TECHNICAL SERVICE BULLETIN

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HOT MELT ADHESIVES

INTRODUCTION

"Hot melts" are solid materials which, at elevated temperatures, become fluid and tacky enough to be used as adhesives, coatings or binders. Essentially solid and immobile at temperatures below the flow point, hot melts do not require a porous or penetrable surface capable of releasing solvent or water to obtain excellent adhesion. Hot melts have quick initial tack when molten yet harden rapidly when cooled to give a strong adhesive bond. Toxicity problems and fire hazards associated with solvent systems are eliminated.

All of these features, particularly the ability to soften with heat and solidify when cooled, qualify hot melts for bonding and coating smooth surfaced films such as foil, wax paper, polyethylene and other materials used in the packaging industry.

Although hot melts have been known for centuries, the advent of synthetic resins and the use of laboratory tested principles in hot melt manufacture have created new interest in hot melt technology. Their modern usage is based on rapidly growing experimental programs by companies that make or use them.

General Formulating Principles

The basic ingredient in a polymeric hot melt is a film-forming resin such as the polymers of vinyl acetate. These resins form the "backbone" of the hot melt and produce the tough film characteristics which are so important to final adhesive strength.

Waxes and plasticizers are used in hot melt formulating to impart proper flow at temperatures required by the application. In addition, certain waxes are important constituents of a hot melt to control film blocking.

Viscosities of the molten hot melt can be controlled and adjusted to workable levels by incorporating lower molecular weight, resinous "fluxing agents" such as rosin or coumarone-indene resins.

Fillers and pigments are used when firmer films, opacity, color, or lower cost are desired. Stabilizers and anti-oxidants are usually employed to reduce the degradative effects of prolonged exposure to high temperatures.

When transparent colorless films are desired, it is necessary to have the ingredients fully compatible with the hot melt and the hot melt film. If a component has limited compatibility, a blending agent must be included to insure a clear film. For applications requiring non-blocking properties of the film, a judicious balance of plasticizer, wax and a larger proportion of a higher molecular weight grade resin is often required.

Film-Forming Resins

Polyvinyl acetate, polyvinyl butyral and other vinyl acetate derivatives are some of the

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important film-forming resins used in hot melts. GELVA Resins, vinyl acetate homopolymers, are the most widely used film-formers and generally are employed for bonding surfaces such as paper to paper, paper to fabric, fabric to fabric, etc. In addition to being available in a wide range of viscosities, GELVA Resins also have the advantage of lowest cost as compared to the more complex derivatives of vinyl acetate. The latter types are generally used in applications which require specific properties.

The low molecular weight types of GELVA Resin such as GELVA V-7 and V-15 are most often used. The very low viscosity resins such as V-1½ and V-2½ are also available and are employed in combination with the higher viscosity types to reduce melt viscosities.

Carboxylated copolymers of GELVA, such as C-5 V-16R, are widely used in hot melt adhesives where redispersibility of the film is required. As a bookbinding adhesive, for example, the dispersibility of the copolymer film former in de-inking solutions permits waste recovery. In addition, the carboxylated copolymers demonstrate excellent adhesion to specific surfaces such as metals and certain plastic films. To meet specific application needs, Monsanto produces a wide variety of copolymer resins varying in viscosity and degree of carboxylation.

BUTVAR (polyvinyl butyral) Resins are particularly well suited for those hot melt adhesives in which specific adhesion to glass, metals, plastic films and wax is required. BUTVAR Resins are available in several types differing in viscosity and hydroxyl content. BUTVAR B-98 represents a recent polymerization development of a very low viscosity resin of the B-72 type. Both types are widely used in hot melts, but where low hydroxyl content is required for greater compatibility BUTVAR B-76 is suggested.

Plasticizers

The plasticizer system is a primary component of a hot melt formulation. It largely determines film flexibility, flow, tack, and temperature characteristics.

Depending upon their compatibility with the resin, plasticizers can be classed as primary and secondary. Primary plasticizers are generally compatible with the resin over the entire useful range of plasticizer-resin ratio. Primary plasticizers for polyvinyl acetate include dibutyl phthalate, Kronisol, Santicizer 8, Santicizer 140, Santicizer B-16, Santicizer 141, Pycal 94, and Resoflex 296. Primary plasticizers for polyvinyl butyral are butyl ricinoleate, dibutyl phthalate, and tricresyl phosphate.

Secondary plasticizers have limited compatibility with the resin alone, thus are used in combination with a primary plasticizer. They are used most often to lower costs, but do confer such specific properties as improved control of hot melt viscosity or resistance to plasticizer migration in the film. Secondary plasticizers for BUTVAR include dibutyl sebacate and Flexol 3GH; for GELVA, dioctyl phthalate and Aroclor 1242, 1248, and 1254.

Waxes

Waxes are used in hot melts to aid the application of the melt at practical temperatures and viscosities, and also to modify the properties of the coating. Most waxes, because their viscosity is relatively low in the molten state, improve the flow and spreading properties of the hot melt at lower application temperatures. The viscosity depressing effect of the waxes allows the use of resins and other components that confer special properties. The presence of a wax usually gives hot melt coatings good "slip" and non-blocking properties. This is particularly important with hot melt coated materials which are wound into a roll before the coating is thoroughly cooled.

Amorphous waxes are valuable for imparting low moisture vapor transmission to hot melt films. The amorphous paraffin waxes, especially those with a high melting point, are recommended for increased flexibility of the film as well as low moisture vapor transmission.

White, crystalline, high melting (50–60°C. or higher) paraffin waxes are preferred for impart-

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ing moisture-resistant properties to the hot melt film.

For tough, non-tacky, non-smearing, easily heat-sealed coatings, hard waxes such as candelilla, carnauba, or synthetic waxes are suggested.

Fluxing-Extending Resins

In some applications the hot melt may be too viscous or too costly. Fluxing-extending resins are used to overcome these problems.

A few fluxing-extending resins that are used with GELVA, polyvinyl acetate, are:

Rosin WW	SAIB
Nevillac Soft	Santolite MHP
Nevillac Hard	Santolite MS
Nevillac 10°	Arochem 650
Vinsol	

Resins that can be used with BUTVAR, polyvinyl butyral, include:

Staybelite Ester 10	Santolite MHP
Abalyn	Polypale Ester 1
Pentalyn A	Hercolyn
	Pentalyn G

Pigments, Dyes and Fillers

Pigments, dyes, and fillers may be employed to obtain colored or opaque coatings, to reduce costs, or to impart firmness. Their use is similar to that in solvent-based coatings. Examples of these materials are RA-50 titanium dioxide, Al-Sil-Ate W, and Celite.

Stabilizers

Actual chemical breakdown of the melt ingredients is possible by excessive or prolonged heating. When such heating is necessary, small quantities of anti-oxidants and stabilizers may be used to minimize the effect. Ionol, Catalin CAO-3, sodium benzoate, magnesium oxide, calcium stearate, and certain phenols or substituted quinolines are used.

Methods of Preparation

Resin hot melts are usually manufactured commercially in Banbury or Day Mixers, extruders, or modified varnish kettles. The important requirements for manufacture include a means of thoroughly blending the ingredients, agitation at temperatures in the range of 300° to 400°F., and finally a system for emptying the molten melt from the mixing chamber.

Methods of Application

Hot melts can be applied by roller-coating, knife-coating, spraying, or dipping.

Roller coating is particularly suited to the application of low viscosity melts. It is effective in producing thin coatings that are relatively free of striations and other surface defects.

In the dip-coating method, the object is immersed in the molten hot melt. This method is suited to coating irregularly shaped objects.

Knife coating is an effective means of applying viscous hot melts and is often used in general adhesive work.

Spray coating presents an efficient method of applying hot melt adhesives or coatings. Good control of the film distribution is possible and often this technique is used for coating uneven or difficult to reach surfaces.

TYPICAL HOT MELT FORMULATIONS

1. Alkali Dispersible Bookbinding Adhesive

Material	Parts by Weight
Gelva C-5 V-16R	40.00
Dibutyl Phthalate	8.00
Aroclor 1254	26.00
Nevillac Hard	24.00
Acrawax C	1.00
Sodium Benzoate	0.76

Preparation: The dibutyl phthalate, Aroclor 1254, Nevillac hard and Acrawax C are added and melted at 130°C. GELVA C-5 V-16R is added and the temperature raised to 175°C. and held until a uniform melt results. The sodium benzoate is dusted into the molten material after the C-5 V-16R has been added.

Properties: Viscosity: 5000 cps. at 175°C. (Measured at indicated temperature on Brookfield, No. 4 Spindle at 30 RPM.) Alkali redispersible, non-blocking coating or adhesive. 96 hours minimum heat stability at 175°C.

RMC: ca. 35¢/lb.

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2. Polyvinyl Chloride Coated Paper Adhesive

Material	Parts by Weight
Gelva V-7 (or C-3 V-10R)	60
Santicizer B-16	20
Ethyl Cellulose N-4	10

Preparation: The Santicizer B-16 and Gelva Resin are melted at 130°C. The Ethyl Cellulose N-4 is added, the temperature is raised to 170°C. and held there until a uniform melt is obtained.

Properties: Viscosity: 2500 cps. at 170°C. (Brookfield, No. 3 Spindle at 30 RPM.) Quick tack to polyvinyl chloride coated paperboard. Withstands hot water at 200°F.

RMC: ca. 52½¢/lb.

3. Hot Pickup Label Adhesive

Material	Parts by Weight
Butvar B-76	10
Santicizer B-16	10
Castorwax	10
Polypale Ester #1	51.5
Staybelite Ester #10	38.5

Preparation: All the ingredients, except BUTVAR B-76, are added in the order noted and melted at 130°C. The BUTVAR Resin is then added and the temperature raised to 170°C. until all components are uniformly melted.

Properties: Viscosity: 2600 cps. at 150°C., (Brookfield #3 at 30 RPM.) Light yellow, tacky film.

RMC: 35¢/lb.

4. Wax Paper Adhesive

Material	Parts by Weight
Butvar B-76	15
Santicizer B-16	5
Castorwax	36
Acrawax C	2
Polypale Ester #1	24.6
Staybelite Ester #10	18.4

Preparation: The ingredients, except BUTVAR B-76, are added in the order noted and melted at 130° C. BUTVAR B-76 is then added gradually, the temperature is raised to 170°C. and held there until a uniform melt is obtained.

Properties: Viscosity: 2500 cps. at 150° C. (Brookfield #3 at 30 RPM.) Light yellow, non-tacky film.

RMC: 41¢/lb.

5. Packaging Adhesive with Good Low Temperature Performance

FORMULA A

Material	Parts by Weight
Butvar B-76	12
Santicizer B-16	8
Castorwax	44
RA-50 (TiO_2)	1.9
Al-Sil-Ate W	10.4
Polypale Ester #1	14.4
Staybelite Ester #10	10.6

Preparation: Santicizer B-16, Castorwax Polypale Ester and Staybelite Ester are melted at 130°C. BUTVAR is then added gradually, the temperature is raised to 170°C., and held there until a uniform melt is obtained. When all the BUTVAR Resin is melted add the RA-50 and then the Al-Sil-Ate W. Hold the temperature at 160°C. until a homogeneous melt is obtained.

Properties: Viscosity: 2000 cps. at 150°C., (Brookfield, #3 at 12 RPM.) Cream colored, non-tacky film.

RMC: 38¢/lb.

FORMULA B

Material	Parts by Weight
Butvar B-76	10
Santicizer B-16	8
Castorwax	35
Ethyl Cellulose N-10	3
Polypale Ester #1	25.8
Staybelite Ester #10	19.2

Preparation: Melt Santicizer B-16, Castorwax, Polypale Ester, and Staybelite Ester at 130°C. The BUTVAR Resin is then added and the temperature raised to 170°C. until all the BUTVAR is melted. Add Ethyl Cellulose N-10 and hold until a uniform melt is obtained.

Properties: Viscosity: 1100 cps., at 150°C., (Brookfield, #3 at 12 RPM.) Light yellow, non-tacky film.

RMC: 39¢/lb.

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6. Leather-to-Wood Adhesive

Material	Parts by Weight
Butvar B-76	20.0
Santicizer 141	2.5
Rosin WW	60.0
Castorwax	25.0
Armid HT	0.5

Preparation: The Santicizer 141, Rosin WW, Castorwax and Armid HT are melted at 130°C. BUTVAR is then added gradually, the temperature raised to 170°C., and held there until a uniform melt is obtained.

Properties: Viscosity: 2000 cps. at 150° C. (Brookfield, No. 3 Spindle at 30 RPM.)

RMC: ca. 27¢/lb.

7. Aluminum-to-Steel Adhesive

Material	Parts by Weight
Butvar B-98	40
Santicizer 8	30
Polyvinyl Methyl Ether	5

Preparation: Add BUTVAR B-98 to plasticizer. Increase temperature to 160°C. and hold until BUTVAR B-98 is all melted. Add the PVME, increase temperature to 180–190°C. and hold until a uniform melt is obtained.

Properties: Viscosity: 3500 cps. at 180° C. (Brookfield, No. 3 Spindle at 30 RPM.) Quick setting. Flexible film.

RMC: ca. 75¢/lb.

8. Particle Board Adhesive

Material	Parts by Weight
Gelva V-1½	1
Gelva V-7	1
Santicizer 8	1

Preparation: Melt Santicizer 8 and GELVA V-1½ at 130°C. Add GELVA V-7, raise temperature to 150°C., and hold at this temperature until a uniform melt is obtained.

Properties: Viscosity: 1000 cps. at 150°C. (Viscosity measured at indicated temperature on Brookfield No. 3 Spindle at 30 RPM.) Permanently tacky. Clear film.

RMC: ca. 39½¢/lb.

9. Adhesive for Paperboard Containers

Material	Parts by Weight
Gelva V-2½	50
Gelva V-15	50
Rosin WW	50
Dibutyl Phthalate	25

Preparation: Melt dibutyl phthalate, Rosin WW and GELVA V-2½ at 130°C. Add GELVA V-15 and melt at 170°C. When a uniform melt is obtained, adjust to desired operating temperature.

Properties: Viscosity: 9000 cps., at 170°C. (Brookfield, #3 at 12 RPM.) Non-blocking, brittle film.

RMC: 33¢/lb.

10. Heat Seal Adhesive

Material	Parts by Weight
Gelva V-7	80
Santicizer 160	20
Hoechst Wax W	20

Preparation: Melt Hoechst Wax and Santicizer 160 at 100–120°C. Add GELVA V-7 and heat to 150°C.

Properties: Viscosity: 1000 cps. at 150°C. (Brookfield, No. 3 Spindle at 30 RPM.) Flexible, non-blocking coatings. Light colored.

RMC: ca. 44½¢/lb.

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TRADE MARKS AND SOURCES

	Trade Name	Chemical Composition	Supplier
FILM-FORMING RESINS	Butvar B-72A	polyvinyl butyral	17
	Butvar B-76	polyvinyl butyral	17
	Butvar B-98	polyvinyl butyral	17
	Gelva C-3 V-10R	polyvinyl acetate copolymer	17
	Gelva C-5 V-16R	polyvinyl acetate copolymer	17
	Gelva V-1½	polyvinyl acetate	17
	Gelva V-2½	polyvinyl acetate	17
	Gelva V-7	polyvinyl acetate	17
	Gelva V-15	polyvinyl acetate	17
MODIFYING AGENTS	Ethyl Cellulose N-4, N-10	ethyl cellulose	11
	PVME	polyvinyl methyl ether	9
PLASTICIZERS	Aroclor 1242, 1248, 1254	chlorinated biphenyl	15
	Flexol 3GH	triethylene glycol di-2-ethyl butyrate	21
	Santicizer 8	o and p-toluene ethyl sulfonamide	15
	Santicizer B-16	butyl phthalyl butyl glycollate	15
	Santicizer 140	cresyl diphenyl phosphate	15
	Santicizer 141	alkyl aryl phosphate	15
	Santicizer 160	butyl benzyl phthalate	15
	Kronisol	dibutoxyethyl phthalate	7
	Pycal 94	phenyl ether of polyethylene glycol	3
	Resoflex 296	adipic acid resin	5
WAXES	Acrawax C	octadeceneamide	10
	Castorwax	hydrogenated castor oil	4
	Hoechst Wax W	hydrogenated natural fat product	12
FLUXING-EXTENDING RESIN	Arochem 650	isophthalate resin	1
	Nevillac Soft	coumarone-indene alkylated phenol resin	16
	Nevillac Hard	coumarone-indene alkylated phenol resin	16
	Nevillac 10°	coumarone-indene alkylated phenol resin	16
	Pentalyn A, G	pentaerythritol ester of rosin	11
	Rosin WW	rosin	11
	Vinsol	rosin	11
	SAIB	sucrose acetate isobutyrate	8
	Staybelite Ester 10	glycerol ester of hydrogenated rosin	11
	Abalyn	methyl ester of rosin	11
	Santolite MS	aryl sulfonamide-formaldehyde resin	15
	Santolite MHP	aryl sulfonamide-formaldehyde resin	15
	Hercolyn	hydrogenated methyl ester of rosin	11
	Polypale Ester 1	ethylene glycol ester of polymerized rosin	11
PIGMENTS DYES FILLERS	Al-Sil-Ate W	aluminum silicate	19
	RA-50	titanium dioxide	20
	ASP-400	china clay	14
	Celite	diatomaceous earth	13
STABILIZERS	Ionol	2,6-di-tert.-butyl-4-methylphenol	18
	Catalin CAO-3	butylated hydroxy toluene	6
	Armid HT	stearamide	2

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Plastic Products & Resins Division—Adhesive & Textile Products Dept.

ATLANTA, GEORGIA 30305
3390 Peachtree Rd., N.E., Suite 504
CHICAGO, ILLINOIS 60018
3158 Des Plaines Avenue
Des Plaines, Illinois
CINCINNATI, OHIO 45206
2330 Victory Parkway
CLEVELAND, OHIO 44122
3645 Warrensville Center Road
DETROIT, MICHIGAN 48235
500 Northland Towers

HOUSTON, TEXAS 77002
1300 Main Street
LOS ANGELES, CALIFORNIA 90022
6670 E. Flotilla Street
MINNEAPOLIS, MINN. 55402
812 Northstar Center, 110 So. 7th St.
NEW YORK, NEW YORK 10017
277 Park Avenue
PITTSBURGH, PENNSYLVANIA 15222
#4 Gateway Center Bldg.

SAN FRANCISCO BAY AREA 95052
2710 Lafayette, Santa Clara, California
SEATTLE, WASHINGTON 98104
911 Western Avenue
ST. LOUIS, MISSOURI 63166
800 N. Lindbergh Blvd.
SPRINGFIELD, MASS. 01101
730 Worcester St.
Indian Orchard, Mass.
WILMINGTON, DELAWARE 19803
2005 Concord Pike, Fairfax

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