol, anhydrous	Ethanol	Various
Ethyl acetate (99%)	—	Eastman Chemical Company
Potomac red 215-2360	Red lake C toner—resinated	Lansco Colors
Sunbrite™ yellow 274-0042	Diarylide yellow toner—AAOT	Sun Chemical
Sunfast™ blue 249-350	Phthalacyanine; noncrystallizing	Sun Chemical
Raven® 1020	Furnace black	Birla Carbon
Unitane OR-580	Titanium dioxide, rutile	Kemira
Sucrose acetate isobutyrate	Sucrose ester	Eastman Chemical Company
Eastman 168™ non-phthalate plasticizer	Plasticizer	Eastman Chemical Company

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