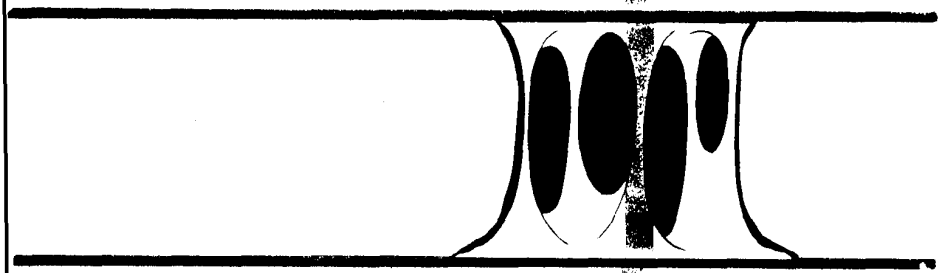
Plasticizers

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# PLASTICIZERS IN SYNTHETIC-RESIN ADHESIVES



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## SYNTHETIC-RESIN ADHESIVES—A GROWING MARKET

Consumption of synthetic-resin adhesives is rapidly expanding both because of continuing displacement of older gluing materials in steadily-growing uses and because of the introduction of many new applications for which conventional adhesives are unsuitable. Superior performance of the synthetic-resin adhesives has enabled them to supplant conventional adhesives based on natural products in many large-volume applications. Wide-spread and increasing usage of synthetic-resin adhesives is foreseen in such diverse industries as the following:

Shoe manufacturing

Book binding

Paper-bag and folding-box-carton manufacturing

Food-container production

Food packaging (labeling, sealing, wrapping, etc.)

Tobacco packaging

Specialty product packaging

Automobile production

Building construction

Use of the proper plasticizer in synthetic-resin adhesives — to best accomplish the desired purpose of the adhesive for its intended application — is extremely important. The plasticizer in an adhesive formulation improves film formation; imparts tack, flexibility, and gloss; decreases drying time; and lowers production costs.

More synthetic-resin adhesives are used today than ever before because:

- Synthetic-resin adhesives adapt well to high-speed sealing and labeling machines, thereby increasing production rates.
- Synthetic-resin adhesives are cleaner, easier to use. They keep maintenance costs down.
- Synthetic-resin adhesives resist deterioration caused by water, light, and fungus much better than the usual adhesives based on natural proteinaceous materials.
- Adhesive emulsions require no volatile, toxic, or flammable solvents. Emulsion properties are easily adjusted and controlled.

Monsanto Chemical Company, a major supplier of plasticizers for synthetic-resin adhesives, offers plasticizers that are efficient, heat and light stable, and non-toxic. Lack of toxicity is especially important now in food applications because of the 1958 amendment to the Federal Pure Food, Drug, and Cosmetic Act. Monsanto plasticizers impart excellent grease resistance and heat



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sealability to the adhesive. Because of the great variety of Monsanto plasticizers, customers can realize lower costs by taking advantage of mixed shipments.

This bulletin suggests typical formulations for various adhesive applications and describes the benefits to be derived from the use of plasticizers in synthetic-resin adhesives. If you need additional assistance, experienced Monsanto technical representatives are always ready to help you with your special formulation problems. Since Monsanto does not have a vested interest in any particular plasticizer, you are assured of advice directed toward achievement of the best possible performance of your product.

## DEVELOPMENT OF SYNTHETIC-RESIN ADHESIVES

Not long ago industrial users or consumers could choose among only a few naturally derived materials for their adhesive applications. Constant industrial demand for adhesives with greater strength, faster tack, and greater versatility for bonding many types of surfaces forced the development of synthetic-resin adhesives. With the great number of excellent adhesives now available, both industry and consumers have a much wider choice and are more likely to obtain suitable adhesives to fill specialized needs.

Only synthetic-resin adhesives are able to tolerate extreme exposure conditions. They withstand temperatures that quickly destroy natural materials, and they bond surfaces — such as rubber and metal — that normally defy bonding. From 1946 to 1956, synthetic-resin adhesives gained dominance among adhesives in major construction. For nearly any fastening job, a good synthetic-resin adhesive is now available.

Synthetic-resin adhesives commonly used are based on vinyl polymers (polyvinyl acetate, polyvinyl alcohol, and polyvinyl chloride); on condensation resins (urea-formaldehyde, melamine-formaldehyde, phenol-formaldehyde, resorcinol-formaldehyde); on cellulose derivatives; polyesters; elastomers; and epoxies. Addition of plasticizers generally modifies an adhesive to suit a particular need.

## TYPES OF RESIN-ADHESIVE FORMULATIONS

The major types of plasticized synthetic-resin-adhesive formulations are emulsion, hot-melt, delayed-tack, solution, pressure-sensitive, and adhesive primers or coatings. These types will be discussed in order. Suppliers of special ingredients are listed at the end of this bulletin.

## EMULSION ADHESIVES

Resin-emulsion adhesives are emulsions of plasticized or unplasticized resins dispersed in a water base. They offer the advantages of reduced fire and toxicity hazard because of the elimination of volatile, flammable, and possibly toxic solvents.



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## POLYVINYL ACETATE ADHESIVES

The widely-used polyvinyl acetate-emulsion adhesives possess quick tack, good adhesion to many surfaces, grease resistance, non-toxicity, and many other desirable features.

### Monsanto Plasticizers for polyvinyl acetate-emulsion adhesives

Monsanto liquid plasticizers most commonly used in the polyvinyl acetate-emulsion adhesives are *Santicizer** 160, dibutyl phthalate, *Aroclor** 1221, *Aroclor* 1232, *Aroclor* 1242, dimethyl phthalate, diethyl phthalate, tricresyl phosphate, *Santicizer* 140, *Santicizer* 141, *Santicizer* M-17, *Santicizer* B-16, *Santicizer* E-15, and *Santicizer* 8.

Dibutyl phthalate imparts good flexibility and softening action with relatively low volatility.

*Santicizer* 160 is considered better than dibutyl phthalate in most applications because of lower volatility, improved moisture resistance, and film toughness.

Diethyl phthalate is used for fast-tack, non-toxic applications.

The *Aroclor* plasticizers impart quick tack, good adhesion to many surfaces, and are widely used in commercial adhesives either as extender plasticizers or alone to make versatile, low-cost adhesives.

Dimethyl phthalate is preferred in polyvinyl acetate adhesives for bonding cellulose acetate film or sheeting because of its better solvency action on the cellulose acetate. Uses for this type of adhesive include covering cut-out windows in cartons or for laminating paper.

*Santicizer* 140, *Santicizer* 141, and tricresyl phosphate are used when flame resistance, oil resistance, and low volatility are desired. *Santicizer* 141 is most efficient in polyvinyl acetate adhesives, followed by *Santicizer* 140 and tricresyl phosphate.

For bonding overlays of paper, *Santicizer* M-17 is frequently used for its superior light stability, quick tack, and solvency on cellulose acetate.

*Santicizer* 8 imparts excellent grease resistance, good flow and wetting action, and improves the bonding of rubber to metal.

Monsanto's solid plasticizers, *Santicizer* 1-H, *Santicizer* 9, diphenyl phthalate, dicyclohexyl phthalate, and *Aroclor* 5460, are frequently used in polyvinyl acetate-emulsion adhesives to impart better heat-sealing characteristics. They also improve moisture and solvent resistance.

For nontoxic adhesives, *Santicizer* B-16, *Santicizer* E-15, *Santicizer* 141, and diethyl phthalate have been accepted by the U. S. Bureau of Animal Industry and the Food and Drug Administration. Typical illustrations of the use of these products include adhesives for food-wrapping films, boxboard manufacture, and envelope adhesives.

Table I on page 5 lists performance data of Monsanto plasticizers in polyvinyl acetate.

*Aroclor, Santicizer: Monsanto Chemical Company trademarks. Registered in U.S. Patent Office.



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Table I. PERFORMANCE OF MONSANTO PLASTICIZERS IN POLYVINYL ACETATE-EMULSION ADHESIVES

| Plasticizer[a] | Volatility 20 Hours at 87° C (Activated Carbon) (per cent) | Low-Temp. Flexibility (Modified Clash & Berg Test) (° C) | Oil Extraction—Weight Loss After 24 Hours at Room Temperature (per cent) | | |
|---|---|---|---|---|---|
| | | | Kerosene | Peanut Oil | Cotton-Seed Oil |
| *Aroclor* 1221 | 5.2 | −5.0 | 0.63 | — | — |
| *Aroclor* 1232 | 4.8 | 4.0 | 0.54 | — | — |
| *Aroclor* 1242 | 4.4 | 5.3 | 0.57 | — | — |
| Triphenyl Phosphate | 2.0 | 5.7 | 0.02 | 0.37 | 0.38 |
| Tricresyl Phosphate | 0.75 | 3.6 | 0.16 | 0.38 | 0.46 |
| Dimethyl Phthalate | 5.6 | −1.6 | 0.92 | 0.75 | 0.93 |
| Diethyl Phthalate | 4.8 | −5.0 | 0.85 | 0.63 | 0.82 |
| Dibutyl Phthalate | 4.4 | −6.1 | 0.59 | 0.51 | 0.59 |
| Diphenyl Phthalate | 5.9 | — | 1.31 | 0.90 | 0.98 |
| *Santicizer* B-16 | 2.2 | −3.9 | 0.08 | 0.46 | 0.36 |
| *Santicizer* M-17 | 3.6 | 1.5 | 0.19 | 0.50 | 0.48 |
| *Santicizer* 1-H | 1.5 | — | 0.96 | 0.36 | 0.53 |
| *Santicizer* 8 | 3.6 | 6.4 | 0.43 | 0.60 | 0.64 |
| *Santicizer* 9 | 3.1 | — | 1.13 | 0.57 | 0.63 |
| *Santicizer* 140 | 1.2 | 5.0 | 0.15 | 0.34 | 0.36 |
| *Santicizer* 141 | 1.8 | −3.3 | 0.17 | 0.42 | 0.31 |
| *Santicizer* 160 | 2.1 | 1.9 | 0.20 | 0.39 | 0.34 |

[a] Formulation: 11 parts plasticizer in 100 parts Gelva S-55 (polyvinyl acetate) emulsion. Film thickness 0.040 inch.



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### Monsanto Resin Additives for Polyvinly Acetate Adhesives

Monsanto industrial resins, *Santolite** MHP and *Santolite* MS-80%, when used to modify polyvinyl acetate adhesives, give a very tough but flexible product. They impart quick tack and adhesion to a wide variety of surfaces. Normally, they are compounded with a liquid plasticizer, such as dibutyl phthalate or *Santicizer* 160, or with an eutectic mixture (1:1) of dibutyl phthalate and triphenyl phosphate.

The *Santolite* resins are especially useful to bond cellophane or aluminum foil to paper.

### Monsanto Preservatives and Odor-Masking Agents for Polyvinyl Acetate Adhesives

Monsanto supplies a complete line of industrial preservatives including *Santobrite**, Monsanto's Penta (pentachlorophenol), and technical sodium benzoate. These materials are useful in preventing fungus attack on the adhesive if natural materials, subject to fungus attack, are incorporated in the formulation.

Monsanto odor-masking agents for polyvinyl acetate include *Santomask** II, methyl salicylate, coumarin, and vanillin.

Literature on these products is available on request.

### Polyvinyl Acetate-Adhesive Formulations

Polyvinyl acetate-emulsion adhesives range in complexity from simple blends of polyvinyl acetate and plasticizer to more complex formulations involving many ingredients.

Formula No. 1, presented as a guide to general polyvinyl acetate-emulsion adhesives, illustrates the types and range of concentrations of ingredients that may be incorporated for various adhesive applications. (An index of formulation ingredients and their suppliers begins on page 24.)

**Formula 1—General Polyvinyl Acetate-Emulsion Adhesive**

| Ingredient | Parts by Weight |
|---|---|
| Polyvinyl acetate emulsion (55% solids) | 100 |
| Plasticizer | 10 - 50 |
| Clay filler | 0 - 30 |
| Cooked starch or dextrine | 0 - 1000 |
| Preservative | 0 - 2 |
| Stabilizer | 0 - 2 |
| Wetting Agent | 0 - 0.2 |
| Secondary Water | 0 - 100 |
| Defoamer | 0 - 2 |
| Odorant (masking agent) | 0 - 1 |

*Santolite, Santobrite, Santomask: Monsanto Chemical Company trademarks. Registered in U.S. Patent Office.



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Formulas 2 through 6 illustrate five of the most widely used applications for polyvinyl acetate adhesives.

### Formula 2—Quick-Tack Polyvinyl Acetate-Emulsion Adhesive

| Ingredient | Parts by Weight |
|---|---|
| Gelva S-55 polyvinyl acetate emulsion | 100 |
| *Santicizer* 160 | 12 |
| *Santicizer* 8 | 12 |
| Water | 9.0 |

### Formula 3—Polyvinyl Acetate Adhesive or Glue for Wood

| Ingredient | Parts by Weight |
|---|---|
| Gelva S-55 polyvinyl acetate emulsion | 95 |
| *Santicizer* 160 or dibutyl phthalate | 3 |
| Water | 2 |

### Formula 4—Low-Cost, Quick-Tack Polyvinyl Acetate Adhesive

| Ingredient | Parts by Weight |
|---|---|
| Gelva S-55 polyvinyl acetate emulsion | 100 |
| *Aroclor* 1232 | 11 |

### Formula 5—Typical Polyvinyl Acetate Combining Adhesive

| Ingredient | Parts by Weight |
|---|---|
| Polyco 117 H | 64.9 |
| Dibutyl phthalate | 26.6 |
| Water | 8.5 |
| Solids content 62.5 | |
| Viscosity 2500 - 3000 centipoises | |



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### Formula 6 Illustrates a Polyvinyl Acetate Adhesive for Padding

| Ingredient | Parts by Weight |
|---|---|
| Polyco 117-H | 42.3 |
| Tricresyl phosphate | 11.6 |
| Water | 4.6 |
| Polyco 118 | 41.5 |

Add Polyco 118 to 117-H with good agitation. Then slowly add tricresyl phosphate with high-speed agitation. Blend water slowly.

| | |
|---|---|
| Solids content | 40 |
| Viscosity | 4000 - 5000 centipoises |

For bonding moisture-proof cellophane to aluminum foil or paper or for bonding aluminum foil to paper, Formula 7 is especially useful. Adhesion develops rapidly, and good bond strength is maintained at high temperatures.

### Formula 7—Polyvinyl Acetate-Emulsion Adhesive for Cellophane, Aluminum Foil, and Paper

| Ingredient | Parts by Weight |
|---|---|
| Gelva S-55 polyvinyl acetate emulsion | 100 |
| *Santicizer* 160 | 9 |
| *Santolite* MS-80% | 13.5 |
| Water | 13.4 |

Polyvinyl acetate emulsions are used for grease-proof coatings on paper. Although Formula 8, for "flatboard," and Formula 9, for "flexible board," are not used in true adhesive applications, they are included to show the versatility of Monsanto's plasticizers in polyvinyl acetate formulations.

| Ingredient | Parts by Weight Formula 8 | Formula 9 |
|---|---|---|
| Elvacet 81-900 polyvinyl acetate emulsion | 100.0 | 100.0 |
| *Santicizer* 141 | 8.25 | 13.75 |
| York Whiting No. 7, superfine calcium carbonate | 119.25 | 96.75 |
| Rutile titanium dioxide | 13.25 | 10.75 |
| Tamol 731 dispersing agent (25% aq. soln.) | 2.1 | 1.8 |
| Elvanol 71-30 polyvinyl alcohol (10% aq. soln.) | 30.0 | 30.0 |
| Poly-G P-1200 polypropylene glycol | 1.0 | 1.0 |
| Water | 34.0 | 34.0 |



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| Properties | Formula 8 | Formula 9 |
|---|---|---|
| Total solids | 65 | 65 |
| Viscosity (26° C), centipoises | 1600 | 2700 |
| Pigment-to-binder ratio | 2:1 | 1.5:1 |
| PVAc resin-to-PVA resin ratio | 18:1 | 18:1 |
| PVAc resin-to-plasticizer ratio | 6.6:1 | 4:1 |

To prepare these grease-proof coatings, the following procedure is suggested:

1. Prepare a stock solution by mixing polyvinyl alcohol in water at room temperature. Heat for 30 to 40 minutes at 185° to 190° F. The water required to adjust the solids content may be added to this stock solution.
2. Continue stirring, and add the *Santicizer* 141, Poly-G P-1200 defoamant, and Tamol 731 pigment-dispersant solution.
3. Add the pigments, stirring until dispersion is complete.
4. Add the polyvinyl acetate emulsion, and stir until a homogenous mixture is obtained.

A grease-resistant coating for wrapping papers, such as used for bakery goods, is illustrated in Formula 10. The composition may be applied with a roller coater provided with a smoothing roll to give a uniform, continuous film. About 140° F is required for optimum film formation, if it is to be used as a laminating adhesive.

**Formula 10—Polyvinyl Acetate Grease-Resistant Paper Coating**

| Ingredient | Parts by Weight |
|---|---|
| Elvacet 81-900 polyvinyl acetate emulsion | 100 |
| *Santicizer* B-16 | 3.5 |
| Titanium dioxide | 7.0 |
| Water | 15 - 30 |
| Quilon | 0 - 5 |

For many applications, incorporation of a solid plasticizer to provide rapid heat-sealing is desirable. Formulas 11, 12, and 13 illustrate the technique of dispersing diphenyl phthalate, *Santicizer* 1-H, and triphenyl phosphate, respectively, in water, for convenient incorporation into a polyvinyl acetate adhesive.

| Ingredient | Parts by Weight | | |
|---|---|---|---|
| | Formula 11 | Formula 12 | Formula 13 |
| Diphenyl phthalate | 100 | — | — |
| *Santicizer* 1-H | — | 100 | — |
| Triphenyl phosphate | — | — | 100 |
| Water | 100 | 100 | 100 |
| Polyvinylpyrollidone | 4.7 | 4.4 | 4.4 |
| Carboxymethylcellulose | 1.3 | 1.3 | 1.3 |



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The procedure for preparation of these formulations is as follows:

1. Grind the solid plasticizer with dry ice to the desired particle size. The dry ice prevents coagulation of the solid plasticizer as a result of softening from frictional heat.

2. Add the thickening agents to the water, and agitate this mixture until solution is effected.

3. Slowly add the solid plasticizer to the water-thickener mixture with good agitation. This dispersion may be used in any desired polyvinyl acetate-emulsion formulation.

### POLYSTYRENE-EMULSION ADHESIVES

Use of polystyrene-emulsion adhesives is increasing. *Santicizer* 160, *HB-40**, diethyl phthalate, dibutyl phthalate, *Aroclor* 1242, *Aroclor* 1248, and *Aroclor* 1254 are extensively used as plasticizers for this resin in adhesive emulsions.

Formula 14 illustrates a basic styrene-emulsion adhesive that is stable and has a high degree of wet tack. The caseinate imparts stability, wet tack, and film toughness. These properties may be varied by alteration of the caseinate concentration.

**Formula 14—Styrene-Emulsion Adhesive**

| Ingredient | Parts by Weight |
|---|---|
| *Lustrex** Styrene 601-40 | 100 |
| *HB-40* | 18.0 |
| Diethyl phthalate | 5.0 |
| Triton X155 | 2.5 |
| Ammonium caseinate, 15% aqueous | 34.0 |

## HOT-MELT ADHESIVES

Hot-melt adhesives are utilized because they set rapidly after application. The molten adhesive is applied to the materials to be joined; the bond sets before the adhesive is cool.

Plasticizers play an important part in the successful manufacturing and application of hot-melt adhesives. Liquid plasticizers, such as *Santicizer* M-17, *Santicizer* 160, dibutyl phthalate, *Santicizer* B-16, and the *Aroclor* liquids, are frequently used.

Solid plasticizers, such as diphenyl phthalate, dicyclohexyl phthalate, *Santicizer* 1-H, *Santicizer* 9, and *Aroclor* 5460, are also utilized in many applications, since they melt at the processing

*HB-40, Lustrex—Monsanto Chemical Company trademarks. Registered in U. S. Patent Office.



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temperature of the hot-melt adhesive. Upon application of the adhesive to the materials to be bonded, these plasticizers solidify as the temperature is reduced, thereby overcoming the problem of excessive softness frequently encountered with hot-melt adhesives.

Formulas 15 and 16 represent two starting formulations for bookbinding adhesives.

**Formula 15**

| Ingredient | Parts by Weight |
|---|---|
| Nevillac Hard Resin | 61.4 |
| *Santicizer* 160 | 15.0 |
| Paraffin Wax | 6.4 |

Mix and heat the ingredients at 250° to 275° F until melted. Raise temperature to 300° to 325° F and add the following with agitation:

| | |
|---|---|
| Vinylite AYAA | 12.9 |
| Ethyl Cellulose | 4.3 |

**Formula 16**

| Ingredient | Parts by Weight |
|---|---|
| Nevindene R-3 or Cumar W-1 | 30 |
| *Santicizer* 8 | 15 |
| Rosin WW | 35 |
| Vinylite XYHL | 15 |
| Mineral Oil | 5 |
| Paraffin Wax | 5 |

Formulas 17 through 19 are good suggested starting points for the development of hot melts for application between 160° and 180° C. By changing the type of polyvinyl acetate resin utilized in the hot melt, the viscosity of the melt can be increased or decreased without changing the ratio of resin to plasticizer. For example, substitution of Gelva V-15 for Gelva V-7 in formulations 17 and 18 increases the melt viscosity.

| | Parts by Weight | | |
|---|---|---|---|
| Ingredients | Formula 17 | Formula 18 | Formula 19 |
| Gelva polyvinyl acetate resin V-7 | 100 | 65 | — |
| Ethyl cellulose | — | 15 | — |
| Gelva C-SV-16R | — | — | 100 |
| *Santicizer* 160 | — | 16 | — |
| Rosin WW | 75 | — | 75 |
| Dibutyl phthalate | 30 | — | 30 |
| *Aroclor* 1254 | 55 | 4 | 55 |



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Polyvinyl butyral hot-melt adhesives are useful for joining cellophane, aluminum foil, glassine, and waxed glassine to themselves. The sealing temperature is usually 200° to 350° F. The pressure can range between 0.5 psi and 30 psi. Polyvinyl butyral hot melts are extremely fast setting—usually from 0.5 to 2 seconds. The molten adhesive is usually applied to both surfaces to be bonded and allowed to cool and set. The surfaces are then brought together, and the bond is formed under heat and pressure.

**Formula 20—Polyvinyl Butyral Hot-Melt Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Butvar B-76 | 10.5 |
| Opalwax | 30.5 |
| Poly-pale Ester #1 | 19.7 |
| Staybelite Ester #10 | 14.7 |
| *Santicizer* B-16 | 6.0 |
| Armid HT | 11.0 |

The procedure used to make Formula 20 is to dissolve the Butvar B-76 in ethanol. The wax is then added with agitation and slight heating until a homogeneous slurry is obtained. The alcohol is then distilled from the mixture, and the other ingredients are added to the molten Butvar-wax mix. To obtain a smooth formulation, the finished compound should be strained through two thicknesses of cheesecloth.

Formula 21 is a polymethyl methacrylate hot-melt adhesive used to join cloth for inner liners, fabrics, or backings.

**Formula 21—Polymethyl Methacrylate Hot-Melt Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Polymethyl methacrylate | 100 |
| *Santicizer* 160 | 10 |
| Chlorinated rubber | 20 |

A typical cellulose acetate hot-melt adhesive is shown in Formula 22:

**Formula 22—Cellulose Acetate Hot-Melt Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Cellulose acetate | 50 |
| *Santicizer* M-17 | 88 |
| Inert filler | 35 |



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Cellulose acetate butyrate is commonly used for hot-melt applications. Formula 23 is a typical starting formula.

**Formula 23—Cellulose Acetate Butyrate Hot-Melt Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Half-second cellulose acetate butyrate | 35.00 |
| *Aroclor* 5460 | 30.00 |
| Dioctyl phthalate | 15.00 |
| Newport V-40 | 19.89 |
| *Santonox** | 0.1 |
| Syn Fleur #6 | 0.01 |

The above coating can be applied at about 350° F. Ventilation should be provided.

A typical starting formulation for an ethyl cellulose hot-melt adhesive is shown in Formula 24.

**Formula 24—Ethyl Cellulose Hot-Melt Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Ethyl cellulose, 50 cpr | 24 |
| Lopor No. 45 Mineral Oil | 57 |
| Bakers No. 15 Castor Oil | 5 |
| Epoxy soybean oil | 3 |
| Paraffin wax (m.p. 135° F) | 3 |
| *Santonox* | 1 |
| *Aroclor* 5460 | 7 |

## DELAYED-TACK ADHESIVES

Delayed-tack adhesives differ from hot-melt adhesives, which become nontacky upon cooling. Delayed-tack adhesives are normally tack-free at ordinary temperatures, after they are spread and dried on a surface. After subsequent heat activation they maintain tackiness for from several hours to several days over a fairly wide temperature range. This slow-setting property permits necessary mechanical handling before the adhesive cools and sets.

*Santonox: Monsanto Chemical Company trademark. Registered in U.S. Patent Office.



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Solid plasticizers, such as diphenyl phthalate, *Santicizer* 1-H, and *Santicizer* 9, make possible the delayed-tack properties of these unusual adhesives. The solid plasticizers are chosen for their compatibility with the base resin, their solvency action on the base resin, the temperature at which the adhesive is activated, their lack of disagreeable odor, and their crystallizing characteristics.

The patent literature relating to delayed-tack adhesives should be investigated by those desiring to produce them; for example, U. S. Patents 2,462,029; 2,608,542; 2,608,543; 2,613,156; and 2,613,191. Formulas 25 through 27 are quoted from the patents as indicated.

### Formula 25—Delayed-Tack Adhesive

(U. S. Patent No. 2,462,029, Example 96)

| Ingredients | Parts by Weight |
|---|---|
| *Santicizer* 1-H | 50 |
| Vinsol Resin | 50 |
| Thinned amine dispersant | 250 |
| Acrysol M.R. | 10 |

"*The thinned amine dispersant* is a mixture composed of 1 part stearic acid, 1 part Poly-pale resin, a polymerized rosin containing approximately 40% dipolymers of abietic acid (Hercules Powder Co.), 1 part 2-amino-2-methyl-1-propanol (Commercial Solvents Corp.), and 3 parts water. This composition is designed solely as a dispersion assistant....." (from column 10 of this patent)

### Formula 26—Delayed-Tack Adhesive

(U. S. Patent No. 2,462,029, Example 18)

| Ingredients | Parts by Weight |
|---|---|
| Diphenyl phthalate | 52.5 |
| Nevindine R-3 | 30.0 |
| Thinned amine dispersant (see formula 25) | 198.0 |
| Hycar OR-25 | 43.5 |

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



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### Formula 27—Polystyrene-Emulsion, Delayed-Tack Adhesive

(U. S. Patent No. 2,613,156, Example I)

"Ten (10) parts polystyrene (molecular weight 10,000 to 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 trademark 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 adhesive forms a smooth, non-grainy film when spread evenly on paper and dries to a completely tack-free surface. When heated to 170° F the film becomes very tacky and powerfully adhesive.

### Formula 28—Polyamide Delayed-Tack Adhesive

| Ingredients | Parts by Weight |
|---|---|
| Versamid 940 | 100 |
| *Santicizer* 9 | 31.6 |
| Candelilla wax | 5.9 |
| Isopropyl alcohol | 29.5 |
| Toluene | 29.5 |

## SOLUTION ADHESIVES

Solution synthetic-resin adhesives differ from the emulsion adhesives in that solvents other than water carry the adhesive. The use of solution adhesives improves the "bite" or adhesion to many of the materials to be joined. Following is a discussion of various solution adhesives.

### VINYL ADHESIVES

Formula 29 is a non-toxic, grease-resistant paper coating, which is readily heat sealable.

### Formula 29—Vinyl Solution Coating

| Ingredients | Parts by Weight |
|---|---|
| Vinylite VYHH | 80 |
| Vinylite VMCH | 10 |
| Vinylite VAGH | 10 |
| *Santicizer* 141 or *Santicizer* M-17 | 20 |
| Acetone | 250 |
| Methyl ethyl ketone | 100 |



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## NITROCELLULOSE ADHESIVES

Nitrocellulose-lacquer coatings are frequently applied to make cellophane heat sealable and moisture resistant. Formulas 30 and 31 illustrate starting formulations for this type of application. Formula 32 is typical of a starting formulation for a nitrocellulose cement.

**Formulas 30, 31, and 32—Nitrocellulose Lacquers and Cement**

| | Heat-Sealable Cellophane Lacquer | | Nitrocellulose Cement |
|---|---|---|---|
| | Parts by Weight | | |
| **Ingredients** | **Formula 30** | **Formula 31** | **Formula 32** |
| Nitrocellulose (½-sec.SS) | 15 | 50 | — |
| Nitrocellulose (30-40 sec.RS) | — | — | 10 |
| Dibutyl phthalate | 8 | 7 | — |
| Dicyclohexyl phthalate | — | 20 | — |
| *Santicizer* 160 | — | — | 5 |
| *Santolite* MHP | 16 | 12 | — |
| Dammar wax | — | 8 | — |
| *Santolite* MS-80% | — | — | 12 |
| Paraffin wax | — | 3 | — |
| Denatured alcohol | 15 | 50 | — |
| Ethyl acetate | 31 | 104 | 34 |
| Acetone | — | — | 34 |
| Toluene | 15 | 50 | — |

## CELLULOSIC ADHESIVES

Formulations 33 and 34 illustrate suggested starting formulations for cellulose acetate butyrate.

**Formula 33—For Sealing Paper to Paper or to Cellulose Acetate Butyrate**

| Ingredients | Parts by Weight |
|---|---|
| Cellulose acetate butyrate (half second) | 15 |
| *Santolite* MHP | 15 |
| Ethyl alcohol (95%) | 15 |
| Isobutyl acetate | 10 |
| Toluene | 35 |
| Hi-Flash naphtha | 10 |



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### Formula 34—For Sealing Paper to Cellulose Acetate

| Ingredients | Parts by Weight |
|---|---|
| Cellulose acetate butyrate (half second) | 12 |
| *Santolite* MHP | 18 |
| Ethyl alcohol (95%) | 15 |
| Isobutyl acetate | 10 |
| Toluene | 35 |
| Hi-Flash naphtha | 10 |

Formula 35 gives outstanding grease resistance and light stability.

### Formula 35—Grease-Resistant Coating

| Ingredients | Parts by Weight |
|---|---|
| Cellulose acetate LL-1 | 20 |
| *Santicizer* M-17 | 10.2 |
| *Santicizer* 8 | 2.5 |
| Acetone | 16.8 |
| Methyl ethyl ketone | 37 |
| Methyl cellosolve acetate | 7 |
| Ethyl lactate | 7 |

A formulation useful for self adhesion of ethyl cellulose is as follows:

### Formula 36—For Self Adhesion of Ethyl Cellulose

| Ingredients | Parts by Weight |
|---|---|
| Ethyl cellulose N-14 | 10 |
| Lewisol 28 | 5 |
| Dibutyl phthalate | 1.5 |
| Toluene-alcohol blend (4:1) | 83.5 |



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## POLYURETHANE ADHESIVES

The advent of urethane foam has increased the need for adhesives to bond it to itself or to other materials. Formula 37 is an example of a good starting formulation for this application.

**Formula 37—Polyurethane Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Multranil 176 | 100 |
| Mondur C | 5 |
| Ethyl acetate | 50 |
| *Aroclor* 1254 | 20 |

Formula 37 has a maximum work life of 48 hours. Excessive humidity or temperature shorten the work life. It is recommended that only enough adhesive for one day's use be mixed at a time. The formula may be diluted with acetone or ethyl acetate if desired.

This adhesive may be applied by a cold method. The adhesive is applied, allowed to stand at room temperature for 10 to 30 minutes until the solvent evaporates. The pieces to be joined are compressed at 50 psi for at least 15 seconds.

The adhesive surfaces may also be heated with infrared lamps to 130° F for 4 minutes to evaporate the solvent. While still warm, the pieces should be pressed together at 50 psi for 3 to 10 minutes.

## CHLORINATED-RUBBER ADHESIVES

Chlorinated rubber is used in heat-sealing adhesives because of its low moisture-vapor transmission, chemical resistance, and heat sealability. Formula 38 is a suggested starting formulation for a heat-sealing chlorinated-rubber adhesive. When 5 to 7 pounds are applied to a ream of paper, this coating allows only 1/16 gram of moisture vapor to pass through 100 square inches of paper in 72 hours.

| Ingredients | Formula 38 Heat-Sealing Chlorinated-Rubber Adhesive | Formula 39 Chlorinated-Rubber Label Adhesive |
|---|---|---|
| | Parts by Weight | |
| Parlon 125-centipoise type | 60 | 20 |
| *Aroclor* 1254 | — | 6 |
| *Aroclor* 1260 | — | 6 |
| Dibutyl phthalate | 14 | — |
| Paraffin Wax | 5 | — |
| Pentalyn H | 21 | — |
| Toluene | — | 68 |
| Solvent | as needed | — |



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## ZEIN ADHESIVES

Formulations 40 and 41, based upon zein, illustrate the versatility of Monsanto plasticizers to produce specialty formulations with unusual characteristics.

### Formula 40—Zein Label Varnish

| Ingredients | Parts by Weight |
|---|---|
| Zein | 100 |
| Rosin WW | 100 |
| *Santolite* MHP | 20 |
| *Santicizer* 8 | 25 |
| Proprietary or 91% isopropanol | 190 |

### Formula 41—Zein Foil-Tinting Base

| Ingredients | Parts by Weight |
|---|---|
| Zein A | 100 |
| *Santolite* MHP | 65 |
| *Santicizer* 8 | 70 |
| 91% Isopropanol | 230 |
| 85% Phosphoric acid | 2.3 |
| Coloring | as needed |

## PRESSURE-SENSITIVE ADHESIVES

Pressure-sensitive adhesives are materials that are tacky at ordinary temperatures and require little or moderate pressure for fixing in place. Formulations 42 through 45 illustrate four pressure-sensitive adhesives.

### Formula 42—Pressure-Sensitive Adhesive (calender onto fabric)

| Ingredients | Parts by Weight |
|---|---|
| Cellulose acetate (type A-9, 40 mesh) | 1 |
| *Santicizer* 8 | 2.5-5 |
| *Santolite* MHP | 1-2 |



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### Formula 43—Pressure-Sensitive Adhesive (calender onto fabric)

| Ingredients | Parts by Weight |
|---|---|
| Vinylite AYAF (polyvinyl acetate) | 5 |
| Arofene 700 (100% phenolic resin) | 36 |
| *Santicizer* B-16 | 18 |

### Formula 44—Pressure-Sensitive Adhesive (hot-melt type)

| Ingredients | Parts by Weight |
|---|---|
| Pale crepe rubber | 15-20 |
| Vistanex (polyisobutylene) | 5-15 |
| Ester gum | 20 |
| *Santolite* MHP | 20 |
| Methyl abietate, *Santicizer* 160, dibutyl phthalate, *Aroclor*, or *Santicizer* B-16 | 25-50 |
| Wax (Montan, paraffin, carnauba, or amorphous microcrystalline) | 1-20 |

Melt all components except rubber at about 210° F. Add rubber, and reduce temperature to 180° F. Stir at this temperature for 1 to 2 hours until mixture becomes smooth. Hot cast on suitable surface.

### Formula 45—Pressure-Sensitive Adhesive (solution type)

| Ingredients | Parts by Weight |
|---|---|
| Parlon 1259 type | 5 |
| Staybelite Ester #10 | 10 |
| Dibutyl phthalate | 10 |
| Acetone | 52.5 |
| Hexane | 22.5 |



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## ADHESIVE PRIMERS

Adhesive primers are used in the same fashion as paint primers; that is, one is applied as a preliminary coating so that the secondary coating can adhere better. The secondary coat may be any type of vinyl chloride, if the primer, such as the one illustrated in Formula 46, is first applied.

**Formula 46—Adhesive Primer (for bonding vinyl to paper or cotton cloth)**

| Ingredients | Parts by Weight |
|---|---|
| Vinylite VYMS | 18 |
| Vinylite VMCH | 2 |
| *Santicizer* 160 | 15 |
| Methyl ethyl ketone | 25 |
| Solvesso No. 1 | 17 |

Since synthetic fabrics, such as nylon or Dacron, have particularly non-adhesive surfaces, adhesive primers are especially useful. Formula 47 provides a very effective adhesive primer coat for nylon and Dacron, as well as for metal.

**Formula 47—Adhesive Primer for Synthetic Fabrics**

| Ingredients | Parts by Weight |
|---|---|
| Vinylite VMCH Vinyl Resin | 100 |
| Dioctyl phthalate (DOP) | 60 |
| Methyl ethyl ketone | 200 |
| Mondur M | 5 |

Formula 47 is made by mixing methyl ethyl ketone with the plasticizer, then adding the resin. The shelf life of the mixture is indefinite until the Mondur M is added. Upon addition of Mondur M the adhesivity of the compound decreases by 15 to 20 percent in 10 days. Accordingly, Mondur M is added last, just before the adhesive is to be applied; and only as much adhesive should be finally compounded as can be used within a day or so.



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## MISCELLANEOUS FORMULATIONS

### EPOXY-RESIN ADHESIVES

Epoxy resins are widely used in adhesive applications. Monsanto Chemical Company's *Mod-Epox** organophosphorus compound improves the bond strength of epoxy adhesives (Formulas 48, 49, and 50). *Mod-Epox* also reduces the viscosity of epox adhesives, maintains chemical resistance, and lowers the cost considerably.

**Formulas 48, 49, and 50 — Epoxy-Resin Adhesives**

| Ingredients | Formula 48 | Formula 49 | Formula 50 |
|---|---|---|---|
| | | Parts by Weight | |
| Liquid epoxy resin (EV-200) | 100 | 100 | 100 |
| Diethylenetriamine | 12 | 8 | 13 |
| *Mod-Epox* | — | 25 | — |
| Butyl glycidyl ether | — | — | 13.5 |

**Cure:** 20 hours at room temperature plus 2 hours at 100° C.

**Tensile Shear-bond Strength**

| | Formula 48 | Formula 49 | Formula 50 |
|---|---|---|---|
| Aluminum - Aluminum | 1880 psi | 2590 psi | 2010 psi |
| Steel - Steel | 2000 | 3060 | — |
| Glass - Glass | 2750 | 4900[a] | — |

[a] Cohesive failure of resin. Adhesive bond intact.

*Aroclor* and *Montar** chlorinated polyphenyls are frequently used to extend epoxy adhesives and coatings. The use of these materials greatly reduces costs with a minimum effect on chemical resistance or adhesive characteristics of the compounds.

*Mod-Epox; Montar. Monsanto Chemical Company trademarks. Registered in U. S. Patent Office.



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## POLYURETHANE-RESIN ADHESIVES

Polyurethane resins are commonly used in flocking adhesives. The following formulation is typical of a flocking adhesive:

**Formula 51—Polyurethane-Resin Flocking Adhesive**

| Ingredients | Parts by Weight |
|---|---|
| Part A — | |
| Multranil FLD | 100 |
| *Aroclor* 1254 | 20 |
| Mondur C | 5 |
| Part B — | |
| Multranil FLD | 100 |
| Mondur C | 5-10 |

Part A is applied to the fabric by knife coating and allowed to dry thoroughly. The fabric is then coated with Part B, and the material is flocked immediately.

## TOXICOLOGICAL CHARACTERISTICS

The 1958 amendment to the Pure Food, Drug, and Cosmetics Act has caused some uncertainty about the kinds of materials that can be used in adhesives.

The Food and Drug Administration has ruled that it will approve any material that does not migrate from the adhesive into the food. Migration is determined by use of a suitable dye.

Monsanto offers six plasticizers that are approved by the Food and Drug Administration as being non-toxic. These products are:

*Santicizer* 141
*Santicizer* B-16
*Santicizer* E-15
Diethyl phthalate
Dioctyl phthalate
Diisooctyl phthalate } (For foods with high water content only)

Use of these materials as plasticizers in synthetic adhesives should greatly aid acceptance of the adhesive.



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## INGREDIENT INDEX

| Ingredient | Identification | Supplier |
|---|---|---|
| Acrysol* | Synthetic-resin emulsions | Rohm & Haas Co. |
| Aluminum oxide | | Reynolds Metal Co. |
| Ammonium caseinate | | National Casein Co. |
| Armid* | Amides | Armour Industrial Chemical Co. |
| Arofene* | Modified phenolic and maleic resins | U. S. Industrial Chemicals, Inc. |
| Bakers castor oil | | Baker Castor Oil Co. |
| Butvar* | Polyvinyl butyral resins | Shawinigan Resins Corp. |
| Butyl glycidyl ether | | Shell Chemical Co. |
| Candelilla wax | | Concord Chemical Co. |
| Carboxymethylcellulose | | Antara Chemicals Division General Aniline & Film Corp. |
| Cellulose acetate | | Eastman Chemical Products Co. |
| Cellulose acetate butyrate | | Eastman Chemical Products Co. |
| Chlorinated rubber | | Hercules Powder Co. |
| Cumar* | Coumarone-indene resins | Allied Chemical Corp. |
| Dammar wax | | Hathaway Allied Products |
| Diethylenetriamine | | Union Carbide Chemical Co. |
| Elvacet* | Polyvinyl acetate emulsion | E. I. du Pont de Nemours & Co. |
| Epoxy soybean oil | | Rohm & Haas Co. |
| Ester gum | | Glidden Company |
| Ethyl cellulose | | Hercules Powder Co. |
| Gelva* | Polyvinyl acetate emulsion | Shawinigan Resins Corp. |
| Geon* | Polyvinyl materials | B. F. Goodrich Chemical Co. |
| Hycar* | Resins and synthetic rubber products | B. F. Goodrich Chemical Co. |
| Lewisol* | Rosin-modified maleates | Hercules Powder Co. |
| Lopor* No. 45 | Mineral oil | Esso Standard Oil Co. |
| Methyl abietate | | Hercules Powder Co. |

*Trademark registered in U.S. Patent Office.



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Ingredient Index - Continued

| Ingredient | Identification | Supplier |
|---|---|---|
| Methyl Cellosolve* acetate | | Union Carbide Chemical Co. |
| Mondur* | Isocyanates | Mobay Chemical Co. |
| Montan wax | | Beacon Company |
| Multranil* | Synthetic resin | Mobay Chemical Co. |
| Nevillac* | Phenol-modified coumarone-indene resins | Neville Chemical Co. |
| Nevindene* | Coumarone-indene resins | Neville Chemical Co. |
| Newport V-40* | Pine resin | Newport Industries, Inc. |
| Nitrocellulose | | Hercules Powder Co. |
| Opalwax* | Castor oil, synthetic wax | Baker Castor Oil Co. |
| Parlon* | Chlorinated rubber | Hercules Powder Co. |
| Pentalyn* | Pentaerythritol esters of rosin | Hercules Powder Co. |
| Poly-G* P-1200 | Polypropylene glycol | Olin Matheieson Chemical Co. |
| Poly-pale* esters | Glyceryl & glycol esters of polymerized rosin | Hercules Powder Co. |
| Polyco* | Polyvinyl acetate emulsion | The Borden Co. |
| Polymethyl methacrylate | | Rohm & Haas Co. |
| Polyvinylpyrollidone | | Antara Chemicals Division General Aniline & Film Corp. |
| Quilon* | Chrome complex | E. I. du Pont de Nemours & Co. |
| Solvesso* | Aromatic solvent | Esso Standard Oil Co. |
| Staybelite* esters | Hydrogenated rosin esters | Hercules Powder Co. |
| Syn Fleur* | Odorant | Syn Fleur Scientific Co. |
| Triton* X-155 | Wetting, emulsifying, dispersing, scouring agents | Rohm & Haas Co. |
| Versamid* | Polyamide resins | General Mills, Inc. |
| Vinsol* | Pine resin | Hercules Powder Co. |
| Vinylite* | Vinyl resins | Union Carbide Plastics Co. |
| Vistanex* | Polyisobutylene resin | Enjay Company |
| York Whiting* | Superfine calcium carbonate | National Gypsum Co. |
| Zein | | Corn Products Sales Co. |

*Trademark registered in U.S. Patent Office.



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## TECHNICAL LITERATURE ABOUT MONSANTO PLASTICIZERS

The following technical bulletins and brochures give technical information about the properties and applications of the Monsanto plasticizers and other products that are mentioned in this bulletin. Monsanto technical literature is continuously revised to contain the most recent and reliable information possible. Your request for any literature will be promptly and cheerfully filled without obligation, of course.

### General

"Monsanto Plasticizers"; Booklet containing technical data about all of Monsanto's plasticizers

"Seven Plasticizers for non-toxic applications"

"How you can benefit from Monsanto Solid Plasticizers"

### Phthalate Plasticizers

| | |
|---|---|
| *Santicizer* 160 (butyl benzyl phthalate): | Technical Bulletin PL-160 |
| Dibutyl Phthalate: | Technical Bulletin PL-302 |
| Diethyl Phthalate and Dimethyl Phthalate: | Technical Bulletin PL-303 |
| Dicyclohexyl Phthalate: | Technical Bulletin PL-312 |
| Di-(2-ethylhexyl) Phthalate (DOP): | Technical Bulletin PL-318 |
| Diphenyl Phthalate: | Technical Bulletin PL-319 |

### Phthalyl Glycollate Plasticizers

| | |
|---|---|
| *Santicizer* E-15 (Ethyl phthalyl ethyl glycollate): | Technical Bulletin PL-15 |
| *Santicizer* B-16 (Butyl phthalyl butyl glycollate): | Technical Bulletin PL-16 |
| *Santicizer* M-17 (Methyl phthalyl ethyl glycollate): | Technical Bulletin PL-17 |

### Phosphate Plasticizers

| | |
|---|---|
| *Santicizer* 140: | Technical Bulletin PL-140 |
| *Santicizer* 141 (non-toxic plasticizer): | Technical Bulletin PL-141 |
| Triphenyl Phosphate (flame-retarding plasticizer): | Technical Bulletin PL-301 |
| Tricresyl Phosphate (flame-retarding plasticizer): | Technical Bulletin PL-305 |



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### Sulfonamide Plasticizers

| | |
|---|---|
| *Santicizer* 1-H: | Technical Bulletin PL-1-H |
| *Santicizer* 8: | Technical Bulletin PL-8 |
| *Santicizer* 9: | Technical Bulletin PL-9 |

### Aroclor Plasticizers

| | |
|---|---|
| The *Aroclors*: | Application Data Bulletin O-P-115 |
| *Aroclors* 1221, 1232, and 1242 for polyvinyl acetate emulsion adhesives: | Technical Bulletin PL-321 |

### Other Plasticizers

| | |
|---|---|
| *HB-40* (partially hydrogenated terphenyl): | Technical Bulletin O-104 |
| *Mod-Epox* (epoxy-resin modifier): | Technical Bulletin PL-313 |

### Resin Additives

| | |
|---|---|
| *Santolite* MHP and *Santolite* MS-80% (Monsanto industrial resins): | Technical Bulletin PL-320 |

### Preservatives and Stabilizers

| | |
|---|---|
| *Santobrite* and Penta for the preservation of paints and water-base adhesives: | Technical Bulletin SC-2 |
| *Santonox* and *Santonox* R, antioxidants for polyethylene: | Technical Bulletin PL-324 |
| Sodium Benzoate, Technical: | Technical Data Sheet |

### Odor-Masking Agents

| | |
|---|---|
| "Coumarin Monsanto": | folder |
| "Methyl Salicylate Monsanto": | folder |
| *Santomask* 11, Odor-Control Agent for Paint, Ink, Plastics, and Other Odorous Products: | Technical Bulletin PL-325 |
| "Vanillin Monsanto": | folder |



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## SHIPPING INFORMATION

Most Monsanto plasticizers are shipped in bulk in tank cars or tank trucks (within established delivery zones) from six strategically-located bulk-storage stations. As supplier of the world's largest selection of plasticizers, Monsanto offers savings through mixed shipments of different plasticizers (compartmented tank cars and tank trucks or mixed trucklots of drums) for all of your plasticizer needs.

No shipping limitations apply to any of Monsanto's plasticizers. Shipping classifications and net contents of standard containers are tabulated below for the plasticizers mentioned in this bulletin.

| Product | Classification | Standard Containers | |
|---|---|---|---|
| | | 55-gal. drums (lb., net) | 5-gal. drums (lb., net) |
| Dimethyl phthalate | Dimethyl phthalate | 530 | 40 |
| Diethyl phthalate | Diethyl phthalate | 500 | 45 |
| Dibutyl phthalate | Dibutyl phthalate | 475 | 40 |
| Dioctyl phthalate | Dioctyl phthalate | 445 | 40 |
| Dicyclohexyl phthalate | Dicyclohexyl phthalate | 350 | — |
| Diphenyl phthalate | Diphenyl phthalate | 400 | — |
| *Santicizer* 160 | Butyl benzyl phthalate (Resin plasticizer) | 500 | 40 |
| *Santicizer* E-15 | Resin plasticizer | 535 | 45 |
| *Santicizer* B-16 | Resin plasticizer | 500 | 40 |
| *Santicizer* M-17 | Resin plasticizer | 550 | 50 |
| Tricresyl phosphate | Resin plasticizer | 530 | 45 |
| Triphenyl phosphate | Resin plasticizer | 225 | — |
| *Santicizer* 140 | Resin plasticizer | 545 | 50 |
| *Santicizer* 141 | Resin plasticizer | 495 | 45 |
| *Santicizer* 1-H | Resin plasticizer | — | 80[a] |
| *Aroclor* 1221 | Synthetic resin | 520 | |
| *Aroclor* 1232 | Synthetic resin | 550 | |
| *Aroclor* 1242, 1248, 1254, 1260 | Synthetic resins | 600 | — |
| *Aroclor* 5460 | Synthetic resin | 500 | |
| *HB-40* | Resin plasticizer | 450 | 40 |
| *Mod-Epox* | Chemical, NOIBN | 510 | 45 |
| *Santolite* MHP | rail: synthetic resin without filler | — | 60[b] |
| *Santolite* MS-80 | truck: synthetic resin, solid mass | 540 | 45 |
| *Santomask* II | Chemical, NOIBN | 250[c] | 45 |
| *Santonox* | Chemical, NOIBN | 150 | — |

[a] corrugated carton (16" x 8" x 9")
[b] 7 gallon
[c] 33 gallon



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Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing patents covering any material or its use.

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