Adhesive file

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CHEMICALS — PLASTICS

MONSANTO PLASTICIZERS
in Synthetic Resin Adhesives

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Monsanto Chemical Company, Organic Chemicals Division, St. Louis 1, Mo.

INTRODUCTION

The superior properties of plasticized synthetic resin adhesives are causing these preparations to rapidly displace or supplement conventional animal and vegetable base adhesives. The synthetic resin adhesives referred to are primarily adhesives based on polyvinyl acetate and its co-polymers with polyvinyl chloride or polyvinyl alcohol, but also included are adhesives with such bases as nitrocellulose, zein, casein, acrylates, polystyrene, cellulose and other polymers.

Synthetic resin adhesives find a wide and increasing usage in such diverse industries as the following:

- Shoe industry
- Book binding industry
- Paper bag and folding box carton manufacturing
- Sanitary food container producers
- Laminators and converters of packaging products
- Tobacco industry (packaging)
- Automotive industry
- Food industry (for labels and carton sealing), etc.

Factors contributing to the rapid increase in the quantity use of synthetic resin adhesives are these:

1) Synthetics are better adapted to high speed machinery operation and make up their increased cost over other adhesive types by the resultant increases in production rates.

2) Synthetic adhesives are cleaner and easier to use from a production and maintenance standpoint.

3) Synthetic adhesives have superior water, mold and fungus resistance and better light stability than conventional organic adhesives. Also, any degree of flexibility can be obtained.

4) Adhesive emulsions obviate the use of volatile, toxic or flammable solvents. Emulsion properties can be carefully adjusted and controlled for specific needs.

Plasticizers are essential in synthetic resin adhesives for improving film formation, imparting tack, decreasing drying time, imparting flexibility and gloss and reducing costs. Production rates are often increased several hundred percent by switching from ordinary pastes and glues to synthetic resin adhesives. Emulsion adhesive costs are reduced because plasticizers increase emulsion viscosities [illegible] is often used to [illegible] with a [illegible] relatively [illegible].

Monsanto [illegible] also supplies [illegible] agents, and [illegible]

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TYPES OF RESIN ADHESIVE FORMULATIONS

The major types of plasticized synthetic resin adhesive formulations are A, Emulsion; B, Hot-melt; C, Delayed-tack; D, Solvent; E, Pressure Sensitive and F, Adhesive Primers or Coatings. These will be discussed in order. Units for all formulations are weight percent or parts by weight. Sources of ingredients are listed at the back of this bulletin.

A. Emulsion Adhesives

Resin emulsion adhesives are emulsions of plasticized resins dispersed in a water base. They are often extended with materials like starch paste and thus require the incorporation of a preservative. The resin most commonly used in emulsion adhesives is polyvinyl acetate. The following is a typical polyvinyl acetate emulsion adhesive formula:

A.-1.	Polyvinyl acetate emulsion (55% solids)	100
	Plasticizer	10 -50
	Clay Filler	0 -30
	Cooked starch or dextrine	0 - 1,000
	Preservative	1 -2
	Stabilizer	1 -2
	Wetting Agent	0 -0.2
	Secondary water	75 -100
	Defoamer	1 -2
	Odorant (masking agent)	0 -1

The plasticizers most commonly used in polyvinyl acetate emulsion adhesives are dibutyl phthalate and orthonitrobiphenyl (ONB). Dibutyl phthalate imparts good flexibility and softening action with relatively low volatility. ONB is not quite as efficient as dibutyl phthalate as a plasticizer, but is widely used because of its economy as either an "extender" plasticizer or as the sole primary plasticizer.

Dimethyl phthalate is used in some cases because of its low cost and because it is a better solvent for bonding to cellulose acetate film or sheeting where this material is used in making windows in or laminations to paper. Tricresyl phosphate and Santicizer* 140 are used where flame resistance, oil resistance and low volatility are desired. Santicizer 140 is more efficient than TCP and has better light stability and less odor.

Santicizer M-17 is an excellent plasticizer for bonding acetate overlays to paper, because of its superior light stability. Santicizer 8 imparts good flow and wetting action and has excellent grease resistance. Santicizer 160 is considered better in some applications than dibutyl phthalate because of its lower volatility, greater film toughness and improved moisture resistance.

Santicizer products B-16, E-15 and 141 are used for nontoxic applications (food wrapping films, etc.) and have been granted approval for such uses by the U. S. Bureau of Animal Industry and the U. S. Food and Drug Administration.

DSW 587008

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A. Emulsion Adhesives (continued)

Monsanto industrial resins, Santolite* MHP and MS-80%, are the best resin additives for use with polyvinyl acetate for imparting quick tack. They are being used successfully for bonding cellophane to cellophane and aluminum foil to paper. These resins make a very tough but flexible adhesive and are normally compounded with some liquid plasticizer like dibutyl phthalate, or with an eutectic mixture (1:1) of dibutyl phthalate and triphenyl phosphate.

The table on page 5 gives data evaluating various Monsanto plasticizers in combination with polyvinyl acetate. Properties evaluated are compatibility, volatility, low temperature flexibility and grease resistance.

It will be noted that the typical emulsion adhesive formulation A.-1 requires a preservative. Monsanto supplies an excellent line of industrial preservatives which includes Santobrite*, Santophen* 20, Milmer*I and these masking agents: methyl salicylate, Santomask*, saccharin, coumarin and vanillin. Literature on these products is available. At the back of this bulletin is a listing of the various trade marked products mentioned in succeeding formulas.

Formulas A.-2 and A.-3 below are more examples of polyvinyl acetate (PVA) emulsion adhesives.

A.-2. Quick Tack PVA Emulsion Adhesive

Gelva Emulsion S-56 (51% solids)	100
Dibutyl Phthalate	11.8
Santicizer* 8	11.8
Water	9.4

Through the use of other additives, adhesives designed for specialized purposes may be formulated. As an example, the following formulation shows good properties as an adhesive for bonding moistureproof cellophane to aluminum foil or to paper; or for bonding aluminum foil to paper.

A.-3. Polyvinyl Acetate Emulsion Adhesive

Gelva Emulsion S 55**	100
Dibutyl Phthalate	9
Santolite* MS-80%	13.5
Water	13.4

This formulation shows rapid development of adhesion and maintains good bond strength at elevated temperatures.

The following formula is an example of a low molecular weight styrene polymer emulsion adhesive.

*SANTOLITE, SANTOBRITE, SANTOPHEN, MILMER, SANTOMASK, SANTICIZER: Reg. U.S. Pat. Off.
**See listing on page 8.

DSW 587009

STLCOPCB4092343

A. Emulsion Adhesives (continued)

A.-4. Styrene Emulsion Adhesive

HB-40*	18.0
Diethyl Phthalate	6.0
Triton X155**	2.5
Lustrex* Styrene 601-40	100.0
Ammonia Caseinate, 15%	34.0

Formula A.-4. illustrates a basic, stable composition which possesses a high degree of wet tack. Such properties as stability, wet tack, and film toughness are imparted to this composition by the caseinate present and are varied by changes in the caseinate ratio.

The following formulation is suggested as a grease-resistant coating for paper products for wrapping such items as bakery goods.

A.-5. Polyvinyl Acetate Grease-resistant Paper Coating

Elvacet 81-900**	100
Santicizer* B-16	3.5
Tri-Pure **(titanium dioxide)	7.0
Water	15-30
Quilon**	0-5

The above composition is applied with a roll coater provided with a smoothing roll to develop a uniform continuous film. If used as a laminating adhesive, about 140°F. heat is required for optimum film formation.

B. Hot-melt Adhesives

Hot-melt adhesives may be made with either liquid or solid plasticizers, depending upon the properties desired in the end product. Santicizers* M-17 and 160 and dibutyl phthalate are favored because of their excellent heat stability and mild odor. Of the solid plasticizers, diphenyl phthalate and Santicizer 1-H are preferred because they have the least odor and are in the proper melting point range for most applications. Three formulations are given (all parts are by weight or in weight percent).

B.-1. Hot-melt Coating

Cellulose Acetate	50
Santicizer* M-17	88
Inert fillers	35

B.-2. Hot-melt Bookbinding Adhesive

Neville Hard Resin**	61.4%	Mix and heat
Santicizer 160*	15.0%	at 250°-275°F.
Paraffin wax	6.4%	until melted.

Raise temperature to 300°-325°F. and agitate after adding:

Vinylite AYAA (polyvinyl acetate)	12.9%
Ethyl cellulose	4.3%

B.-3. Bookbinding Hot Melt (application temp.: 165°175°F.)

Copolymer C-3	100
Aroclor* 1254	50-70
Dibutyl Phthalate or Santicizer 160	20-35
Clay	20-35
Fluxing resins (Bell-Ro or Rosin WW)	75

*SANTICIZER, AROCLOR, HB-40, LUSTREX: Reg. U.S. Pat. Off. Monsanto products.
**See product listing on page 8.

DSW 587010

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C. Delayed-tack Adhesives

These preparations, after they are spread and dried on a surface, are normally tack-free at ordinary temperatures. They are activated by heat and possess the property of maintaining tackiness over a fairly wide temperature range from several hours to several days. This permits the necessary mechanical handling, while two surfaces are being united, before the adhesive becomes nontacky by cooling and setting. Thus, the action of delayed-tack adhesives differs from that of hot-melt adhesives where tackiness terminates on cooling alone.

Solid plasticizers, such as diphenyl phthalate and Santicizers* 1-H and 9, make possible the "delayed-tack" feature of these unusual adhesives. Plasticizers are selected on the basis of their effect on the base resin (i.e., the temperatures at which the adhesive quality is activated and de-activated), and for their heat and light stability, odor, nontoxicity where required, etc. Much of this art is described in the patent literature (for example, U.S. patents numbered 2,462,029; 2,608,542; 2,608,543; 2,613,156 and 2,613,191) which should be investigated by those desiring to produce delayed-tack adhesives. Sample formulations below were taken from such patents, as indicated.

C.-1. **Example 9b Delayed-tack Adhesive** (from U.S. Patent No. 2,462,029)

Santicizer* 1-H	50
Vinsol Resin	50
Thinned Amine Dispersant	240
Acrysol M.R.	10

"The thinned amine dispersant is a mixture composed of 1 part stearic acid, 1 part "polypale resin", a polymerized rosin containing approximately 40% dipolymers of abietic acid (Hercules Powder Co.), 1 part of 2amino-2methyl-1 propanol (Commercial Solvents Corp.) and 3 parts of water. This composition is designed solely as a dispersing assistant . . ."†

†From Column 10 of above patent.

C.-2. **Example 18 Delayed Tack Adhesive** (from U.S. Patent No. 2,462,029)

Diphenyl Phthalate	52.5
Nevindine R-3	30.0
Thinned amine dispersant (see above)	198.0
Hycar OR-25	43.5

The above formulation is nontacky at ordinary temperatures and is heat activated at about 150°F. The compound will then remain adhesive through temperatures as low as 50°F. Once set, the adhesive continues to hold at ordinary temperatures.

C.-3. **Polystyrene Emulsion Delayed-tack Adhesive**
(Example I of U.S. Pat. No. 2,613,156)

"Ten (10) parts polystyrene (molecular weight 10,000 - 15,000) and 40 parts diphenyl phthalate are mixed and heated together at approximately 190°F., forming a clear fluid. While still at this temperature, the fluid is poured into a solution of 6 parts of a 25% aqueous solution of Aerosol OT and 4.5 parts polyvinyl alcohol (of the grade sold under the trade name of Elvanol 50-42) in 75.5 parts water; the solution being at a temperature of approximately 190°F., constant agitation is maintained, resulting in a homogeneous emulsion. The emulsion is then permitted to cool." (This formulation is improved by the addition, after cooling, of 8 parts of Geon polyblend 550X20.)

This will form a smooth nongrainy film when spread evenly on paper and will dry to a completely tack-free surface. When heated to 170°F., the film becomes very tacky and powerfully adhesive, retaining these properties for as long as 70 seconds while cooling.

*SANTICIZER, Reg. U.S. Pat. Off. Monsanto Product. See product listing on page 8.

DSW 587011

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