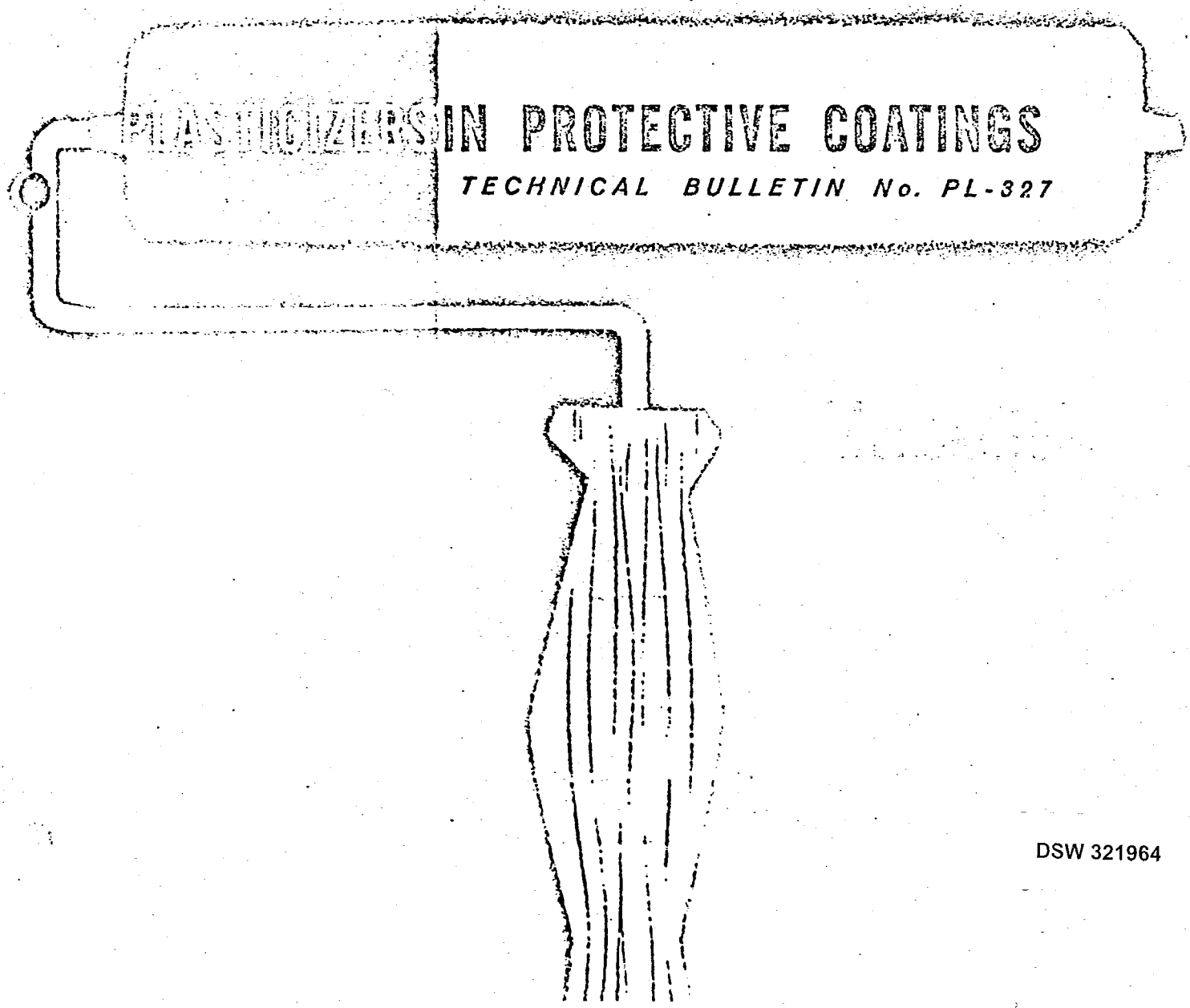
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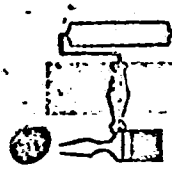
# PLASTICIZERS IN PROTECTIVE COATINGS

*TECHNICAL BULLETIN No. PL-327*



DSW 321964

STLCOPCB4073614



PROTECTIVE COATINGS -- A LARGE MARKET

## GROWING IMPORTANCE OF SYNTHETIC RESINS IN COATINGS

Pictures and inscriptions painted on Egyptian tombs and Chinese temples as long ago as 2000 B.C. mark the earliest known use of paint-like materials. Paint technology has still not changed its predominant reliance on naturally occurring materials, symbolized by pails of white lead and linseed oil. True, modernization has seen the development of new pigments, better vehicles, and more efficient manufacturing techniques, but the old stand-bys are still in use.

The development of synthetic resins, however, has freed industry from dependence on natural resins and has enabled the production of faster-drying and more-durable and more-resistant protective coatings than could be made from natural raw materials alone. The nitrocellulose-lacquer development in the early 1920's revolutionized automobile finishing. The discovery of alkyd resins in the late 1920's and the introduction of latex paints in the late 1940's further broadened the outlets for protective coatings and increased the sales of these products. Now, annual sales of protective-coatings materials amount to more than 600-million gallons, valued at more than 1.5-billion dollars.

## ROLE OF PLASTICIZERS IN PROTECTIVE COATINGS

Success of the new synthetic resins in protective coatings often depends largely on the modifiers used with them. Plasticizers—one of the most important types of modifiers—can improve such vital characteristics as flow, levelling, brushability, impact resistance, drawability, gloss, and luster.

As a basic producer of more than 80 different plasticizers, Monsanto Chemical Company is an important partner with synthetic-resins manufacturers and protective-coatings producers in the selection and development of the particular plasticizer system that imparts the best all-around durability, performance, and economy for every coating application.

This bulletin is presented to help protective-coatings manufacturers formulate better finishes. It should be remembered that each *suggested starting formulation* should be carefully evaluated by the formulator in both laboratory and service tests before any final formulation is based on information contained in this bulletin. Of course, Monsanto's technical-service representatives are prepared to offer unbiased recommendations for plasticizer systems to meet any performance requirement, without obligation.



STLCOPCB4073615

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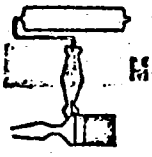
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DSW 321966



# MONSANTO PLASTICIZERS IN CELLULOSIC COATINGS

## NITROCELLULOSE

Nitrocellulose is the basic film former for lacquers. Both the R. S. (regular-soluble) and the S.S. (spirit-soluble) grades are generally used in lacquers. Films applied by these lacquers possess the following characteristics:

Fast drying
Clarity
Color stability
Hardness
Flexibility
Mar and scuff resistance

These lacquers are used for a wide variety of coatings, including the following typical applications:

Wood and furniture lacquers
Plastics lacquers
Paper coatings and impregnants
Metal lacquers
Automobile lacquers
Textile coatings
Aerosol lacquers
Bronzing lacquers

Nitrocellulose films, however, are quite brittle without plasticization. A wide variety of plasticizers is used to improve the gloss, flexibility, and adhesion of these films; and the use of plasticizers increases the solids content of nitrocellulose films. The performance of various Monsanto plasticizers in nitrocellulose is shown in Table I.

TABLE I—PERFORMANCE OF
MONSANTO PLASTICIZERS IN NITROCELLULOSE FILM

| Plasticizer (50 PHR) | Flexibility (Schopper Fold Cycles) | Tensile Strength (psi) | Elongation (%) | Moisture Permeability [a] (%) |
|---|---|---|---|---|
| Control (none) | 20 | 8660 | 6 | 100 |
| Dibutyl Phthalate | 10 | 2740 | 4 | 65 |
| SANTICIZER* 160 | 14 | 3610 | 10 | 19 |
| Triphenyl Phosphate | 24 | 4480 | 8 | 56 |
| Tricresyl Phosphate | — | 1230 | 24 | 28 |
| SANTICIZER 1-H | 10 | 3310 | 7 | 41 |
| SANTICIZER 8 | 16 | 2310 | 11 | 63 |

a) Relative to permeability of unplasticized film as 100%.

* SANTICIZER: Monsanto Chemical Company Trademark. Registered in U.S. Patent Office.



DSW 321967

STLCOPCB4073617

The use of nitrocellulose lacquers on furniture has assumed large proportions. These lacquers give excellent protective coatings. Shown below are several examples of wood-finishing lacquers:

| Ingredients | 1[a] | 2[b] | 3[c] |
|---|---|---|---|
| | Parts by Weight | | |
| R.S. Nitrocellulose (1/4-sec.)[d] | — | 100 | 100 |
| R.S. Nitrocellulose (1/2-sec.)[d] | 60 | — | — |
| R.S. Nitrocellulose (5-6 sec.) | 30 | — | — |
| Maleic Resin (58% in toluene) | 310 | 70 | 40 |
| Non-Oxidizing Alkyd (60% n.v.) | — | 60 | 30 |
| SANTOLITE* MHP | — | 15 | 30 |
| SANTICIZER 160 or Dibutyl Phthalate | 15 | — | — |
| SANTICIZER 165 or Dioctyl Phthalate | — | 50 | 17 |
| Zinc Stearate Paste | 120[e] | — | — |
| Castor Oil | 18 | — | 15 |
| Hi-Flash Naphtha | 210 | — | 155 |
| Toluene | 105 | 135 | 70 |
| Xylene | 17 | — | — |
| Ethanol | 18 | — | 15 |
| Isopropanol | — | — | 65 |
| Butanol | 55 | 55 | — |
| Ethyl Acetate | 200 | 60 | — |
| Butyl Acetate | 325 | 120 | — |
| Cellosolve** Acetate | — | — | 150 |
| Methyl Ethyl Ketone | — | 190 | — |

a) Maleic resin-based wood sanding sealer

b) Clear, high-gloss furniture lacquer with good polishing properties

c) Clear brushing lacquer

d) 75-per cent nonvolatile in ethanol

e) Zinc Stearate Paste composition:

| Ingredients | Parts by Weight |
|---|---|
| R.S. Nitrocellulose (5-6 sec.) | 25 |
| Zinc Stearate | 50 |
| Magnesium Carbonate | 1 |
| Castor Oil | 8.5 |
| Hi-Flash Naphtha | 90 |
| Ethanol | 38 |
| Ethyl Acetate | 45 |
| Butyl Acetate | 17 |

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

** Trademark of Union Carbide Corp.



DSW 321968

STLCOPCB4073618

Another broad area of application for nitrocellulose lacquers is in automobile finishing. Shown below are suggested formulations for the three coats used in the build-up of an automobile finish:

| Ingredients | 4[a] | 5[b] | 6[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Nitrocellulose (¼-sec.)[d] | -- | -- | 100 |
| Nitrocellulose (½-sec.) | 100[e,f] | 100[d] | -- |
| Non-Drying Coconut Alkyd | 80[f, g] | 56[g] | 75 |
| Blown Soya Oil | -- | 43 | -- |
| SANTICIZER 160 or Dibutyl Phthalate | -- | -- | 24 |
| Dioctyl Phthalate | -- | 13 | -- |
| Tricresyl Phosphate | 9[f] | -- | -- |
| Magnesium Silicate | 9 | -- | -- |
| Fibrous Magnesium Silicate | 29 | -- | -- |
| Dispersing & Grinding Agent | -- | 3 | -- |
| Zinc Chromate | 10.9 | -- | -- |
| Red Iron Oxide | 55 | -- | -- |
| Titanium Dioxide (Rutile) | -- | 55 | -- |
| Lacquer Diluent | -- | 85 | -- |
| Toluene | 25 | 195 | -- |
| Xylene | 10 | -- | 160 |
| Ethanol | -- | 65 | 13 |
| Isopropanol | 15 | -- | -- |
| Butanol | -- | 55 | 35 |
| Ethyl Acetate | 20 | -- | -- |
| Butyl Acetate | -- | 110 | 95 |
| Butyl *Cellosolve* | -- | -- | 60 |
| Methyl Ethyl Ketone | -- | 55 | -- |
| Methyl Isobutyl Ketone | 5 | | |

*a*) Rust-inhibiting primer

*b*) Tint base that can be pigmented to prepare a glossy finish

*c*) Clear, exterior metal lacquer

*d*) 75-per cent nonvolatile in ethanol

*e*) 25-per cent solution in solvent consisting of:

| Solvents | Per Cent |
|---|---|
| Toluene | 50 |
| Ethanol | 10 |
| Butanol | 5 |
| Ethyl Acetate | 20 |
| Butyl Acetate | 15 |

*f*) Add indicated ingredients (60% of the non-drying alkyd) after other materials have been ground in a ball mill.

*g*) 65-per cent nonvolatile in xylene.



DSW 321969

STLCOPCB4073619

Clarity and adhesion are especially important whenever clear or pigmented coatings are applied to metal surfaces. Shown below are example formulations for several metal lacquers:

| Ingredients | 7[a] | 8[b] | 9[c] | 10[d] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| R.S. Nitrocellulose (¼-sec.)[e] | -- | 100 | -- | -- |
| R.S. Nitrocellulose (½-sec.)[e] | 80 | -- | -- | 100 |
| R.S. Nitrocellulose (20-sec.)[e] | 20 | -- | 100 | -- |
| Non-Drying Alkyd (60% NV) | 30 | -- | 125 | -- |
| SANTOLITE MHP | 25 | -- | 12 | -- |
| Shellac Solution (37% in methanol) | -- | -- | -- | 42 |
| Damar Solution (50% in xylene) | -- | 7.7 | -- | -- |
| SANTICIZER 160 or Dibutyl Phthalate | -- | -- | 45 | 32 |
| Tricresyl Phosphate | 11 | 12 | -- | -- |
| Toluene | 175 | -- | 345 | 150 |
| Xylene | 56 | 140 | -- | -- |
| Butanol | 55 | 40 | 25 | 60 |
| Ethyl Acetate | -- | -- | 85 | 95 |
| Butyl Acetate | 115 | 45 | 200 | 65 |
| Butyl Lactate | -- | 45 | -- | -- |

a) General-purpose, clear, metal lacquer
b) Lacquer with exceptional flexibility and adhesion for collapsible tubes, such as toothpaste tubes
c) Clear, silver lacquer
d) Clear, brass lacquer
e) 75-per cent nonvolatile in ethanol

Various other metal and specialty lacquers are illustrated below:

| Ingredients | 11[a] | 12[b] | 13[c] | 14[d] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| R.S. Nitrocellulose (¼-sec.)[e] | 22 | 50 | 100 | 100 |
| R.S. Nitrocellulose (½-sec.)[e] | -- | 50 | -- | -- |
| Coconut Oil Alkyd (Non Drying) | 100 | 125[f] | 60 | 55 |
| Dibutyl Phthalate | 75 | -- | 24 | 16 |
| Diisodecyl Phthalate | -- | 22 | -- | -- |
| SANTOLITE MHP | -- | -- | 16 | 12 |
| Aluminum Powder | -- | 30 | -- | -- |
| Carbon Black | 11 | -- | -- | -- |
| Titanium Dioxide (Rutile) | -- | -- | -- | 65 |
| Dispersing/Grinding Agent | 3 | -- | -- | 4 |
| Processed Clay | -- | -- | -- | 2 |
| Toluene | -- | 335 | -- | -- |
| Xylene | 170 | -- | -- | -- |
| Ethanol | 16 | 55 | 30 | -- |
| Butanol | 45 | 40 | -- | -- |
| Ethyl Acetate | -- | 115 | -- | -- |
| Butyl Acetate | 105 | 155 | -- | -- |
| Butyl Cellosolve | 65 | -- | 52 | 35 |
| Methyl Isobutyl Ketone | -- | -- | 428 | 300 |
| Dichlorodifluoromethane | -- | -- | 709 | 590 |

a) Hot-spray, exterior, metal lacquer
b) Aluminum lacquer for a chrome finish
c) Clear aerosol lacquer
d) White aerosol lacquer
e) 75-per cent nonvolatile in ethanol
f) 60-per cent nonvolatile in xylene



DSW 321970

STLCOPCB4073620

Paper has become an important area for coatings and lacquers. Most protective-coated papers are used for cartons and labels. Lacquer films have also made washable wallpaper possible. Shown below are four example formulations of common paper lacquers. Nitrocellulose is the base for fingernail lacquers, of which formulation 19 is typical.

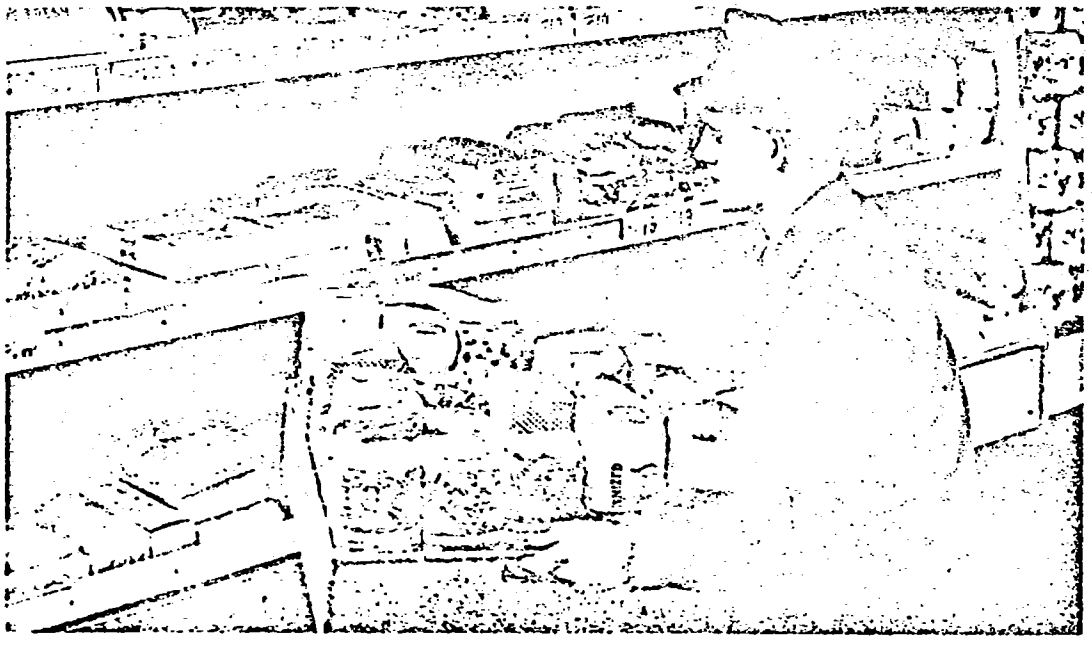
| Ingredients | 16[a] | 17[b] | 18[b] | 19[c] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| R.S. Nitrocellulose (½-sec.) | 100 | -- | -- | 100 |
| S.S. Nitrocellulose (½-sec.) | -- | 100 | 100 | -- |
| *Blacar** H-4055 | -- | -- | -- | -- |
| Diethylene glycol ester of terpene dibasic acid | 72 | 21 | -- | -- |
| SANTICIZER 160 or Dibutyl Phthalate | 28 | 6 | 30 | 50 |
| Dicyclohexyl Phthalate | -- | 17 | 28 | -- |
| Damar Resin (Dewaxed) | -- | 52 | 16 | -- |
| Paraffin Wax | -- | 16 | 6 | -- |
| SANTOLITE MHP | -- | -- | 20 | 100 |
| Toluene | 200 | 5 | 300 | 350 |
| Ethanol | 40 | 85 | 60 | 50 |
| Butanol | 40 | 85 | 60 | -- |
| Ethyl Acetate | 40 | 85 | 60 | 200 |
| Butyl Acetate | 80 | 170 | 120 | 150 |

*a*) Heat-sealing coating for paper. Dioctyl, dibutyl, and dicyclohexyl phthalates, as well as tricresyl phosphate, can be interchanged as the platicizer with little effect in performance. The S. S. nitrocellulose would give a slightly better heat-seal test on glassine.

*b*) Moisture-proof, heat-sealing paper lacquer

*c*) Fingernail lacquer

* Trademark of Cary Chemicals, Inc. for vinyl chloride-vinyl acetate copolymers



Nitrocellulose-based heat-seal coatings are widely used in the packaging of baked goods and other food products.



DSW 321971

STLCOPCB4073621

One of the expanding applications for nitrocellulose lacquers is as coatings for plastics materials. Shown below are example formulations of various lacquers for plastics:

| Ingredients | 20[a] | 21[b] | 22[c] | 23[d] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| R.S. Nitrocellulose (½-sec.) | 100 | — | 100 | — |
| R.S. Nitrocellulose (5-6-sec.) | — | 100 | — | 100 |
| *Super Beckacite** #1001 Oil-reactive phenolic resin | 100 | — | — | — |
| Non-oxidizing Alkyd Resin | — | 100 | — | — |
| Dioctyl Phthalate | 25 | — | — | 25 |
| SANTICIZER 160 or Dibutyl Phthalate | — | 30 | 30 | — |
| Dihydroabietyl phthalate | — | — | — | 125 |
| Partially Esterfied Pentaerithritol-Maleic Rosin | — | — | 100 | — |
| Partially hydrogenated methyl ester of wood rosin | — | — | 100 | — |
| Low-color blown castor oil | 25 | — | — | — |
| Titanium Dioxide (Rutile) | 62.5 | — | — | — |
| VM & P Naphtha | — | — | 410 | — |
| Toluene | 525 | — | — | 290 |
| Xylene | — | 90 | — | — |
| Ethanol | 155 | — | 55 | 90 |
| Ethyl Acetate | — | — | — | 175 |
| Butyl Acetate | 370 | — | — | — |
| Amyl Acetate | — | 370 | — | — |
| Butyl *Cellosolve* | — | — | — | 30 |
| Methyl Ethyl Ketone | — | 1080 | | |
| Methyl Isobutyl Ketone | — | — | 770 | — |

Typical pigments and dyes can be incorporated by normal techniques.

a) Lacquer with good adhesion to molded phenolic plastics

b) Lacquer for acrylic plastics (automobile ornaments)

c) Coating for ethyl cellulose plastics including the "soft" types

d) Lacquer for *Mylar*-** and saran-coated cellophane, has excellent toughness, adhesion, and flexibility. Dries in one minute at 100° C.

* Trademark of Reichhold Chemical Industries

** Trademark of E. I. du Pont de Nemours & Co.



DSW 321972

STLCOPCB4073622

## ETHYL CELLULOSE

Five basic properties make ethyl cellulose useful in many types of finishes and coatings:

Color retention and stability
Low-temperature flexibility
Selective solubility
Alkali resistance

As a result of these properties ethyl cellulose is used in a wide variety of coatings, including the following:

Cable lacquers
Aluminum-foil coatings
Paper lacquers
Gel lacquers
Plastics lacquers
Furniture finishes
Sanding sealers
Metallic finishes
Decalcomania lacquers
Floor-covering lacquers
Bronzing lacquers
Stop-off lacquers

A wide variety of plasticizers is used with ethyl cellulose to develop its best properties to most satisfactorily meet the requirements of each particular application. Table II presents evaluations of various Monsanto plasticizers in ethyl cellulose with an ethoxy content of from 48 to 49.5 per cent:

TABLE II—PERFORMANCE OF MONSANTO PLASTICIZERS IN ETHYL CELLULOSE (48- TO 49.5-% ETHOXY) FILM

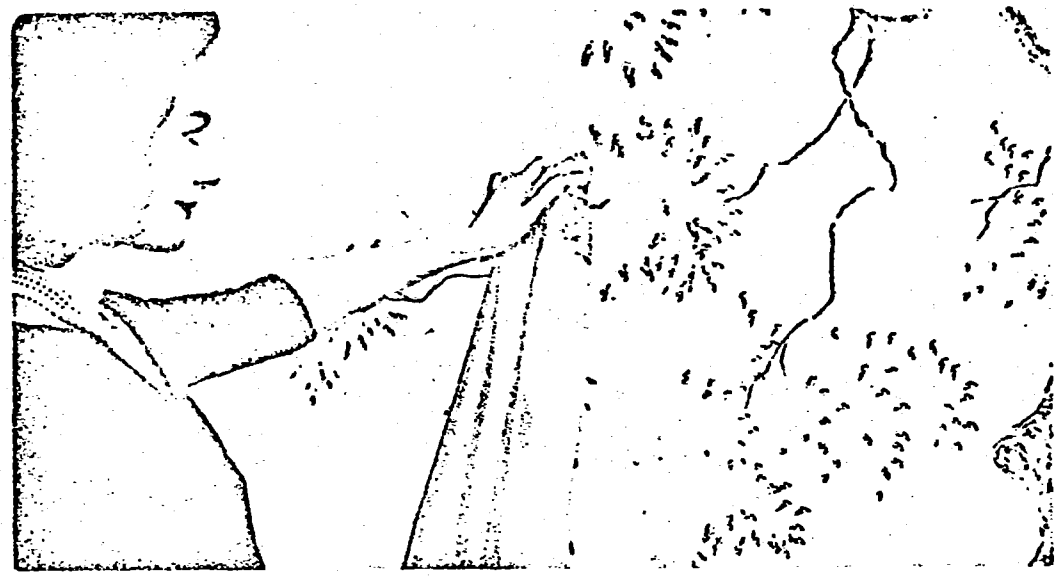
| Plasticizer (15 PHR) | Yield Point (psi) | Tensile Strength (psi) | Elongation (%) | Hardness (relative) | Volatility | Flexibility on Light Exposure |
|---|---|---|---|---|---|---|
| Control (none) | 6755 | 8960 | 30 | 100 | E[a] | E[a] |
| Dibutyl Phthalate | 3625 | 5120 | 38 | 35 | G | E |
| Diphenyl Phthalate | 5405 | 7680 | 38 | 80 | E | G |
| Tricresyl Phosphate | 4550 | 7465 | 48 | 70 | E | E |
| SANTICIZER 140 | 5405 | 8535 | 38 | 80 | E | E |
| Triphenyl Phosphate | 4550 | 6685 | 30 | 70 | E | E |
| SANTICIZER E-15 | 4265 | 7785 | 40 | 65 | G | E |
| SANTICIZER B-16 | 3485 | 4905 | 36 | 50 | G | E |
| SANTICIZER M-17 | 4125 | 7965 | 38 | 60 | G | E |
| SANTICIZER 1-H | 5475 | 7750 | 32 | 80 | E | E |
| SANTICIZER 8 | 4620 | 6900 | 34 | 70 | G | E |
| SANTICIZER 9 | 4620 | 7325 | 40 | 70 | G | E |
| AROCLOR* 1242 | 4905 | 7395 | 36 | 75 | P | G |
| AROCLOR 1248 | 5475 | 7540 | 30 | 80 | P | G |
| AROCLOR 1254 | 6185 | 7825 | 28 | 90 | G | G |
| AROCLOR 1262 | 7110 | 8035 | 22 | 105 | E | G |
| AROCLOR 4465 | 8535 | 9030 | 22 | 125 | G | P |

a) E = excellent
G = good
P = poor

* AROCLOR: Monsanto Chemical Company Trademark. Registered in U.S. Patent Office.

DSW 321973

STLCOPCB4073623



Ethyl cellulose-based lacquers improve the gloss and protect the appearance of high-quality wallpapers.

Shown below are several suggested starting formulations for ethyl cellulose-based lacquers:

| Ingredients | 24[a] | 25[b] | 26[c] | 27[d] | 28[e] |
|---|---|---|---|---|---|
| | Parts by Weight | | | | |
| Ethyl Cellulose | 100[f] | 100[g] | 100[g] | 100[h] | 100[i] |
| AROCLOR 1254 | 64 | -- | -- | -- | -- |
| AROCLOR 5460 | 304 | 100 | -- | -- | -- |
| Diphenyl Phthalate | -- | -- | 72 | -- | -- |
| Tricresyl Phosphate | -- | 30 | -- | -- | 22 |
| Dioctyl Phthalate | -- | -- | -- | 34 | -- |
| Liquid poly(methylstyrene) | -- | -- | -- | 27 | -- |
| Partially esterified pentaerythritol-maleic rosin | -- | -- | -- | -- | 100 |
| Octylphenol | -- | 2.3 | 7.2 | -- | -- |
| *Pentaphen** 65 (*p-tert*-amylphenol) | -- | -- | -- | 1.8 | -- |
| SANTOCEL**FRC silica gel | -- | -- | -- | 16 | -- |
| Antioxidant | 0.4 | -- | -- | -- | -- |
| Titanium Dioxide (Rutile) | 200 | -- | -- | -- | -- |
| Epoxy stabilizer | 4 | -- | -- | -- | -- |
| Toluene | -- | 466 | 344 | -- | 178 |
| Xylene | 1120 | 146 | 107 | 428 | -- |
| Ethanol | -- | 117 | 85 | -- | 353 |
| Butanol | 280 | 39 | 29 | 107 | 236 |
| Butyl Acetate | -- | -- | -- | -- | 154 |
| *Cellosolve* | -- | -- | -- | -- | 108 |
| Butyl *Cellosolve* | -- | -- | -- | -- | 143 |

a) Alkali-resistant white lacquer

b) Hard lacquer for rigid surfaces

c) Tough lacquer for many surfaces

d) Wallpaper lacquer

e) Polystyrene lacquer (to minimize polystyrene crazing, polystyrene solvents are kept at a minimum)

f) 47.5-49.0-% ethoxy, 10 cp

g) 47.5-49.0-% ethoxy, 14 cp

h) 47.5-49.0-% ethoxy, 22 cp

i) 45.5-46.8-% ethoxy, 200 cp

* Trademark of Pennsalt Chemicals, Inc.

** SANTOCEL: Monsanto Chemical Company Trademark. Registered in U.S. Patent Office.



DSW 321974

STLCOPCB4073624

Ethyl cellulose is widely used as a resin in protective-metal finishes, such as the following suggested starting formulations:

| Ingredients | 29[a] | 30[b] | 31[b] | 32[b] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| Ethyl cellulose (45.5-56.8-% ethoxy) | 100[c] | 100[d] | 100[d] | 100[c] |
| *Super Beckacite* #1001 | — | — | 46.7 | — |
| Glycerine ester of hydrogenated wood rosin | — | — | — | 80 |
| RESIMINE* 881 melamine-formaldehyde resin | 50 | — | — | — |
| AROCLOR 1254 | — | 33.3 | — | — |
| AROCLOR 5460 | — | 33.3 | — | — |
| Tricresyl phosphate | — | — | 10 | — |
| Triphenyl phosphate | 47 | — | 10 | — |
| SANTICIZER B-16 | — | — | — | 20 |
| SANTONOX* antioxidant | 1 | — | — | — |
| Ultraviolet-light Screener | 1 | — | — | — |
| Epoxy Stabilizer | 1 | — | — | — |
| Xylene | 1072 | 267 | 267 | 320 |
| Isopropanol | 200 | 66.7 | 66.7 | 80 |
| Butyl Acetate | 68 | — | — | — |

*a*) Chromium lacquer

*b*) Aluminum-foil lacquer

*c*) 14 cp

*d*) 10 cp

Solid plasticizers such as dicyclohexyl phthalate, triphenyl phosphate, and *A*ROCLOR 5460 are used in flow-back lacquers to give the desired flow-back characteristics. The flow-back is usually achieved by brief heating to about 350°F. Formulations 33 and 34 illustrate the use of solid plasticizers in typical flow-back lacquers based upon ethyl cellulose:

| Ingredients | 33 | 34 |
|---|---|---|
| | Parts by Weight | |
| Ethyl cellulose (47.5-49.0-% ethoxy, 10 cp) | 100 | 100 |
| Partially-esterified pentaerythritol-maleic rosin | — | 16.7 |
| AROCLOR 5460 or liquid poly(methylstyrene) | 30 | 31.7 |
| Triphenyl Phosphate | 16.7 | — |
| Dicyclohexyl Phthalate | — | 16.7 |
| Carnauba Wax | 3.3 | 1.7 |
| Toluene | 240 | 310 |
| Ethanol | 60 | 78 |

* RESIMENE and SANTONOX: Monsanto Chemical Company Trademarks. Registered in U.S. Patent Office.



DSW 321975

STLCOPCB4073625

The following suggested starting formulations illustrate the use of ethyl cellulose in two strippable coatings (Formulations 35 and 36) and in a hot-melt coating (37):

| Ingredients | 35[a] | 36[b] | 37[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Ethyl cellulose (47.5-49.0-% ethoxy, 50 cp) | 100 | 100 | 100 |
| *Paraplex** RG-2 polyester resin | 13 | — | — |
| *Super Beckacite* #2000 Non-oil-reactive phenolic resin | — | — | 100 |
| Hydrogenated wood rosin | — | — | 133 |
| Raw Castor Oil | 61 | — | — |
| Hydrogenated Castor Oil | — | — | 133 |
| Paraffin Wax (m.p., 135°F) | — | — | 167 |
| Dioctyl phthalate | — | — | 33 |
| AROCLOR 1254 | 22 | 100 | — |
| Soy-bean lecithin | 8.7 | — | — |
| Octylphenol | — | 2 | — |
| Stearic Acid | — | 2 | — |
| *Pentaphen* | 2.2 | — | — |
| Non-leafing aluminum | 114 | — | — |
| Heptane | 326 | 306 | — |
| Toluene | 196 | 184 | — |
| Ethanol | 65 | 61 | — |
| Isopropanol | 65 | 61 | — |

a) Aluminum colored

b) Solvent based

c) Low moisture permeability, good heat-sealing characteristics, and excellent low-temperature flexibility

The use of ethyl cellulose in size emulsions is shown in the following formulation, which is made by dissolving the resins and plasticizer in the solvents and the emulsifying agent in the water. The lacquer phase is added to the water phase with agitation. The resulting crude emulsion is homogenized by one pass through a Premier Eppenbach or Montar-Gaulin mill. The resultant finished emulsion is filtered through a 30-mesh cloth.

| Ingredients | 38 |
|---|---|
| *Lacquer Phase* | Parts by Weight |
| Ethyl cellulose (47.5-59.0-% ethoxy, 100 cp) | 100 |
| *Durez*** 550 Phenol-Formaldehyde Resin | 20 |
| Triphenyl phosphate | 70 |
| Xylene | 270 |
| Hi-flash Naphtha | 160 |
| Butanol | 50 |
| *Water Phase* | |
| Potassium Oleate | 5 |
| Water | 325 |

*Trademark of Rohm & Haas Co.

**Trademark of Hooker Chemical Corp.



DSW 321976

STLCOPCB4073626

## CELLULOSE ACETATE-BUTYRATE

Cellulose acetate-butyrate resins display excellent low-viscosity properties, making attainable high-nonvolatile-content lacquers for spray, roll-coat, or brush application. On evaporation of the solvent, these lacquers produce films with the following characteristics:

Adhesion
Clarity
Toughness
Heat resistance
Solvent resistance

Cellulose acetate-butyrate can be utilized in a broad range of air-curing coatings, including the following:

Clear and pigmented metal lacquers
Paper and textile coatings and impregnants
Plastics lacquers
Hot-melt coatings
Wood lacquers
Protective peelable coatings
Glass and rubber coatings

Cellulose acetate-butyrate resins are available in 17-, 27-, 38-, and 50-weight-per cent butyral content. Since the application of these surface coatings cover such a wide spectrum, the selection of the best combination of cellulose acetate-butyrate resin and plasticizers for a specific use poses complex problems. The performance of various Monsanto plasticizers in the four common cellulose acetate-butyrate resins is shown in Table III.





STLCOPCB4073627

## TABLE III—PERFORMANCE OF MONSANTO PLASTICIZERS IN CELLULOSE ACETATE-BUTYRATE FILM

| Plasticizer (33⅓ PHR) | 17-Wt. %-Butyral | | | 27-Wt. %-Butyral | | | 38-Wt. %-Butyral | | | 50-Wt. %-Butyral | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sward Hardness | Tensile Strength (psi) | Elongation (%) | Sward Hardness | Tensile Strength (psi) | Elongation (%) | Sward Hardness | Tensile Strength (psi) | Elongation (%) | Sward Hardness | Tensile Strength (psi) | Elongation (%) |
| Dimethyl Phthalate | 32 | 6600 | 8 | 58 | 8600 | 19 | 46 | 4200 | 14 | 54 | 4500 | 9 |
| Dibutyl Phthalate | 30 | 3900 | 12 | 40 | 4600 | 29 | 38 | 1800 | 12 | 38 | 2300 | 9 |
| Dioctyl Phthalate | 36 | 4100 | 8 | 44 | 3700 | 12 | 44 | 2900 | 19 | 26 | 1400 | 15 |
| Dicyclohexyl Phthalate | 38 | 6000 | 8 | 38 | 6500 | 25 | 30 | 3900 | 31 | 24 | 2500 | 27 |
| Diphenyl Phthalate | -- | ---- | -- | 36 | 7500 | 18 | 42 | 3800 | 28 | 40 | 2800 | 25 |
| SANTICIZER 160 | 48 | 3800 | 21 | 42 | 4500 | 39 | 42 | 2700 | 13 | 30 | 1600 | 15 |
| Dioctyl Adipate | 34 | 3600 | 9 | -- | ---- | -- | 28 | 2100 | 12 | 14 | 1200 | 8 |
| SANTICIZER E-15 | 26 | 3200 | 22 | 48 | 5900 | 30 | 34 | 2000 | 14 | 20 | 1400 | 13 |
| SANTICIZER B-16 | 24 | 3200 | 23 | 50 | 6000 | 26 | 40 | 1800 | 15 | 18 | 1200 | 17 |
| SANTICIZER M-17 | 24 | 3500 | 18 | 28 | 4100 | 15 | 52 | 1800 | 18 | 22 | 1500 | 19 |
| SANTICIZER 140 | 26 | 4000 | 21 | 40 | 5000 | 20 | 42 | 2700 | 13 | 30 | 1600 | 15 |
| SANTICIZER 141 | 36 | 3000 | 18 | 48 | 4900 | 21 | 44 | 2300 | 15 | 20 | 900 | 10 |
| Tricresyl Phosphate | 28 | 4000 | 15 | 46 | 5900 | 21 | 54 | 3000 | 20 | 40 | 1700 | 17 |
| Triphenyl Phosphate | 40 | 4800 | 15 | 40 | 4700 | 28 | 40 | 2500 | 10 | 30 | 1700 | 15 |
| SANTICIZER 1-H | 32 | 4000 | 21 | 32 | 6900 | 16 | 46 | 3900 | 46 | 28 | 2600 | 31 |
| SANTICIZER 3 | 32 | 3300 | 17 | 32 | 1500 | 15 | 34 | 1800 | 27 | 36 | 1500 | 24 |

DSW 321978

STLCOPCB4073628

Shown below are several example formulations for important cellulose acetate-butyrate lacquers:

| Ingredients | 39[a] | 40[b] | 41[c] | 42[d] | 43[e] |
|---|---|---|---|---|---|
| | Parts by Weight | | | | |
| Cellulose Acetate-Butyrate (½-sec.) | 100 | 100 | 100 | 100 | 100 |
| Amberol* 820 hard rosin-modified maleic resin | — | 79 | — | — | — |
| Acrylic Ester Resin | — | — | — | 42 | — |
| *FDC 555B*** (50% n.v.) | — | — | — | — | 22 |
| AROCLOR 1260 | — | — | — | 25 | — |
| AROCLOR 1262 | 75 | — | — | — | — |
| AROCLOR 5460 | — | — | — | 25 | 22 |
| Tricresyl Phosphate | — | 31.6 | — | — | — |
| SANTICIZER 409 | — | — | — | — | 13 |
| SANTOLITE MHP | — | — | 50 | — | — |
| Solvesso*** 100 | — | — | — | — | 51 |
| Toluene | 240 | 475 | 200 | 250 | 286 |
| Ethanol | 60 | 105 | 50 | 560 | 14 |
| Butanol | — | — | — | 417 | 57 |
| Isobutyl Acetate | 25 | — | 50 | — | — |
| Acetone | — | 264 | 50 | — | — |
| Methyl Ethyl Ketone | — | — | — | 167 | — |
| Methyl Isobutyl Ketone | — | — | — | 83.5 | 106 |
| Dow Corning 200 Silicone Fluid (1000 cs) | — | — | — | — | 0.07 |

*a*) Low-cost, flame-resistant lacquer for paper coating and impregnation

*b*) Paper lacquer with exceptional adhesion to inked surfaces

*c*) High-gloss paper lacquer

*d*) Lacquer for cellophane, cellulose acetate-butyrate, and cellulose acetate

*e*) General-purpose metal and metal-foil lacquer (gold, silver, aluminum, and chromium)

Hot-melt coatings constitute an important area of application for ½-sec. cellulose acetate-butyrate lacquers. The use of dioctyl phthalate as the standard plasticizers for hot-melt coatings is shown in the following formulas:

| Ingredients | 44[a] | 45[b] | 46[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Cellulose Acetate-Butyrate (½-sec.) | 100 | 100 | 100 |
| AROCLOR 1260 | — | — | 80 |
| Dioctyl Phthalate | 67 | 66.5 | 20 |
| Titanium Dioxide (non-chalking rutile) | 33 | — | — |
| Calcium Carbonate (precipitated) | 133 | — | — |
| SANTOWHITE† Powder Refined Antioxidant | 0.3 | 0.17 | 0.2 |
| Odor-masking Agent | 0.03 | — | — |

*a*) Pigmented fiberboard knife-coating for exterior exposure

*b*) Clear melt coating for heavy, one-coat film; economical (no solvent loss) and low application hazard

*c*) Clear, low-cost, flame-retardant melt coating

* Trademark of Rohm & Haas Co.

** Trademark of France, Campbell & Darling, Inc.

*** Trademark of Esso Standard Oil Co.

†SANTOWHITE: Monsanto Chemical Company Trademark. Registered in U.S. Patent Office.



DSW 321979

STLCOPCB4073629

Strippable spray coatings are increasingly useful in various industries. Cellulose acetate-butyrate provides an excellent base for coatings of this type. The following are two typical applications:

| Ingredients | 47[a] Parts by Weight | 48[b] Parts by Weight |
|---|---|---|
| Cellulose Acetate-Butyrate (½-sec.) | 100 | 100 |
| AROCLOR 1260 | 60 | — |
| AROCLOR 5460 | — | 27.8 |
| Tricresyl Phosphate | 50 | — |
| SANTICIZER 409 | — | 45 |
| Dioctyl Sodium Sulfosuccinate | 1.6 | 9 |
| Sodium Dichromate | — | 0.7 |
| Toluene | 132 | 312 |
| Ethanol | 63.5 | — |
| Isopropanol | — | 102 |
| Butyl Acetate | 26.5 | — |
| Acetone | 47.5 | — |
| Methyl Ethyl Ketone | 47.5 | 97 |

a) Flame-resistant, brushable coating

b) Temporary, easily strippable coating for shipping tools and machine parts containing corrosion inhibitors

The following formulation illustrates the use of cellulose acetate-butyrate base as a wood filler and prefinish:

| Ingredients | 49 Parts by Weight |
|---|---|
| Cellulose Acetate-Butyrate (½-sec.) | 100 |
| AROCLOR 5460 | 214 |
| Magnesium Silicate | 642 |
| Toluene | 85.7 |
| Butanol | 71.5 |
| Butyl Acetate | 314 |

To provide protective and decorative coatings for materials such as glass, rubber, and leather, various specialty coatings have been developed. The following formulations are characteristic cellulose acetate-butyrate lacquers:

| Ingredients | 50[a] Parts by Weight | 51[b] Parts by Weight |
|---|---|---|
| Cellulose Acetate-Butyrate (½-sec.) | 100 | 100 |
| FCD 555B (50% n.v.) | — | 21.8 |
| Plaskon* 3115 (60% n.v.) Urea-formaldehyde Resin | 74.5 | — |
| SANTICIZER 409 | 74.5 | 20.3 |
| Dow Corning 200 Silicone Fluid (1000 cs) | — | 0.07 |
| SANTOWHITE Powder Refined Antioxidant | 1.1 | — |
| Toluene | 417 | 216 |
| Xylene | 178 | 144 |
| Ethanol | 178 | 57 |
| Butanol | — | 57 |
| Butyl Acetate | 89 | 117 |

a) High-luster lacquer with excellent adhesion to GRS rubber

b) Clear glass lacquer with exceptional adhesion to all types of glass even after water immersion

* Trademark of Allied Chemical Corp.



DSW 321980

STLCOPCB4073630

## CELLULOSE ACETATE

The following properties of cellulose acetate make it adaptable for many specialized lacquers:

Toughness
Clarity
Durability
Stability to heat, light, weak acids, and oils
Good dielectric properties

These properties make it useful for metal, wood, paper, textile, leather, and plastics coatings. Plasticizers improve the flexibility, suppleness, and other physical properties of cellulose acetate films.

In Table IV are presented performance data for several Monsanto plasticizers in cellulose acetate molding compositions.

TABLE IV—PERFORMANCE OF MONSANTO PLASTICIZERS IN CELLULOSE ACETATE COMPOSITIONS

| Plasticizer (51.5 PHR unless otherwise specified) | Solution Temp. (°C) | Hardness at 70°C Rockwell "M" Scale | Flexural Strength (lb./sq. in.) | Water Absorbed in 48 hr. (%) |
|---|---|---|---|---|
| Dimethyl phthalate | 120 | .32 | 5840 | 1.14 |
| Diethyl phthalate | 140 | 15 | 5680 | 1.20 |
| SANTICIZER M-17 | 148 | 65 | 7110 | 0.77 |
| SANTICIZER E-15 | 148 | 50 | 6930 | 0.97 |
| SANTICIZER 8 | 133 | 75 | 6860 | 0.94 |
| SANTICIZER 9 | 153 | 90 | 9160 | 0.85 |
| Triphenyl phosphate (42.5 PHR) | 180 | 81 | 9020 | 1.17 |

Shown below are two example formulations of cellulose acetate lacquers:

| Ingredients | 52[a] Parts by Weight | 53[b] Parts by Weight |
|---|---|---|
| Cellulose Acetate[c] | 100 | 100 |
| Alkyd Resin | 40 | 30 |
| SANTICIZER M-17 | 50.7 | 37 |
| Zinc Oxide | 80 | -- |
| Phosphoric Acid (aids adhesion to metal) | 0.05 | 0.05 |
| Toluene | 312 | 372 |
| Ethanol | 176 | 206 |
| Butanol | 38.7 | 54.4 |
| Methyl Acetate | -- | 137.5 |
| Nitromethane | 244 | 287 |
| 1-Nitropropane | 176 | 206 |

a) White metal lacquer for interior use

b) General-purpose spray lacquer

c) 52.5-53.5% combined acetic acid, low viscosity



DSW 321981

STLCOPCB4073631

Paper and cloth coatings are important areas of application for cellulose acetate. Shown below are three suggested starting formulations:

| Ingredients | 54[a] | 55[b] | 56[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Cellulose Acetate | 100[d] | 100[d] | 100[e] |
| Triphenyl Phosphate | 18.5 | — | 60 |
| SANTICIZER M-17 | 16 | — | — |
| SANTICIZER E-15 | — | 67 | — |
| SANTICIZER 1-H | — | — | 50 |
| Water | — | 67 | — |
| Ethanol | 108 | 100 | 100 |
| Butanol | — | — | 40 |
| Methyl Acetate | — | — | 650 |
| Ethyl Acetate | — | 350 | — |
| Acetone | 660 | — | — |

a) Heat-resistant paper lacquer

b) Greaseproof food-packaging lacquer

c) Flame-retardant, stain-resistant cloth coating

d) 55-56-% combined acetic acid, low viscosity

e) 54-55-% combined acetic acid, high viscosity

Cellulose acetate lacquers impart the best adhesion, gloss, and durability on cellulose acetate plastics. The use of these lacquers minimizes plasticizer migration. Shown below are some characteristic formulations:

| Ingredients | 57[a] | 58[b] | 59[b] | 60[c] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| Cellulose Acetate | 100[d] | 100[d] | 100[d] | 100[e] |
| *Durez* 500 | — | — | 60 | — |
| SANTICIZER E-15 | 100 | 20.5 | — | — |
| SANTICIZER M-17 | — | — | 40 | — |
| SANTOLITE MHP | — | — | — | 82 |
| Water | — | — | — | 151 |
| Toluene[f] | 260 | 136 | 226 | — |
| Ethanol | 136 | 41 | 68 | 415 |
| Ethyl Acetate | — | — | — | 149 |
| Methyl *Cellosolve* | — | — | — | 102 |
| Methyl Cellosolve Acetate | 740 | 116 | 193 | — |
| Acetone | — | 273 | 453 | — |
| 1-Nitropropane | — | 116 | 193 | — |

a) Plasticizer-migration-resistant lacquer

b) Cellulose acetate plastics lacquer

c) Gel dipping lacquer

d) 55-56-% combined acetic acid, low viscosity

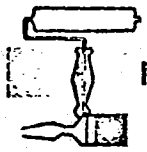
e) 52.3-53.5-% combined acetic acid, low viscosity

f) Add toluene slowly





STLCOPCB4073632



## MONSANTO PLASTICIZERS IN VINYL COATINGS

### POLY(VINYL ACETATE)

Surface coatings based on poly(vinyl acetate) fulfill a variety of requirements and are characterized by:

Ease of application

Fast drying

Good adherance

High gloss

Transparency

Resistance to water, fats, and oils

Poly(vinyl acetate)-based formulations are used extensively in the following applications:

Cloth coating

Paper coating and impregnation

Paint primers and sealers

Interior and exterior paints

Greaseproof, oil-resistant coatings

Wall-patching compounds

A wide selection of plasticizers for poly(vinyl acetate) and its co-polymers is available. Generally these plasticizers increase flexibility and tack, increase water and grease resistance, and lower heat-sealing temperature. Performance evaluations of several Monsanto plasticizers in poly(vinyl acetate)-emulsion adhesives are listed in Table V.



DSW 321983

STLCOPCB4073633

## TABLE V—PERFORMANCE OF MONSANTO PLASTICIZERS IN POLY(VINYL ACETATE)-EMULSION ADHESIVES

| Plasticizer[a] | Volatility (24 hours at 87° C; Activated Carbon) (%) | Low-Temp. Flexibility (Modified Clash & Berg Test) (°C) | Oil Extraction—Weight Loss After 24 Hours at Room Temperature (%) | | |
|---|---|---|---|---|---|
| | | | Kerosene | Peanut Oil | Cottonseed 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) 11 parts in 100 parts *Gelva** S-55 poly(vinyl acetate) emulsion. Films 0.040-inch thick.

* Gelva: Trademark of Shawinigan Resins Corp. Registered in U.S. Patent Office.

DSW 321984

STLCOPCB4073634

The following suggested starting formulations illustrate the toughness, durability, and grease resistance imparted to paper and cloth coatings by poly(vinyl acetate):

| Ingredients | 61[a] | 62[b] | 63[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Poly(vinyl acetate) emulsion | 100[d] | 100[e] | 100[e] |
| Elvanol* 7130 Poly(vinyl alcohol) (10% Aq. Sol'n.) | — | 30 | 30 |
| Methyl Ester of partially hydrogenated wood rosin | 8 | -- | -- |
| SANTICIZER 160 or Dibutyl Phthalate | 17 | -- | -- |
| SANTICIZER 141 | -- | 8.25 | 13.75 |
| Calcium carbonate (fine ground) | -- | 119.25 | 96.75 |
| Titanium Dioxide (Rutile) | -- | 13.25 | 10.75 |
| Tamol** 731 Dispersing Agent (25% Aq. Sol'n.) | -- | 2.10 | 1.80 |
| Water | 9.4 | 34 | 34 |
| Polypropylene Glycol (1200 molecular weight) | -- | 1 | 1 |
| **Properties** | | | |
| Total Solids, per cent | | 65 | 65 |
| Viscosity (26°C), cp | | 1600 | 2700 |
| Pigment : Binder Ratio | | 2 : 1 | 1.5 : 1 |
| PVAc Resin : PVA Resin Ratio | | 18 : 1 | 18 : 1 |
| PVAc Resin : Plasticizer Ratio | | 6.6 : 1 | 4 : 1 |

*a*) Artificial-leather coating for knife-coating of cloth or paper

*b*) Pigmented greaseproof coating for flat board

*c*) Greaseproof coating for flexible board

*d*) *Polyco*** 117H

*e*) *Gelva* S-55 or *Elvacet** 81-900

*Preparation of 61*

Blend plasticizer and wood-rosin methyl ester. Then add poly(vinyl acetate) emulsion.

*Preparation of 62 and 63*

1. Prepare a stock solution of poly(vinyl alcohol) by slurrying in water at room temperature with good agitation. Heat for 30 to 40 minutes at 185° to 190°F. Add water for solids control as required.
2. Continue stirring, add the plasticizer, polyethylene glycol defoamer, and *Tamol* 731 pigment disperser.
3. Add the pigments, stirring until dispersion is complete.
4. Add the poly(vinyl acetate) emulsion and stir until a homogeneous mixture is obtained.

* Trademarks of E. I. du Pont de Nemours & Co.
** Trademark of Rohm & Haas Co.
*** Trademark of The Borden Co.



DSW 321985

STLCOPCB4073635

A paint thinner and a quick-drying primer sealer for masonry and wallboard coatings are exemplified by the following suggested formulations:

| | 64[a] | 65[b] |
|---|---|---|
| *Part I* | Parts by Weight | |
| Gelva poly(vinyl acetate) Emulsion TS 22 | 100 | 100 |
| SANTICIZER 160 or dibutyl phthalate | 8 | 8.8 |
| *Part II* | | |
| Water | 58 | 40 |
| Carboxymethyl Cellulose (High-Viscosity Type 70) | 1.25 | 0.6 |
| Burtonite* X 90 guar-seed gum | 0.75 | — |
| *Part III* | | |
| Water | 260 | 80 |
| *Tamol* N dispersing agent | — | 0.3 |
| Tetrasodium pyrophosphate | — | 0.3 |
| Titanium Dioxide (Rutile) | — | 15 |
| Mica | — | 30 |
| Talc | — | 30 |

a) Paint thinner

b) Pigmented primer-sealer: quick drying, non-penetrating, and insoluble in mineral spirits

*Preparation*

1. Prepare Part I by adding the plasticizer at a moderate rate to the emulsion with stirring. Continue agitation for 20 to 30 minutes or until a smooth, uniform mixture is obtained.

2. To prepare Part II, stir the carboxymethyl cellulose into the water, continuing agitation until complete solution occurs. For the thinner, add the guar-seed gum and stir until a completely homogeneous mixture is obtained (about 10 minutes). Use of water at 70° C (160°F) accelerates solution of the thickeners. Stir the plasticized emulsion (Part I) into the thickener (Part II).

3. a) Add the remaining water to the thinner (formulation 64).

   b) For the sealer (formulation 65), dissolve the dispersing and deflocculating agents into the water. Stir in the pigments, and mix or grind the slurry. Add the sealer base (the mixture of Parts I and II) and thoroughly mix with the pigment slurry.

* Trademark of The Burtonite Company



DSW 321986

STLCOPCB4073636

Poly(vinyl acetate)-emulsion paints for interior and exterior surfaces are suggested in the following formulations:

| Ingredients | 66[a] | 67[b] |
|---|---|---|
| *Part I* | Parts by Weight | |
| Water | 41.0 | 19.8 |
| *Burtonite* X-90 guar-seed gum | 0.8 | 0.68 |
| *Part II* | | |
| *Gelva* Poly(vinyl acetate) emulsion TS 22 | 100 | 100 |
| SANTICIZER 160 or Dibutyl Phthalate | 13.2 | 8.2 |
| *Part III* | | |
| Water | 110 | 67 |
| *Tamol* 731 (1% soln.) Dispersing Agent | 6.5 | 1.2 |
| Carboxymethyl Cellulose (Low-Viscosity Type 70) | 1.2 | 0.9 |
| Chromium Oxide, opaque | 6.5 | — |
| Titanium Dioxide (rutile, 30%; calcium sulfate, 70%) | 66 | 33.4 |
| Titanium Dioxide (rutile) | 33 | 29.6 |
| Mica | 14.6 | — |

a) Light-green, interior, emulsion paint

b) White, exterior, emulsion paint

*Preparation*

*Part I*

Add the guar-seed gum to the water with high-shear mixing until a homogeneous solution is obtained (about 10 minutes).

*Part II*

While stirring the poly(vinyl acetate) emulsion with a high-shear mixer, slowly add the plasticizer. Stir for 20 to 30 minutes after the plasticizer is added or until the mixture becomes uniform. Add the plasticized poly(vinyl acetate) emulsion (part II) to the guar-seed-gum solution (part I), and stir for 10 minutes or until homogeneous.

*Part III*

With the colloid mill operating, sift the carboxymethyl cellulose into the water and dispersing-agent solution in an aluminum or stainless-steel vessel. Mix until dissolved. Slowly sift in pigments in the order listed. Grind to desired fineness. Add paint base and stir for 10 minutes. Filter through an 80-mesh screen.



DSW 321987

STLCOPCB4073637

The following suggested formulation is for a poly(vinyl acetate)-based latex wall-patching compound:

| Ingredients | 68<br>Parts by Weight |
|---|---|
| Poly(vinyl acetate) emulsion | 100 |
| Hydroxyethyl Cellulose (75% n.v.) | 50 |
| Tricresyl Phosphate | 5 |
| *Metro-Nite* #6 | 772 |
| Water | 63 |
| Ethylene Glycol | 35 |

*Preparation*

Mix the poly(vinyl acetate) emulsion and the hydroxyethyl cellulose solution in a pony mixer until completely dispersed. Stir in the water and ethylene glycol. Mix for 5 minutes, and add the *Metro-Nite* in 5 equal portions, allowing each portion to wet down thoroughly before adding the next portion. Add the tricresyl phosphate and continue to mix for 30 minutes.

*Properties*

| | |
|---|---|
| Consistency | Pasty - spreadable and workable |
| Nonvolatiles, per cent | 81 |
| Pigment : Binder Ratio, weight | 12.2 : 1 |
| Density, lb./gal. | 16.6 |

Vinyl acetate is often copolymerized, as for example, with vinyl pyrrolidone. The following common Monsanto plasticizers are compatible with vinyl acetate-vinyl pyrrolidone (70/30 to 30/70) copolymers:

Dimethyl Phthalate
Dibutyl Phthalate
SANTICIZER B-16
SANTICIZER E-15
SANTICIZER 141
SANTICIZER 213
SANTOLITE MHP

Dimethyl Phthalate and SANTICIZER E-15 are particularly effective in imparting flexibility to this copolymer. The following starting formulation gives an anti-tarnish coating that dries to a clear, smooth film without "orange peel" and that can be simply washed off with a synthetic-detergent solution:

| Ingredients | 69<br>Parts by Weight |
|---|---|
| Vinyl Acetate/Vinyl Pyrrolidone Copolymer (70/30) | 100 |
| SANTICIZER B-16 | 5 |
| Isopropanol | 145 |
| Propellant 11* | 375 |
| Propellant 12* | 375 |

* For non-aerosol applications substitute methanol for propellant.





STLCOPCB4073638

## POLY(VINYL CHLORIDE)

Poly(vinyl chloride) and its copolymers are widely used in protective coatings. In general, coatings based on poly(vinyl chloride) display the following characteristics:

Hardness
Flexibility
Abrasion resistance
Chemical and water resistance
Greaseproofness
Electrical resistance
Nontoxicity
Odorlessness
Tastelessness
Flame retardance

Poly(vinyl chloride) coatings may be applied in any of the following forms:

*Solution.* Solvent must be volatilized to develop strength.

*Latex* (emulsion). Water must be volatilized. Short bake helps develop optimum properties.

*Plastisol.* No volatile solvent. Curing temperature: 300°-350°F.

*Organosol.* Some volatile solvent to control sprayability or coatability. Curing temperature: 300°-350°F.

*Powder* (fluidized bed). Product to be coated is heated to high temperature and suspended in fludized poly(vinyl chloride) powder.

Since the applications for poly(vinyl chloride) are so broad, only solution and latex coatings are described in this bulletin. Other Monsanto literature discusses plastisols and organosols in detail.

Monanto offers more than 70 plasticizers to enable the poly(vinyl chloride) formulator to develop the balance of characteristics required to meet his requirements successfully. The performance of some of the plasticizers in poly(vinyl chloride) is indicated in Table VI.



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## TABLE VI—PERFORMANCE OF MONSANTO PLASTICIZERS IN POLY(VINYL CHLORIDE)

| Plasticizer (67 PHR) | Volatility (% lost) | Low-Temp. Flexibility ($T_f$, °C) | Water Immersion: Soluble Matter (%) | Water Immersion: Water Absorbed (%) | Kerosene Extraction (% lost) | Hardness Shore "A" | Migration Linde Silica Days: 1 (%) | 3 (%) | 7 (%) |
|---|---|---|---|---|---|---|---|---|---|
| Diisodecyl phthalate | 2.2 | —35 | 0.02 | 0.24 | > 70 | 78 | 1.51 | 2.93 | 4.76 |
| Diisooctyl phthalate | 4.3 | —37 | 0.03 | 0.25 | 42 | 74 | 1.17 | 2.11 | 4.73 |
| Di-2-ethylhexyl phthalate | 4.5 | —39 | 0.03 | 0.25 | 46 | 66 | 1.08 | 2.13 | 3.98 |
| SANTICIZER 160 | 11.3 | —24 | 0.05 | 0.30 | 5.2 | 66 | 1.27 | 2.56 | 4.15 |
| SANTICIZER 165 | 10.3 | —41 | 0.04 | 0.28 | 27 | 72 | 0.93 | 3.56 | 5.23 |
| SANTICIZER 213 | 18.1 | —21 | 0.56 | 0.80 | 6.3 | 77 | 1.2 | 2.7 | 4.8 |
| SANTICIZER 214 | 10.0 | —36 | 0.22 | 1.8 | > 70 | 75 | 1.06 | 3.27 | 5.84 |
| SANTICIZER 602 | 3.5 | —36 | 0.03 | 0.25 | 63 | 73 | 1.05 | 2.58 | 4.22 |
| SANTICIZER 603 | 12.8 | —36 | 0.05 | 0.27 | 45 | 77 | 0.96 | 3.14 | 5.82 |
| SANTICIZER 630 | 18.8 | —33 | 0.10 | 0.33 | 35 | 76 | 0.89 | 2.32 | 4.22 |
| SANTICIZER 631 | 16.2 | —35 | 0.09 | 0.31 | 40 | 74 | 0.97 | 2.57 | 4.60 |
| Tricresyl phosphate | 1.0 | —10 | 0.03 | 0.26 | 2.4 | 79 | 0.4 | 0.8 | 1.6 |
| SANTICIZER 140 | 3.6 | —15 | 0.04 | 0.30 | 2.1 | 76 | 0.63 | 1.63 | 2.70 |
| SANTICIZER 141 | 7.4 | —39 | 0.06 | 0.36 | 7.3 | 64 | 1.55 | 4.6 | 9.0 |
| Di-2-ethylhexyl adipate | 13.9 | —66 | 0.10 | 0.66 | > 70 | 65 | 7.5 | 13.5 | 21.0 |
| Diisodecyl adipate | 3.4 | —65 | 0.07 | 0.36 | > 70 | 74 | 9.0 | 17.7 | 27.4 |
| Di-(*n*-octyl, *n*-decyl) adipate | 8.1 | —63 | 0.08 | 0.53 | > 70 | 68 | 7.8 | 22.8 | 35.9 |
| SANTICIZER 409 (50 PHR) | 0.8 | —8.7 | ---- | ---- | 1.2 | 92 | 0.25 | 0.49 | 0.69 |

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## Solution Coatings

Because of their excellent permanence and performance characteristics, poly(vinyl chloride) resins are ideally suited for metal coatings. Like other coatings, however, they require a suitable primer for satisfactory adhesion. The following formulations exemplify the versatility of Monsanto plasticizers in the manufacture of poly(vinyl chloride) solution prime coatings:

| Ingredients | 70[a] | 71[a] | 72[b] | 73[c] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| Vinylite* VMCH[d] | 62.5 | — | — | — |
| Vinylite VYHH[d] | 37.5 | 100 | — | 100 |
| Exon ** 470[d] | — | — | 100 | — |
| Esterified Copal Resin | — | 16 | — | — |
| Tricresyl Phosphate | — | — | 4 | — |
| SANTICIZER 409 | — | — | 12 | — |
| Dioctyl Phthalate | 18 | 25 | — | 26 |
| Red lead pigment | — | — | 140 | — |
| Blue lead pigment | — | — | — | 241 |
| Zinc Oxide (colloidal) | — | 314 | — | — |
| Titanium Dioxide | 75 | — | — | — |
| Propylene Oxide | — | — | 4 | — |
| Toluene | 216 | 170 | 188 | 162 |
| Xylene | — | — | — | 40 |
| Methyl Isobutyl Ketone | 216 | 170 | 100 | 162 |
| Ethyl Amyl Ketone | — | — | 8 | — |
| Cyclohexanone | — | — | — | 40 |

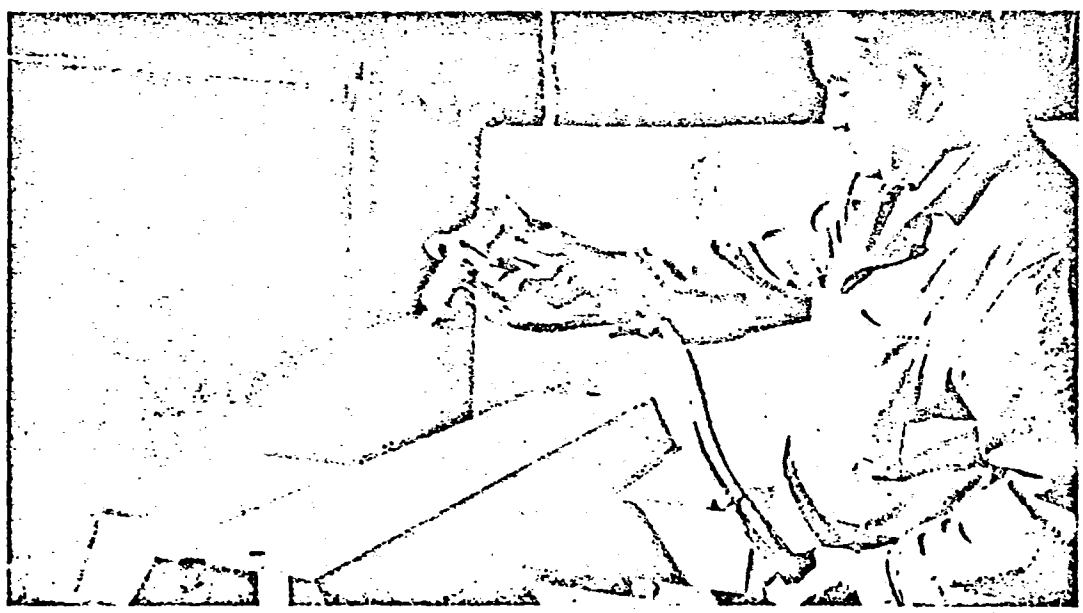
*a*) Air-dry or low-bake primer (200° - 300°F for a short time)

*b*) General-purpose primer

*c*) High-temperature-bake primer (350° - 375°F)

*d*) Vinyl chloride copolymer (metal-adhesion type)

* Trademark of Union Carbide Corp.
** Trademark of Firestone Plastics Co.



Vinyl solution primers and finish coatings impart attractive, durable protection to numerous metal products.



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A variety of solution formulations may be used in intermediate and final coats as illustrated below:

| Ingredients | 74[a] | 75[b] | 76[b] | 77[b] | 78[c] | 79[d] | 80[e] |
|---|---|---|---|---|---|---|---|
| | Parts by Weight | | | | | | |
| Exon 450[f] | -- | -- | -- | -- | -- | 100 | -- |
| Vinylite VAGH[f] | 100 | -- | -- | 50 | 67.1 | -- | -- |
| Vinylite VYHH[f] | -- | 100 | 100 | -- | -- | -- | 100 |
| Vinylite VMCH[f] | -- | -- | -- | 50 | -- | -- | -- |
| Urea-Formaldehyde resin | -- | -- | -- | -- | 18.7 | -- | -- |
| Rosin WW | -- | -- | -- | -- | -- | -- | 100 |
| Liquid epoxy resin | -- | -- | -- | -- | 14.2 | -- | -- |
| Tricresyl Phosphate | 10 | -- | -- | -- | -- | 13.4 | 38 |
| SANTICIZER 141 | -- | 19 | -- | -- | -- | -- | -- |
| Dioctyl Phthalate | -- | -- | 18 | 10 | 7.5 | -- | -- |
| Diisodecyl Phthalate | -- | 9 | -- | -- | -- | -- | -- |
| SANTICIZER 409 | -- | -- | -- | -- | -- | 6.7 | -- |
| Blown Castor Oil | -- | 1.25 | -- | -- | -- | -- | -- |
| Titanium Dioxide | -- | 42 | 67 | -- | 57 | 100 | -- |
| Zinc Oxide | -- | 36 | -- | -- | -- | -- | -- |
| Cuprous Oxide | -- | -- | -- | -- | -- | -- | 1000 |
| Aluminum pigment | 45 | -- | -- | 45 | -- | -- | -- |
| Antimony Oxide | -- | 17.5 | -- | -- | -- | -- | -- |
| Propylene Oxide | -- | -- | -- | -- | -- | 6.7 | -- |
| Stabilizer | -- | -- | -- | -- | -- | 13 | -- |
| Toluene | 204 | 160 | 193 | 255 | -- | 127 | -- |
| Xylene | -- | 40 | 48 | -- | 140 | -- | 220 |
| Methyl Isobutyl Ketone | 204 | 160 | 193 | 255 | 84 | 435 | 350 |
| Cyclohexanone | -- | 40 | 48 | -- | 56 | -- | -- |

a) Intermediate coating

b) General-purpose industrial coating

c) Metal finish

d) Corrosion-resistant coating

e) Anti-fouling coating (MIL P-15931)

f) Vinyl chloride-vinyl acetate copolymer

When extreme corrosion resistance is required, the use of AROCLOR plasticizers is suggested: for imparting resistivity to chemical attack, they are unsurpassed. Independent evaluations of the chemical resistance of vinyl chloride-vinyl acetate copolymer paint, modified by eight types of materials (alkyd resin, phenolic-chinawood oil varnish, ester gum-linseed oil varnish, AROCLOR 1254, dioctyl phthalate, tricresyl phosphate, polymeric plasticizer, and acrylic polymer), showed that AROCLOR 1254 has the "best all-around chemical resistance, failing badly only in the gasoline test."

Paints were sprayed onto solvent-cleaned, unprimed, cold-rolled-steel panels, which were then immersed in seven types of solutions until failure. The data in Table VII, excerpted from the November 1955 issue of *Official Digest* of the Federation of Paint and Varnish Production Clubs, compare the chemical resistance imparted by AROCLOR 1254 and by dioctyl phthalate.



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## TABLE VII—COMPARATIVE CHEMICAL RESISTANCE OF PLASTICIZERS IN VINYL CHLORIDE-VINYL ACETATE COPOLYMER PAINT

| Plasticizer | | Time to Failure in Corrosive Media | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dioctyl Phthalate (%) | AROCLOR 1254 (%) | 10% Sodium Hydroxide (days) | 10% Hydrochloric Acid (hours) | Gasoline (days) | 5% Sodium Hypochlorite (days) | 10% Acetic Acid (hours) | Linseed Oil Fatty Acids (days) | 1% Tide at 160°F (days) |
| 10 | — | 120[a] | 92 | 0.4 | 4 | 84 | 60 | 21 |
| — | 10 | 120[a] | 168[a] | 5 | 13 | 168[a] | 90[a] | 22 |
| 25 | — | 60 | 24 | 0.4 | 4 | 84 | 27 | 25 |
| — | 25 | 120[a] | 120 | 0.4 | 14.5 | 120 | 90[a] | 22 |
| 40 | — | 60 | 24 | 0.4 | 4 | 48 | 22 | 25 |
| — | 50 | 120[a] | 96 | 0.4 | 11 | 100 | 60 | 22 |

a) End of test

In other corrosion-resistance tests of poly(vinyl chloride) plastisols, containing 70 parts plasticizer per 100 parts resin, a formulation that contained 1 part AROCLOR 1254 to 3 parts dioctyl phthalate was much more resistant to 15 per cent nitric acid at either 23° or 50°C for six months than a compound plasticized with dioctyl phthalate alone.

The plastisol modified with both AROCLOR 1254 and dioctyl phthalate was also more resistant to 25 per cent chromic oxide at 50°C for four weeks and was equivalent at 23°C for six months in comparison with the dioctyl phthalate-modified vinyl plastisol.

Coatings are frequently based on combinations of vinyl chloride-vinyl acetate copolymer and nitrocellulose resins, as exemplified by the following suggested starting formulations:

| Ingredients | 81[a] | 82[b] | 83[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Blacar H-4055 | 50.2 | 40 | 50 |
| R.S. Nitrocellulose (½ sec.) | 49.8 | 60 | 50 |
| Tricresyl Phosphate | 39.2 | — | — |
| Dioctyl Phthalate | — | 22 | 35 |
| Epoxy resin | — | 3 | — |
| Titanium Dioxide (non-chalking rutile) | 38.8 | — | 50 |
| Carbon black | 3.3 | — | — |
| Toluene | 357 | 200 | 175 |
| Xylene | 32.4 | 100 | 100 |
| n-Butanol | 25.9 | — | — |
| Ethyl acetate | 58.3 | — | — |
| Butyl acetate | 142.5 | 124 | 125 |
| Cellosolve Acetate | — | — | 50 |
| Methyl Isobutyl Ketone | — | 25 | 50 |
| Methyl Amyl Ketone | 32.4 | 50 | — |

a) Gray automobile lacquer

b) Clear indoor lacquer

c) White indoor lacquer; apply over suitable primer and bake ½ hour at 150°F



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The following formulation illustrates a nontoxic paperboard coating for food packaging:

| Ingredients | 84<br>Parts by Weight |
|---|---|
| *Vinylite* VYHH | 80 |
| *Vinylite* VMCH | 10 |
| *Vinylite* VAGH | 10 |
| SANTICIZER 141 | 25 |
| Acetone | 300 |
| Methyl Isobutyl Ketone | 175 |

Strippable lacquers have become increasingly important as protective coatings for a variety of materials. Shown below are two formulations (85 and 86) that illustrate this type of coating and one (87) that exemplifies a sprayable coating with good webbing characteristics:

| Ingredients | 85[a] | 86[b]<br>Parts by Weight | 87[c] |
|---|---|---|---|
| *Exon* 468 vinyl chloride-vinyl acetate copolymer | 27 | — | — |
| *Exon* 470 vinyl chloride copolymer (metal-adhesion type) | 3 | — | — |
| *Exon* 481 vinyl chloride-vinyl acetate copoylmer | 70 | — | — |
| *Vinylite* VYHH vinyl chloride-vinyl acetate copolymer | — | 100 | 100 |
| SANTICIZER 160 | — | 11 | 80 |
| SANTICIZER 409 | 31 | — | — |
| Dioctyl Phthalate | 16 | — | — |
| Dioctyl Adipate | 14.7 | — | — |
| AROCLOR 1254 | — | — | 32 |
| Prime pigments | 27 | — | — |
| Titanium Dioxide | — | 5.5 | — |
| Stabilizer | 12 | — | — |
| Propylene Oxide | 6 | — | — |
| Socony White Oil #318 | — | 6.7 | — |
| Toluene | 70 | — | 118 |
| Xylene | — | 24 | — |
| Methyl Ethyl Ketone | 312 | 254 | 294 |

*a*) Sprayable waterproof coating

*b*) Lacquer with good spray qualities and quick-drying, hard, and opaque film

*c*) Sprayable web coating



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## Latex (Emulsion) Coatings

Whenever the characteristics of poly(vinyl chloride) and its copolymers are desired, but the hazard of flammable solvents cannot be tolerated, the use of a poly(vinyl chloride) latex (emulsion) is indicated. Shown below are three suggested starting formulas:

| Ingredients | 88[a] | 89[b] | 90[c] |
|---|---|---|---|
| | Parts by Weight | | |
| *Geon** 251 | — | — | 100[d] |
| *Geon* 352 | 100[d] | — | — |
| *Geon* 576 | — | 100[d] | — |
| Dioctyl Phthalate (65% emulsion)[e] | 20 | — | — |
| Dioctyl Adipate (65% emulsion)[e] | 15 | 10 | — |
| SANTICIZER 141 (65% emulsion)[e] | — | — | 25 |
| SANTICIZER 409 (65% emulsion)[e] | 15 | — | — |
| AROCLOR 1254 (45% emulsion) | — | — | 7 |
| *Goodrite** K-710 thickener (5% solution) | 1 | — | — |
| *Mobilcer*** R microcrystalline wax (45% emulsion) | — | 3 | — |
| *Keltex**** thickening agent (2% solution) | — | 1 | — |
| Titanium Dioxide (50% dispersion) | 30 | — | — |
| Calcium Carbonate (50% dispersion) | 15 | — | 250 |
| Antimony Oxide (50% dispersion) | — | — | 45 |
| Color Pigment (50% dispersion) | — | — | 15 |
| Iron Oxide (50% dispersion) | — | 20 | — |
| Dibasic Lead Phosphite (50% dispersion) | — | — | 5 |

a) Thin fabric coatings. Excellent for bridge coats on loosely woven fabrics before subsequent spread coating with an organosol or plastisol

b) Jute-felt floor covering or automobile-trunk liner

c) Flameproof coating: complete immersion then squeeze rolls (patented)

d) Solids

e) *Typical Plasticizer Emulsion:*

| Ingredients | Parts by Weight |
|---|---|
| Plasticizer | 65 |
| Water | 33.4 |
| Oleic Acid | 1.25 |
| Ammonium Hydroxide (28%) | 0.35 |

* Trademarks of B. F. Goodrich Chemical Co. for poly(vinyl chloride) resins

** Trademark of Socony Mobil Oil Co.

*** Trademark of Kelco Co.



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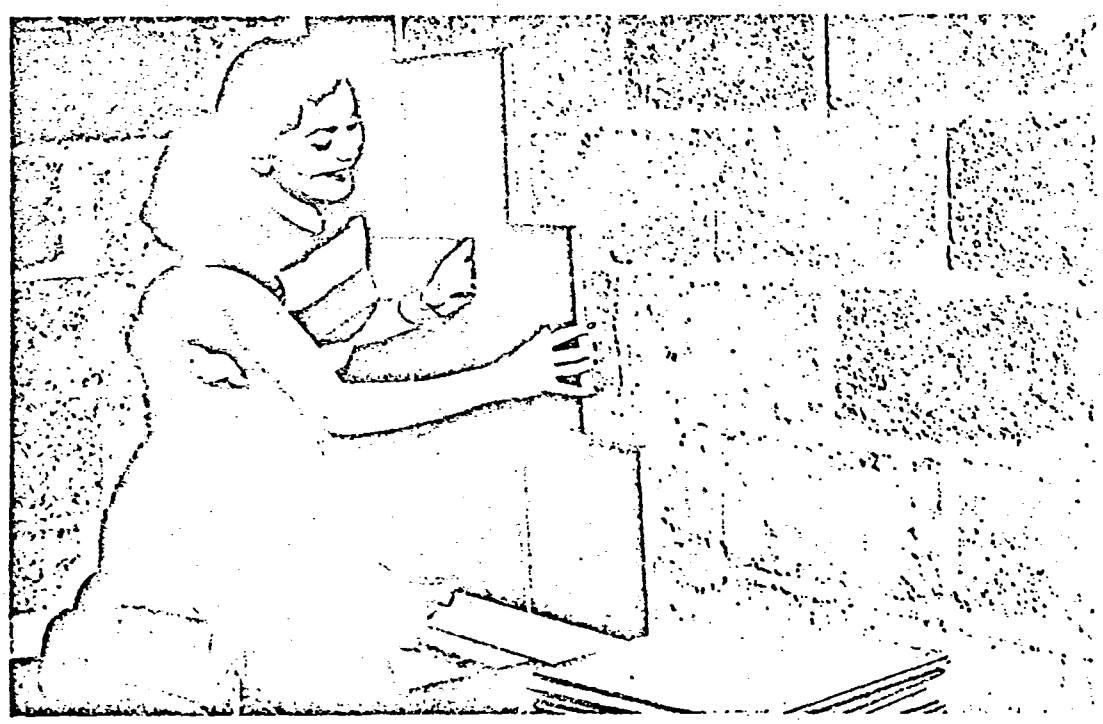
The use of vinyl chloride-vinylidene chloride copolymer latexes in fire-retardant, intumescent coatings for wallboard and acoustic tile is shown below. The use of the solid plasticizer, diphenyl phthalate, improves the viscosity stability of formulation 91.

| Ingredients | 91 | 92 |
|---|---|---|
| | Parts by Weight | |
| *Part I* | | |
| Monoammonium Phosphate | 56 | 56 |
| Dicyandiamide | 10 | 10 |
| Pentaerythritol | 22 | 22 |
| Titanium Dioxide (Rutile) | 12 | 12 |
| Diphenyl Phthalate | 5 | — |
| Anionic Wetting Agent, Acid Stable | 1.25 | — |
| Water | 47-34 | 46-61 |
| *Part II* | | |
| Dow Latex 744-B (vinyl chloride-vinylidene chloride copolymer) | 40 | 42.8 |
| SANTICIZER 141 or Dioctyl Phthalate | — | 10 |
| Suspension Agent, Acid Stable | — | 0.6 |
| Anionic Emulsifier, Acid Stable | — | 1.2 |

*Preparation*

1. Mix the intumescent agents, pigment (and plasticizer and wetting agent for formulation 91), and water. Disperse with two passes through a high-speed stone mill.

2. Add the latex (plasticized for formulation 92) with medium stirring.

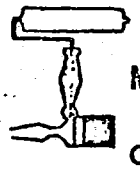


The applications of vinyl latex coatings are increased by the addition of intumescent and fire-retardant agents.





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## MONSANTO PLASTICIZERS IN RUBBER COATINGS

### CHLORINATED RUBBER

Chlorinated-rubber-based coatings are widely used because of their resistance to corrosive agents, moisture, fungus, mold, and other destructive agents. Consequently they are used in such applications as the following, which require extreme resistance to the above deteriorating agents:

Masonry
Flame-retardant finishes
Chemical plants
Railroad equipment
Marine equipment
Swimming pools
Food-processing buildings
Highway paints

Monsanto manufactures many plasticizers that are useful with chlorinated rubber. Particularly beneficial are the AROCLOR compounds, which enhance the chemical resistance of the chlorinated-rubber-based finishes. Table VIII indicates the utility of various Monsanto plasticizers in chlorinated rubber:

TABLE VIII—EVALUATION OF MONSANTO PLASTICIZERS IN CHLORINATED RUBBER

| Plasticizer | Good adhesion to | | | | | | Resistance to | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aluminum | Steel | Copper | Transite | Sealed Wood | Cellophane | 10% Hydrochloric Acid | 5% Sodium Hydroxide | Sodium Chloride | Water | Sword Hardness | Cold-Check Resistance (cycles) |
| AROCLOR 1254 | — | — | — | X | — | X | X | X | X | X | 35 | 3 |
| AROCLOR 1260 | — | — | — | X | — | X | X | X | X | X | 40 | 4 |
| AROCLOR 5460 | X | X | — | X | — | — | X | X | X | X | 22 | 2 |
| Dibutyl Phthalate | X | — | X | — | — | — | X | — | X | X | 53 | 5 |
| SANTICIZER B-16 | — | — | X | — | X | — | X | — | X | X | 45 | 7 |
| Tricresyl Phosphate | X | — | X | X | X | — | X | — | X | X | 56 | 5 |
| Triphenyl Phosphate | — | — | X | — | X | — | X | — | — | — | 60 | 4 |
| SANTOLITE MHP | — | — | — | — | — | — | — | — | — | — | 28 | 2 |

X—indicates good adhesion or resistance

Although chlorinated rubber is unaffected by acids, alkalies, salts, moisture, and fungus, it is very hard and brittle. Consequently plasticizers and plasticizing resins must be added to make useful coatings. To make chemical- and corrosion-resistant coatings, the modifiers must likewise be nonreactive with acids, alkalies, and salts. As little as five per cent of a saponifiable material, such as linseed oil, alkyd resin, or ester plasticizer, seriously detracts from the alkali resistance of the finished coating. Monsanto AROCLOR compounds, such as AROCLOR 5460 and AROCLOR 1254 or 1260, are the best available plasticizing resin and plasticizers, respectively, since they are unaffected by acids, alkalies, or salts. The following formulations illustrate the use of AROCLOR compounds in combination with chlorinated rubber to make chemically resistant maintenance coatings:



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| Ingredients | Primers | | Top Coats | | | |
|---|---|---|---|---|---|---|
| | 93[a] | 94[b] | 95 | 96 | 97[c] | 98[d] |
| | Parts by Weight | | | | | |
| *Parlon** (20-cp) chlorinated rubber | 100 | 100 | 100 | 100 | 100 | 100 |
| Long-oil drying alkyd | -- | -- | -- | -- | -- | 44.5 |
| AROCLOR 1254 | 44 | 43 | 54.5 | 43.5 | 55.5 | 55.5 |
| AROCLOR 5460 | 27 | 27 | 27 | 27 | 33 | -- |
| Dioctyl Sebacate | -- | -- | -- | 11 | -- | -- |
| Titanium Dioxide | -- | -- | 116 | 116 | 89 | 89 |
| Zinc Oxide | -- | -- | -- | -- | 11 | 11 |
| Zinc Dust | -- | 1015 | -- | -- | -- | -- |
| Silica Flour | -- | -- | -- | -- | -- | 16.5 |
| Carbon Black | -- | -- | 1.2 | 1.2 | 3 | 1 |
| Red Lead (97%) | 555 | -- | -- | -- | -- | -- |
| Eipchlorohydrin | 0.6 | 0.45 | 0.5 | 0.5 | -- | -- |
| Dibasic Lead Phosphite | 4 | 4 | 4 | 4 | -- | -- |
| *Bentone*** 34 gelling agent | 12 | 12 | 12 | 12 | 12 | 12 |
| Xylene | -- | -- | -- | -- | -- | 239 |
| *Solvesso* 140 | 104 | 75 | 79 | 79 | -- | -- |
| *Solvesso* 150 | -- | -- | -- | -- | 237 | -- |
| Turpentine | 33 | 25 | 21 | 21 | 26 | -- |
| *Amsco***D* | 280 | 200 | 200 | 200 | -- | -- |

a) Good adhesion to steel; resists salt-fog test or water immersion at 100°F

b) Outstanding resistance to salt-fog test or water immersion at 100°F

c) Meets alkali-resistance requirements of Federal Specification TT-P-91

d) For basement floors

The high-alkali content of fresh concrete or masonry requires the use of saponification-resistant modifying resins and plasticizers in chlorinated-rubber coatings. In highway paints, the need for corrosive-resistant plasticizers is further intensified by the spreading of salt and other chemicals during winter. The abrasive action of sand, cinders, etc. on highway markings requires the use of nonoxidizing materials that do not harden and cause embrittlement and loss of abrasion resistance of the paint. The alkali- and chemical-resistant and nonoxidizing AROCLOR compounds meet the stringent requirements for highway-paint plasticizers.

Swimming-pool paints modified only with AROCLOR plasticizers are much more resistant to blistering than chlorinated-rubber paints modified with alkyd resins. *High* pigment-volume concentration is recommended for *concrete* swimming pools to let the moisture in the concrete above the water line escape without buildup of blister-causing hydrostatic pressure. *Low* pigment-volume concentration is suggested for *steel* swimming pools, however, to help form a water-impervious film to reduce blistering. The following suggested swimming-pool-paint formulations have given excellent performance:

* Trademark of Hercules Powder Company
** Trademark of National Lead Company
*** Trademark of American Mineral Spirits Company





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| Ingredients | For Concrete 99 | For Concrete 100[a] | For Steel 101[b] |
|---|---|---|---|
| | Parts by Weight | | |
| *Lacquer Phase* | | | |
| *Parlon* (20-cp) chlorinated rubber | 100 | 100 | 100 |
| *Duraplex** C-49 (100%)[c] | 50 | 50 | 50 |
| AROCLOR 1254 | 50 | 50 | 50 |
| Titanium Dioxide (Rutile) | 112 | 112 | 50.5 |
| Magnesium Silicate | 115 | 116 | 50.7 |
| Phthalocyanine Green | 2.9 | 3 | 1.3 |
| *Bentone* 34 gelling agent | 13 | 12 | 5 |
| *Tween*** 60 surfactant | — | 8.5 | — |
| Epichlorohydrin | 1 | — | 0.6 |
| Xylene | 450 | 210 | 285 |
| *Solvesso* 100 | 90 | 50.7 | 28 |
| *Water Phase* | | | |
| Methyl Cellulose (4000 cp) | — | 7.6 | — |
| Sodium Oleate | — | 15.7 | — |
| Distilled Water | — | 520[d] | — |
| **Properties** | | | |
| Solids, wt. per cent | 45.1 | 64.1 | 50.0 |
| Pigment volume-concentration, % | 35 | 35[d] | 20 |
| Viscosity, Krebs units | 74 | — | 75 |
| Viscosity, Brookfield, cp. | | | |
| No. 4 spindle, 30 rpm | — | 6,000 | — |
| No. 4 spindle, 12 rpm | — | 12,000 | — |

*a)* Emulsion, prepared by slow addition of water phase to lacquer phase with mixing until smooth emulsion is formed

*b)* Meets gloss requirements of Federal Specification TT-P-95

*c)* Compatabilized by the presence of AROCLOR 1254

*d)* In lacquer phase

The use of AROCLOR plasticizers in chlorinated-rubber coatings for railroad equipment helps improve the necessary resistance to high humidity, extreme weathering, and various chemicals and fumes. The following suggested formulations for a primer-and-topcoat system provide maximum chemical resistance, especially for use on tank, hopper, and cattle cars and on right-of-way equipment in industrialized or coastal areas:

| Ingredients | 102 Primer | 103 Topcoat |
|---|---|---|
| | Parts by Weight | |
| *Parlon* (20-cp.) chlorinated rubber | — | 100 |
| *Aroplaz* *** 1365 | 62 | — |
| *Bakelite* **** CKU-5962 phenolic resin dispersion | 38 | — |
| Maleic Acid | 2 | — |
| AROCLOR 1254 | — | 49 |
| AROCLOR 5460 | — | 26 |
| Titanium Dioxide | — | 157 |
| Lampblack | — | 0.9 |
| Zinc Chromate | 105 | — |
| Magnesium Silicate | 19 | — |
| Aluminum Sterate (10% gel in xylene) | 1.5 | — |
| Cobalt Naphthenate (6% cobalt) | — | 0.08 |
| Epichlorohydrin | — | 0.5 |
| Epoxy Stabilizer | — | 2 |
| Antiskinning Agent | 2 | — |
| Xylene | 270 | 290 |
| Hi-Flash Naphtha | — | 158 |
| Turpentine | — | 79 |

* Trademark of Rohm & Haas Co.

** Trademark of Atlas Powder Co.

*** Trademark of Archer-Daniels-Midland Co.

**** Trademark of Union Carbide Corp.



DSW 321999

STLCOPCB4073649

Chlorinated rubber makes effective wood coatings for long service life, as illustrated by the following formulations:

| Ingredients | 104[a] | 105[b] | 106[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Parlon chlorinated rubber | 77 (20 cp) | 100 (20 cp) | 100 (10 cp) |
| Long-oil drying-alkyd | 23 | -- | -- |
| *Duraplex* C-55 | -- | 50 | -- |
| Linseed oil | -- | -- | 115 |
| AROCLOR 1254 | 23 | 50 | 14 |
| AROCLOR 5460 | -- | -- | 57 |
| Titanium Dioxide | 96.5 | -- | -- |
| Xylene | 89.5 | 40 | -- |
| Hi-Flash Naphtha | 77 | -- | -- |
| *Solvesso* 100 | -- | 320 | 286 |
| Turpentine | -- | 40 | -- |
| Mineral Spirits | -- | -- | 286 |

a) Marine finish with good resistance to salt water and to algae and other marine growth

b) Extremely abrasion resistant

c) Rapid-drying finish. Partial replacement of linseed oil with AROCLOR 5460 speeds the dry time and improves the alkali and chemical resistance. The AROCLOR plasticizes the oxidized linseed oil to prevent brittleness.

A three-coat, high-build, maintenance-paint system has been developed, based on an all-chlorinated vehicle: chlorinated rubber and AROCLOR plasticizers. Conventional brush or spray coats are usually only about 1 mil thick, so at least five coats are needed to attain the minimum 5-mil thickness recommended for maximum chemical resistance. The required thickness is easily built up with the chlorinated coatings by either brushing or spraying: primer, 2 mils; mid coat, 3 mils; and top coat, 1 mil.

This new system has been compared with all classes of commercial maintenance coatings in both laboratory and exposure tests. Coated panels were subjected to spot tests and immersion tests in salt fog and hot water with various chemical reagents. Color slides of the test panels are available for examination from Hercules Powder Company, Wilmington, Delaware.

| Ingredients | Primer | Mid Coat | Top Coat |
|---|---|---|---|
| | | Parts by Weight | |
| Parlon Chlorinated Rubber | 100 (20 cp.) | 100 (20 cp.) | 100 (10 cp.) |
| AROCLOR 1254 | 55 | 49.5 | 40 |
| AROCLOR 5460 | 26.5 | 24.8 | 24 |
| Dioctyl Sebacate | -- | -- | 10 |
| Red Lead (97% grade) | 182 | -- | -- |
| Zinc Yellow | 30 | -- | -- |
| Mica | 30 | 32 | -- |
| Indian Red * | 5 | -- | -- |
| Talc | 68.5 | -- | -- |
| *Bentone* 38 gelling agent | 13 | 3.3 | -- |
| Magnesium Silicate | -- | 77 | -- |
| Titanium Dioxide (Rutile) | -- | 20 | 115 |
| Lampblack | -- | 1.6 | 1.3 |
| Stabilizer A-5 ** | 3 | 3 | 3 |
| Epichlorohydrin | 0.5 | 0.5 | 0.5 |
| Toluene | 470 | 518 | 186 |
| Xylene | -- | -- | 187 |

* C. K. Williams Co., Div. of Chas. Pfizer & Co., Inc.
** Union Carbide Plastics Co.



DSW 322000

STLCOPCB4073650

A recently-developed continuous-painting process for finishing metal offers savings on capital investment, plant space, and operating costs. The technique utilizes the physical properties of trichloroethylene, the only solvent in the paint. Metal parts enter the unit covered with grease and leave the other end completely painted and dry to the touch. Detailed information about the process can be obtained from Du Pont, Wilmington, Delaware. The following formulation has given good characteristics in this continuous-painting system:

| Ingredients | 107 Vehicle | Pigment Dispersion[a] |
|---|---|---|
| | Parts by Weight | |
| *Parlon* chlorinated rubber (*20-cp*) | 67 | -- |
| Long-oil drying resin | 8 | 25 |
| AROCLOR 1254 | 33.5 | -- |
| Titanium Dioxide (Rutile) | -- | 100 |
| *Bentone* 38 gelling agent | -- | 1.3[b] |
| Epoxy stabilizer | 2.6 | -- |
| Trichloroethylene | 143 | 54 |

a) Add pigment dispersion to the vehicle after 24 hours in pebble mill

b) Add gelling agent to pigment dispersion during last two hours of grind

Mastic compositions are used to deposit thick films with a minimum number of coats. Mastics modified with AROCLOR compounds can effectively seal cracks in concrete, smooth rough concrete surfaces for subsequent glossy coatings, give excellent corrosion resistance under severe conditions, and retard fire. A typical starting formulation is the following:

| Ingredients | 108 Parts by Weight |
|---|---|
| *Parlon* chlorinated rubber (*20-cp*) | 100 |
| AROCLOR 1254 | 30 |
| AROCLOR 5460 | 49 |
| Asbestos | 160 |
| Titanium Dioxide (Rutile) | 25 |
| Toluene | 300 |

Although this mastic formulation adheres well to either wood or masonry, a primer is suggested before application to steel. To further increase fire retardance, replacement of 33 parts of the asbestos by 47 parts of antimony oxide is suggested as a starting formulation.

A combination of chlorinated rubber and a rosin-derived alkyd resin, plasticized with AROCLOR 1254, forms the basis of a high-gloss paper coating that is nonblocking and heat sealable. It gives a gloss of 79, is nonblocking either face-to-face or face-to-back for 40 hours at 130° F and 2 psi, and is heat sealed in ¼ second at 275° F and 120 psi.

| Ingredients | Paper Coating parts by weight |
|---|---|
| *Parlon* Chlorinated Rubber (10 cp.) | 47.4 |
| Neolyn* 23 Rosin-Derived Alkyd Resin | 52.6 |
| AROCLOR 1254 | 5.3 |
| Toluene | 105 |

* Trademark of Hercules Powder Co.



DSW 322001

STLCOPCB4073651

## CHLORINATED POLYPROPYLENE

Chlorinated polypropylene produces clear, colorless films, appears equal to chlorinated natural rubber in chemical resistance, and is noticeably more heat and light stable. AROCLOR plasticizers are very compatible with the resin and are recommended in the following starting formulations:

| Ingredients | 109 | 110 |
|---|---|---|
| | Parts by Weight | |
| Chlorinated Polypropylene | 100 (*10 cp*) | 100 (*20 cp*) |
| AROCLOR 5460 | 27 | 27 |
| AROCLOR 1254 | 44 | 44 |
| Dioctyl Sebacate | 7.8 | 7.8 |
| Epoxy Stabilizer | 3.1 | 3.1 |
| Toluene | 260 | 260 |
| *300°F Heat Stability* | Film Properties[a] | |
| 1 hour | v. sl. yellow | v. sl. yellow |
| 2 hours | v. sl. yellow | sl. yellow |
| 3 hours | sl. yellow | mod. yellow |
| 5 hours | mod. yellow | -- |
| 18 hours | black | -- |
| *Sunlight Stability** | | |
| 24 hours | sl. yellow | v. sl. yellow |
| 48 hours | sl. yellow | sl. yellow |
| 96 hours | mod. yellow | sl. yellow |
| 144 hours | mod. yellow | brown |
| *Two-week Chemical Resistance* | | |
| Water | excellent | excellent |
| 10% hydrochloric acid | excellent | excellent |
| 1% sodium hydroxide | excellent | excellent |

a) Lacquers were sprayed on "bonderized" steel panels. Films were 2.5- to 3.0-mils thick after 72-hours air drying.

*Determined in the Atlas Electric Devices Co. *Fade-Ometer*



DSW 322002

STLCOPCB4073652

## STYRENE-BUTADIENE COPOLYMERS

Styrene-butadiene-copolymer resins are widely used in the following suface-coatings applications:

- Enamels
- Maintenance finishes
- Exterior masonry finishes
- Aluminum finishes
- Wall sealers
- Paper coatings
- Printing inks

These resins form films by evaporation of solvent. Paint formulations based on styrene-butadiene resins have demonstrated the following advantages:

- Good resistance to alkalies and acids
- Excellent water resistance
- Satisfactory rate of moisture-vapor transmission
- Tough, durable films
- Excellent adhesion to masonry and allied surfaces
- Resistance to mildew
- Resistance to staining and discoloration
- Self-cleaning through controlled pigment chalking
- Ease of application
- Rapid drying
- Excellent can stability

The most common plasticizers for styrene-butadiene resins are the AROCLOR compounds, but SANTICIZER B-16, SANTICIZER 160, dibutyl phthalate, dioctyl phthalate, and tricresyl phosphate are also useful.



DSW 322003

STLCOPCB4073653

Shown below are several example formulations based on these copolymer resins:

| Ingredients | 111[a] | 112[b] | 113[c] | 114[d] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| *Pliolite*® S-3 | 3 | — | — | — |
| *Pliolite* S-5 | 97 | — | — | — |
| *Pliolite* S-5A | — | 100 | 100 | — |
| *Pliolite* VT | — | — | — | 100 |
| AROCLOR 1254 | 48 | 50 | 48 | 49 |
| AROCLOR 5460 | 48 | 50 | 52 | 53 |
| Titanium Dioxide (Rutile) | 242[d] | 140 | 160 | 164 |
| Phthalocyanine Green Toner | — | 11.6 | — | — |
| Lampblack | — | 1.2 | — | — |
| Zinc Oxide | 69 | — | — | — |
| Magnesium Silicate | 278 | — | — | — |
| Diatomaceous Silica | 103.5 | 87 | 80 | 82 |
| Mica | — | 93 | — | — |
| Calcium Carbonate | — | 320 | 144 | 147 |
| Soya Lecithin | — | — | 6.4 | 6.6 |
| Thixcin®® Thixotropic Agent | — | 6 | — | — |
| Aluminum Stearate (di-acid) | — | — | 6.4 | 6.6 |
| Hi-Flash Naphtha | — | 234 | — | — |
| Mineral Spirits | 308 | 234 | — | — |
| *Solvesso* 100 | 308 | — | — | — |
| Toluene | — | — | 127 | — |
| VM & P Naphtha | — | — | 190 | 309 |

a) White, non-chalking stucco paint

b) Green masonry and swimming-pool paint

c) White traffic paint

d) For chalking paint: substitute titanium dioxide (anatase)

Formula 115 illustrates a wall primer-sealer:

| Ingredients | 115 Parts by Weight |
|---|---|
| *Pliolite* S-5A (33⅓% in petroleum naphtha) | 48[e] |
| AROCLOR 5460 (50% in mineral spirits) | 22.5[e] |
| AROCLOR 1254 | 11 |
| Lithopone | 92 |
| Titanium Dioxide (Rutile) | 16 |
| Magnesium Silicate | 20 |
| Soya Lecithin | 1.6 |
| Aluminum Stearate | 1.6 |
| Mineral Spirits #10 | 27.5 |
| *After grinding in pebble mill, add the following:* | |
| *Pliolite* S-5A (33⅓% in petroleum naphtha) | 52[e] |
| Mineral Spirits #10 | 11.5 |

e) Solids contents

® Trademark of Goodyear Tire & Rubber Co. for styrene-butadiene resins

®® Trademark of Baker Castor Oil Co.



DSW 322004

STLCOPCB4073654

The following formulations represent metal lacquers for three applications:

| Ingredients | 116[a] | 117[b] | 118[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Marbon* "9200" LLV | 100 | — | — |
| Marbon "9200" LV | — | 100 | — |
| Marbon "9200" MV | — | — | 100 |
| AROCLOR 1254 | 25 | 81 | 26 |
| AROCLOR 5460 | — | 181 | 42 |
| Aluminum Paste | — | 116 | — |
| Pale Gold Brilliant**, #137 | — | — | 157 |
| Mica (water-ground to 325 mesh) | — | 108.5 | — |
| SC*** 100 hydrogenated naphtha | — | — | 111 |
| Mineral Spirits | — | 455 | 163 |
| Xylene | — | 303 | — |
| Ethanol | 12.5 | — | — |
| Ethyl Acetate | 112.5 | — | — |
| Dry Time (Dust Free), min. | 20 | 10 | — |
| Viscosity #4 Ford Cup, sec. | 311 | 14 | — |

a) Clear, rapid-drying hard lacquer
b) Low-cost, general-purpose, interior, aluminum enamel
c) Gold-bronze, decorative finish

A variety of styrene-butadiene-based paints are illustrated by the following starting formulations:

| Ingredients | 119[a] | 120[b] | 121[c] | 122[d] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| Marbon 9545 chips | 7 | — | — | — |
| Marbon 9548 chips | 40 | — | — | — |
| Marbon 9551 chips | 43.5 | — | 23.6 | — |
| Marbon 9566 chips | — | — | 72.8 | — |
| Marbon 10829 chips | 9.5 | — | 3.6 | — |
| Marbon "9200" MV | — | 100 | — | 100 |
| Raw Tung Oil | 5.5 | — | 1.3 | 12 |
| AROCLOR 1254 | 19 | 49.3 | — | 28 |
| AROCLOR 5460 | 15.5 | 49.4 | 10.5 | 33 |
| Titanium Dioxide (Anatase) | — | 129 | — | — |
| Zinc Oxide | — | 37 | — | 10 |
| Extra-Fine Talc | — | 128 | — | — |
| Diatomaceous Silica | — | — | 9.9 | — |
| Chrome Green A 4464 | — | — | — | 88 |
| China Clay | — | — | — | 35 |
| Lecithin | — | — | 0.59 | — |
| Aluminum Stearate | — | — | 0.9 | — |
| Cobalt Naphthenate (6% cobalt) | 0.05 | — | 0.135 | — |
| Zinc Naphthenate (8% zinc) | 0.09 | — | 0.027 | — |
| AFA† X2280 | 0.12 | — | — | — |
| Bentone #34 gelling agent | — | — | — | 3 |
| Mineral Spirits (Low Odor) | — | — | 50 | 137.5 |
| Hi-Flash Naphtha | — | — | 52 | 142 |
| Petroleum naphtha | 133 | 232 | — | — |

a) Tile-red, high-gloss, concrete-floor paint
b) White, exterior, masonry paint
c) Flat, white, interior, wall paint
d) Dark-green, gloss, trim enamel

* Trademark of Borg-Warner Corp. for styrene-butadiene resin
** Trademark of Crescent Bronze Powder Co.
*** Trademark of Central Solvents & Chemicals Co.
† Trademark of Imperial Paper & Color Corp.



DSW 322005

STLCOPCB4073655

The following formulations are suggested for a highway paint and an exterior masonry paint based on styrene-butadiene:

| Ingredients | 123[a] | 124[b] |
|---|---|---|
| | Parts by Weight | |
| *Piccoflex** 120 (flaked) (solids) | 100[c] | 100[d] |
| SANTICIZER 160 or Dibutyl Phthalate | 24 | — |
| AROCLOR 1260 | — | 21 |
| *Ti-Pure*** Titanium Dioxide (Rutile) | 113 (*R-510*) | 122 (R-610) |
| Zinc Oxide | 57 | 41 |
| Barium Sulfate | — | 61 |
| Talc | 279 | — |
| Diatomaceous silica | — | 57 |
| Mica | — | 20 |
| Calcium carbonate (dry ground) | — | 160 |
| Aluminum Stearate | 5.2 | — |
| Lecithin | 3.7 | — |
| Methyl ester of partially hydrogenated wood rosin | — | 5.5 |
| *Troykyd**** ABC drier | — | 2 |
| VM and P Naphtha | 118 | — |
| Hi-flash Naphtha | — | 269 |
| Toluene | 178 | — |

a) Traffic-lane paint: fast drying, nonbleeding on asphalt, no embrittlement with age

b) Exterior masonry paint

c) 60-% cold-cut solution with toluene

d) 50-% cold-cut solution with hi-flash naphtha

*Procedure*

Grind pigments in styrene-butadiene solution and plasticizers. Add remainder of solvent (and stir diatomaceous silica into Formulation 123).

## SYNTHETIC RUBBER

Many Monsanto plasticizers are usable in rubber-based surface coatings, although dibutyl phthalate, dioctyl phthalate, SANTICIZER 160, and tricresyl phosphate are most commonly used. Plasticizers improve gloss and flexibility in most cases.

In crepe-rubber-paint formulations the use of AROCLOR 1262 (from 5- to 50-per cent of the weight of the rubber) increases the gloss, alkali resistance, and adhesivity to steel.

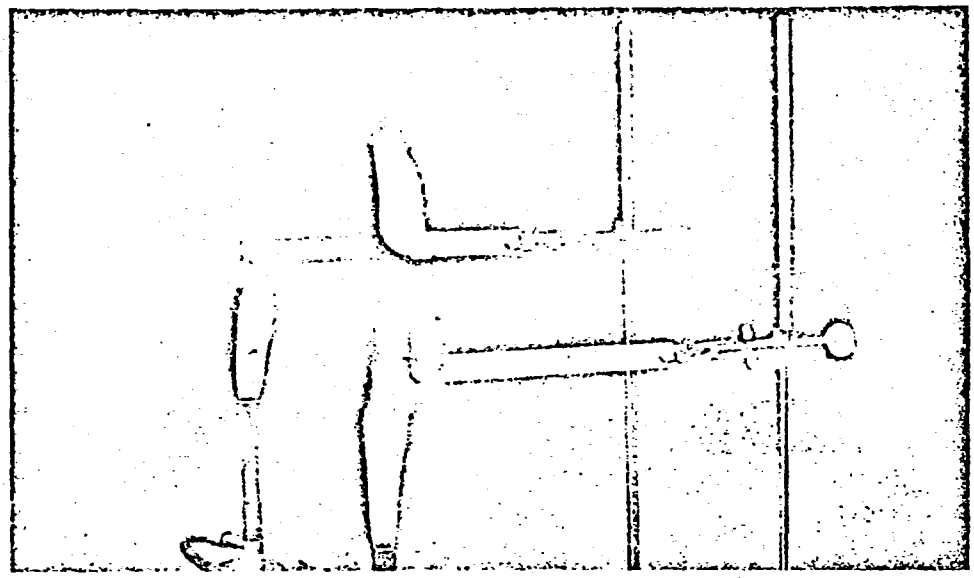
* Trademark of Pennsylvania Industrial Chemical Corp. for styrene-butadiene copolymer resins

** Trademark of E. I. du Pont de Nemours & Co.

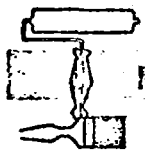
*** Trademark of Troy Chemical Co.



STLCOPCB4073656



The unmodified epoxy resin specimen burns vigorously; the epoxy resin test strip containing Aroclor and antimony oxide is "non-burning" in an identical Bunsen-burner flame.



## MONSANTO PLASTICIZERS IN OTHER RESIN COATINGS

### EPOXIES

Epoxy resins generally possess the highly desirable properties of:

Chemical resistance

Flexibility

Toughness

Adhesion

Available in solid, liquid, and solution forms, they are useful in several types of surface coatings, including the following:

Chemical-resistant coatings

Interior and exterior maintenance coatings

Baking finishes

Laminates

Plasticizers are not ordinarily used in epoxy resins when maximum performance is desired. Because of their high cost, however, epoxy resins are frequently highly filled. Here the use of small amounts of plasticizer aids flow and levelling and helps eliminate "drag". Monsanto has evaluated many plasticizers in epoxy resins, as compiled in Table IX.



STLCOPCB4073657

## TABLE IX—COMPATIBILITY AND PERFORMANCE OF MONSANTO PLASTICIZERS IN EPOXY RESINS

| Plasticizer[a] | Compatibility[b] | | | Viscosity[c] | | Physical Properties After Cure (½ hr @ 100°C) | | | Physical Properties[d] After Heat Aging | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Liquid Resin | Cured Resin | | Before Adding Curing Agent (cp) | After Adding Curing Agent (cp) | Izod Impact Resistance | Clarity; Light Reflected (%) | Shore D Hardness (10 sec) | Shore D Hardness (10 sec) | Weight Change (%) |
| | | Room Temp. | 100°C ½ hr | | | | | | | |
| None (control) | C | C | C | 12,800[e] | 7900 | 0.2 | 3.0 | 78 | 86 | —0.012 |
| Dibutyl Phthalate | C | C | C | 1550 | 1300 | — | 3.5 | 10 | 78 | —0.734 |
| Di-(2-ethylhexyl) phthalate | C | Cl/PS | SlCl | 2650 | 2700 | 0.5-1.9 | 8.0 | 31 | 82 | —0.368 |
| Diisodecyl phthalate | C | Cl/PS | SlCl | 3250 | 2450 | 0.5-0.8 | 7.0 | 48 | 83 | —0.168 |
| Diisodecyl adipate | C | Cl | W | 1200 | 1100 | 0.5-0.8 | 94.0 | 56 | 82 | —0.181 |
| SANTICIZER E-15 | C | C | C | 3050 | 2100 | — | 2.5 | 10 | 80 | 0.119 |
| SANTICIZER M-17 | C | C | C | 3150 | 2450 | — | 3.0 | 6 | 85 | —0.131 |
| SANTICIZER B-16 | C | C | C | 2300 | 2000 | — | 4.5 | 7 | 85 | —0.013 |
| Tricresyl phosphate | C | C | C | 3750 | 3000 | — | 3.5 | 15 | 86 | —0.222 |
| SANTICIZER 140 | C | C | C | 2850 | 2200 | — | 3.5 | 22 | 79 | —0.284 |
| SANTICIZER 141 | C | C | C | 1500 | 1400 | — | 4.0 | 5 | 82 | —0.425 |
| HB-40* | C | SlCl | SlCl | 3900 | 2300 | 0.5-0.6 | 4.0 | 27 | 84 | —0.648 |
| AROCLOR 1248 | C | C | C | 7700 | 4300 | 0.6 | 3.0 | 40 | 88 | —0.682 |
| AROCLOR 1221 | C | C | C | 1650 | 1200 | — | 3.0 | 8 | 81 | —2.118 |
| MOD-EPOX* | C | C | C | 1650 | 1250 | 0.8-0.9 | 4.0 | 84 | 88 | 0.134 |

a) Formulation

| Ingredients | Parts |
|---|---|
| Epoxy Resin | 100 |
| Plasticizer | 25 |
| Tetraethylenepentamine | 8 |

b) C = Compatible
SlCl = Slightly Cloudy
Cl = Cloudy
PS = Phase Separation
W = White

c) Brookfield LVF #4 spindle; 60 rpm unless otherwise specified

d) 24 hours @86°C in activated carbon

e) 30 rpm

* *HB-40 and Mod-Epox:* Monsanto Chemical Company Trademarks. Registered in U.S. Patent Office.

DSW 322008

STLCOPCB4073658

The following suggested formulation for a nitrocellulose-epoxy lacquer can be sprayed either cold or hot (with solvent modifications). It leaves a brilliant appearance.

| Ingredients | 125<br>Parts by Weight |
|---|---|
| ½-sec. Nitrocellulose | 75 |
| Solid Epoxy Resin | 25 |
| Dibutyl Phthalate | 25 |
| | **Parts by Volume** |
| Toluene | 50 |
| Isopropanol | 10 |
| Methyl Isobutyl Carbinol | 5 |
| Methyl Ethyl Ketone | 10 |
| Methyl Isobutyl Ketone | 25 |

## AROCLOR Compounds

Of all the nonreactive plasticizers evaluated, the AROCLOR compounds are the most compatible. Like epoxy resins, they impart excellent chemical and oxidation resistance and improve adhesion. AROCLOR compounds should not be used when solvent resistance is required, since they are true plasticizers and are not chemically bonded to the epoxy resin.

Two major disadvantages of epoxy resins—cost and flammability—are diminished through the use of AROCLOR compounds. AROCLOR compounds, about one-fourth the cost of epoxy resins, permit significant reductions of raw-material costs. Furthermore, non-burning compositions may be made by the use of an AROCLOR compound (15 phr) with antimony oxide (5 phr).

For solventless coatings the fluid AROCLOR compounds, such as AROCLOR 1248 and AROCLOR 1254, are most commonly used. For solvent-containing coatings the resinous AROCLOR compounds (AROCLOR 1262 and AROCLOR 5460) are used alone or in combination with the liquid AROCLOR materials.

The value of AROCLOR plasticizers (1242 and 1260) in reducing the flammability of amine-cured epoxy resins and improving flexural strength and compressive-yield strength, while only slightly affecting compressive strength and heat-distortion temperature, is illustrated by the following suggested starting formulations:

| Ingredients[a] | Control | 126 | 127 | 128 | 129 |
|---|---|---|---|---|---|
| | | | Parts by Weight | | |
| Liquid Epoxy Resin (EV-200) | 100 | 100 | 100 | 100 | 100 |
| Diethylenetriamine | 13 | 13 | 13 | 13 | 13 |
| AROCLOR 1242 | -- | -- | -- | 20 | 15 |
| AROCLOR 1260 | -- | 20 | 15 | -- | -- |
| Antimony Oxide | -- | -- | 5 | -- | 5 |
| **Properties** | | | | | |
| Flammability | 0.82 in./min. | S.E.[b] 1⅛" | N.B.[c] | S.E. 2⅛" | N.B. |
| Heat-Distortion Temp., °C | 117.5 | 87 | 92 | 79.5 | 81.0 |
| Hardness, Rockwell "M" | 104 | 103 | 106 | 108 | 107 |
| Flexural Strength, psi | 20,100 | 23,800 | 22,100 | 21,800 | 22,200 |
| Tensile Strength, psi | 11,400 | 13,000 | 9,800 | 10,700 | 12,800 |
| Compressive-Yield Strength, psi | 15,700 | 17,250 | 16,950 | 17,900 | 16,700 |
| Compressive Strength, psi | 43,000 | 32,900 | 38,150 | 32,500 | 32,400 |

*a*) Cured 16 hours at room temperature, then 2 hours at 100°C

*b*) S.E. = Self extinguishing

*c*) N.B. = Nonburning



DSW 322009

STLCOPCB4073659

## MOD-EPOX

Reactive diluents are added to reduce the viscosity of epoxy resins to improve handling characteristics and to permit the use of higher filler contents. Since they react with curing agents and are higher priced than the epoxy resins, however, they generally tend to result in higher-cost formulations.

MOD-EPOX, on the other hand, is a unique epoxy modifier, which not only reduces the viscosity of liquid epoxy resins by as much as 75 per cent but also speeds cure, maintains hardness and other chemical and physical properties, and reduces curing-agent requirements by about one-third. Thus, since it costs much less than any epoxy resin and any other reactive modifier, and since it reduces the curing-agent requirement, its incorporation generally results in much lower formulation cost. Furthermore, MOD-EPOX is not a skin irritant like other reactive diluents.

The following formulations illustrate blush- and impact-resistant coatings; number 131 has the longer working life:

| Ingredients | 130 | 131 |
|---|---|---|
| | Parts by Weight | |
| *ERL** 2774 Epoxy Resin | 100 | 100 |
| MOD-EPOX | 11 | 11 |
| Magnesium Oxide (fluffy)** | 0.2 | 0.2 |
| Titanium Dioxide | 22 | 22 |
| *Bentone* 38 gelling agent | 3-4 | 3-4 |
| *ZZL**-0803 | -- | 19 |
| *ZZL*-0814 | 13 | -- |
| *ZZLA**-0822 | 13 | 14 |
| Toluene | 2 | -- |
| Xylene | -- | 2 |
| Butanol | -- | 2 |
| Methyl Ethyl Ketone | 2 | -- |
| Working Life, minutes | 20 | 45 |

Epoxy troweling compounds are suggested for use in patching, repairing, and coating, where maximum film thickness and chemical resistance are desired. Such coatings are used to line brick, concrete, and metal tanks, such as plating and storage tanks, where application of conventional coatings is impractical. A formulation for a black, polyamine-cured, epoxy-resin troweling compound is as follows:

| Ingredients | 132 |
|---|---|
| | Parts by Weight |
| Liquid Epoxy Resin | 100 |
| Dibutyl Phthalate | 4 |
| MOD-EPOX | 25 |
| Diatomaceous Earth | 40 |
| SANTOCEL FRC silica gel | 12 |
| Lampblack | 12 |
| Magnesium Oxide (fluffy) | 1 |
| Diethylenetriamine | 3.9 |

* Trademarks of Union Carbide Corp.
** Such as Morton Chemical Co. grade CN-90



DSW 322010

STLCOPCB4073660

*Procedure*

Add the silica gel to a blend of the epoxy resin and dibutyl phthalate while mixing with a high-torque mixer. Slowly add the remaining pigments, with continued agitation. Disperse the pigments with one loose pass on a 3-roll mill.

Add the diethylenetriamine to the pigmented epoxy-resin component and mix thoroughly. Apply the mixture to the surface with a trowel. (Lubricate the trowel for improved smoothness.) These materials set in 2 to 8 hours depending upon the thickness of the coating.

## ACRYLICS

All-acrylic lacquers and acrylic-modified lacquer systems have stimulated a great deal of interest because of their exceptional properties. The presence of acrylic resins in both air-dry and baked finishes generally imparts:

Exceptional durability

Lightfastness

Hardness

High gloss upon polishing

As would be expected, finishes with such properties were pioneered by automobile manufacturers. Acrylic resins have also been utilized in aircraft paints. The addition of acrylic resins to nitrocellulose lacquers produces high-quality, better-performing industrial finishes.

Proper formulation of acrylic lacquers with suitable plasticizers (such as SANTICIZER 160, and especially SANTICIZER 261 and 262, which are less volatile at baking temperatures) imparts exceptional adhesion and improves durability.

Shown below are three suggested all-acrylic automobile lacquers:

| Ingredients | 133 | 134 | 134a |
|---|---|---|---|
| | | Parts by Weight | |
| Roller-Mill Grind: | | | |
| *Lucite** 6011 or 6012 (40% solids) | 4.03 | 3.98 | 4.03 |
| Titanium Dioxide (Rutile) | 6.17 | 6.08 | 6.17 |
| Lampblack | 0.07 | 0.07 | 0.07 |
| *Bentone* 34 | — | 0.70 | — |
| *Cellosolve* Acetate | 2.53 | 2.49 | 2.53 |
| Reduce With: | | | |
| *Lucite* 6011 or 6012 | 17.86 | 17.61 | 11.60 |
| SANTICIZER 160 | 3.76 | 3.70 | 3.76 |
| Cellulose Acetate Butyrate, ½-sec. | — | — | 10.03 |
| Toluene | 23.85 | 23.87 | 21.97 |
| *Cellosolve* Acetate | 17.88 | 17.63 | 17.87 |
| Methyl Ethyl Ketone | 23.85 | 23.87 | 21.97 |
| Solids at Spray Viscosity, % | 18.75 | 18.48 | 18.46 |

* Trademark of the Du Pont Co.



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The following starting formulations are examples of acrylic-modified nitrocellulose and chlorinated-rubber coatings:

| Ingredients | 135[a] | 136[b] | 137[c] | 138[c] |
|---|---|---|---|---|
| | Parts by Weight | | | |
| Acryloid* B-72 | -- | -- | 62.5 | -- |
| Acryloid B-82 | -- | 69 | -- | 62.5 |
| Poly(methyl Methacrylate) | 81 | -- | -- | -- |
| R. S. Nitrocellulose (½ sec.) | 19 | 31 | -- | -- |
| Chlorinated Rubber (20 cp) | -- | -- | 37.5 | 37.5 |
| SANTICIZER 160 | 25 | -- | -- | 25 |
| Dioctyl Phthalate | -- | 25 | 25 | -- |
| Titanium Dioxide (Rutile) | 40 | 67.5 | 40 | 40 |
| Phthalocyanine Green | -- | -- | 1 | 1 |
| Chrome Green | 1 | -- | -- | -- |
| Toluene | 315 | 347 | 315 | 315 |
| Ethanol | 76 | 88 | 76 | 76 |
| Cellosolve Acetate | 76 | 88 | 76 | 76 |
| Methyl Isobutyl Ketone | 315 | 347 | 315 | 315 |
| Viscosity, #4 Ford Cup, sec. | 11 | -- | 11 | 11 |

a) Acrylic-modified nitrocellulose automobile lacquer

b) Acrylic-modified nitrocellulose aircraft finish, resistant to aircraft lubricants. Use MIL-P-7962 (Aer) primer.

c) Acrylic-modified chlorinated-rubber lacquer

## POLYAMIDES

Polyamides are used increasingly in surface coatings applied to such materials as paper, waxed glassine, waterproof cellophane, and plastics. Polyamide films adhere exceptionally well to these substrates and have good flexibility. Polyamide compositions are also used in printing inks, overprint varnishes, paint vehicles, and hot-melt coatings and adhesives.

For most applications the polyamides need no plasticizers since they are somewhat internally plasticized. For use in hot-melt coatings and adhesives, however, external plasticizers are necessary. Performance of various Monsanto plasticizers in polyamide resins is evaluated in Table X.

## ZEIN

Zein, a proteinaceous material derived from corn gluten, has diverse applications, particularly in surface coatings. Both solvent-based and water-based solutions of zein form tough, high-gloss, grease-resistant, quick-drying films. Zein coatings have superior solution stability and, in contrast to most other protein compounds, are resistant to microbial attack.

The plasticization of zein is analogous to that of other synthetic and non-synthetic high polymers. Both primary and secondary plasticizers are commonly employed. Examples of Monsanto primary plasticizers are as follows:

SANTICIZER 3, 8, and 9
SANTOLITE MHP and MS-80%

Secondary plasticizers that enhance compatibility are the following:

Triphenyl Phosphate
Tricresyl Phosphate
Dibutyl Phthalate
Dioctyl Phthalate
SANTICIZER 160
AROCLOR compounds
SANTICIZER B-16

* Trademark of Rohm & Haas Co. for acrylic ester resins



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## TABLE X—EVALUATION OF MONSANTO PLASTICIZERS IN POLYAMIDE RESINS

| Plasticizer | Flexibility | | | Brittleness | | | Friability | | | Hardness (Penetration) | | | Viscosity (Gardner-Holdt) | Sweat | | | Tack | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 PHR | 15 PHR | 25 PHR | 10 PHR | 15 PHR | 25 PHR | 10 PHR | 15 PHR | 25 PHR | 10 PHR | 15 PHR | 25 PHR | 15 PHR | 10 PHR | 15 PHR | 25 PHR | 10 PHR | 15 PHR | 25 PHR |
| Dimethyl Phthalate | N | N | N | B | B | B | S | S | V | 8 | 11 | 15 | -- | V | V | V | N | N | N |
| Diethyl Phthalate | F | F | F | N | N | N | N | V | V | 10 | 12 | -- | -- | S | V | V | N | N | N |
| Dibutyl Phthalate | F | F | N | N | N | N | N | N | V | 9 | 13 | 16 | -- | N | S | V | N | N | N |
| Santicizer 160 | F | F | F | S | S | S | S | S | S | -- | 11 | -- | -- | S | S | -- | N | N | N |
| Dioctyl Phthalate | F | F | F | N | N | N | N | N | S | 6 | 10 | 12 | A1-A | N | N | N | N | N | N |
| Santicizer 140 | V | V | V | N | N | N | N | N | N | 5 | 7 | 14 | A1-A | N | N | N | N | N | N |
| Tricresyl Phosphate | F | F | F | N | N | N | N | N | N | 6 | 7 | 7 | A1-A | N | N | N | N | N | N |
| Santicizer B-16 | F | F | F | N | N | N | S | S | V | 8 | 13 | -- | -- | S | S | S | N | N | N |
| Santicizer E-15 | N | N | N | B | B | B | S | N | N | 8 | 10 | -- | -- | V | V | V | N | N | N |
| Santicizer 8 | F | F | F | S | N | N | N | N | N | 9 | 13 | 20 | A1 | N | N | N | S | T | V |
| Aroclor 1260 | F | F | F | S | S | S | N | N | N | 6 | 7 | 11 | A1-A2 | N | N | N | N | N | N |

Rating Symbols

B — Brittle
F — Flexible
T — Tacky

N — None or negative
S — Slight
P — Partially
V — Very



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Shown below are three starting formulations for zein-based coatings:

| Ingredients | 139[a] | 140[b] | 141[c] |
|---|---|---|---|
| | Parts by Weight | | |
| Zein | 100 | 100 | 100 |
| Hydrogenated Wood Rosin | -- | 50 | 50 |
| WW Rosin | 100 | -- | -- |
| Oleic Acid | -- | 40 | -- |
| SANTICIZER 8 | 25 | -- | -- |
| SANTOLITE MHP | 20 | -- | -- |
| SANTICIZER B-16 | -- | 40 | -- |
| Dioctyl Phthalate | -- | -- | 15 |
| Pigments (optional) | -- | (50) | -- |
| Water | -- | -- | 550 |
| Aq. Ammonia (28%) | -- | -- | 20 |
| 91% Isopropanol or 95% Ethanol | 190 | 230 | -- |

*a*) Spirit varnish for glossy, decorative, protective label coatings

*b*) Grease-proof, fairly water-resistant coating (either clear or pigmented)

*c*) Overprint coating for paper stock and colored paper, characterized by exceptional gloss and resistance to water and dilute alcohol

Decorative metallic-coating formulations that impart high gloss, flexibility, greaseproofness, and water resistance can be prepared either in organic solvents, as illustrated by the following suggested starting formulations, or in water:

| Ingredients | 142[a] | 143[a] | 144[b] |
|---|---|---|---|
| | Parts by Weight | | |
| Zein | 100 | 100 | 100 |
| SANTICIZER 3 | 60 | 50 | -- |
| SANTICIZER 8 | -- | -- | 70 |
| SANTOLITE MHP | 80 | 35 | 60 |
| 85% Phosphoric Acid | -- | -- | 2.3 |
| Aluminum Powder (optional) | (100) | (100) | -- |
| Bronze Powder (optional) | (200) | (200) | -- |
| Alcohol-Soluble Color | -- | -- | as needed |
| Toluene | 20 | -- | -- |
| 91% Isopropanol or 95% Ethanol | 340 | 300 | 230 |

*a*) Lacquer with strong adhesion to glassine and cellophane

*b*) Brilliant, glossy coating for coloring metal foils

The following zein-based coatings represent a paper-coating formulation (No. 145) and a textile-sizing formulation (No. 146):

| Ingredients | 145[a] | 146[b] |
|---|---|---|
| | Parts by Weight | |
| Zein | 100 | 100 |
| Hydrogenated Wood Rosin | -- | 30 |
| WW Gum Rosin | 140 | -- |
| HMP Ester Gum | -- | 20 |
| SANTICIZER 3 | 60 | -- |
| Dioctyl Phthalate | -- | 25 |
| Acetanilide | 13 | -- |
| Zinc Stearate | 7 | -- |
| Water | -- | 500 |
| Aq. Ammonia (28%) | -- | 20 |

*a*) High-gloss, flexible, low-tack, hot-melt paper coating

*b*) Textile sizing to impart stiffness and body





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## VARNISHES AND ALKYDS

The resinous AROCLOR compounds are frequently used in varnishes and alkyd-resin paints to impart durability, quick dry-time, and water and alkali resistance. The AROCLOR compounds do not oxidize, and flame-retardant formulations are produced by combinations of AROCLOR compounds and antimony oxide.

AROCLOR 4465 and AROCLOR 5460 are most commonly used, although AROCLOR 1260 is best for flexible short-oil varnishes. A suggested starting formula is one part oil, one part AROCLOR compound, and one part of another resin. AROCLOR 5460 is also useful in making varnish formulations based on phenolic or ester-gum resins.

Shown below are three suggested starting formulations for flame-retardant paints:

| Ingredients | 147 Semi-Gloss Interior | 148 Exterior | 149 Shingle Stain |
|---|---|---|---|
| | Parts by Weight | | |
| Long-oil Alkyd Resin (60% solution) | 100 | — | — |
| Alkali-refined linseed oil | — | 100 | — |
| Kettle-bodied linseed oil | — | 30 | — |
| AROCLOR 1254 | — | — | 27 |
| AROCLOR 5460 | 40 | 76 | 100 |
| Titanium Dioxide | 69 | 42 | — |
| 35% Leaded Zinc Oxide | — | 180 | — |
| Magnesium Silicate | 36 | 57 | 62 |
| Calcium Carbonate | — | 76 | — |
| Antimony Oxide | 31 | 42 | 77 |
| Barium Sulfate | 114 | — | 77 |
| Red Iron Oxide | — | — | 108 |
| Japan Drier | — | 9.8 | — |
| Aluminum Stearate | — | — | 3.1 |
| Cobalt Naphthenate (6% cobalt) | 0.63 | — | — |
| Lead Naphthenate (24% lead) | 2.7 | — | — |
| Manganese Naphthenate (6% manganese) | 0.31 | — | — |
| Turpentine | — | 42 | — |
| Mineral Spirits | 51 | — | 378 |

## SILICONES

Heat-resistant aluminum coatings based on silicone resins contain AROCLOR compounds as important ingredients. Suggested starting formulations for a heat-resistant coating, enamel, and paint are given below. The coating (Formulation 150) can withstand continuous service at 400° F and a maximum temperature of 800° F. The enamel (No. 151) resists temperatures of 900° to 1000° F in such applications as jet-engine components, exhaust manifolds, and incinerators. The paint (No. 152), which meets Federal Specification TT-P-0028, has excellent resistance to a programmed heat test (including 8 hours at 1200° F) and to a salt-water-spray test (after programmed heating to 500°, 600°, and 900° F).



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| Ingredients | 150 Coating | 151 Enamel Parts by Weight | 152 Paint |
|---|---|---|---|
| Dow Corning 805 Silicone Resin (50% NV) | 100 | -- | -- |
| GE Silicone Resin SR-82 (60% in xylene) | -- | 36 | 15.7 |
| GE Silicone Resin SR-112 (50% in xylene) | -- | 64 | -- |
| Styrene-Butadiene (50% in xylene) | -- | -- | 84 |
| AROCLOR 1254 | -- | -- | 19.5 |
| AROCLOR 4465 (90% nonvolatile) | 151 | -- | -- |
| 60% AROCLOR Solution[a] | -- | 89.5 | -- |
| AROCLOR 5460 (60% in xylene) | -- | -- | 38 |
| Aluminum Paste (74% nonvolatile) | 175 | 51 | 97.5 |
| Cobalt Octoate (6% cobalt) | -- | 0.9 | -- |
| Xylene | 52 | -- | 57 |
| Mineral Spirits | -- | -- | 46 |

a) Composition of AROCLOR Solution

| Ingredient | Weight Per Cent |
|---|---|
| AROCLOR 1262 | 24 |
| AROCLOR 4465 | 36 |
| *Solvesso* 100 | 24 |
| Xylene | 16 |

## PHENOLICS

Plasticizers are frequently used to improve the cold-punching characteristics of phenolic-resin laminates. SANTICIZER 160, tricresyl phosphate, dibutyl phthalate, HB-40, and the AROCLOR compounds are frequently used. The AROCLOR compounds and tricresyl phosphate also impart flame resistance. Diphenyl phthalate is also useful in phenolic compounds.

## MELAMINE

In melamine coating and laminating resins, SANTICIZER 9 promotes solution stability and compatibility, improves flow-out during baking or curing, and reduces pigment discoloration. The final coating has improved impact resistance, abrasion resistance, and buffability.

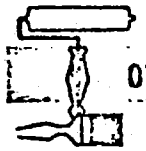
## SHELLAC

SANTICIZER 8 is an excellent plasticizer for shellac. At a concentration of 10 per cent of the weight of shellac, it has a pronounced softening effect but does not affect adhesion. SANTICIZER 9 and B-16 are also useful plasticizers, but less effective than SANTICIZER 8.





STLCOPCB4073666



## OTHER MONSANTO PRODUCTS IN PROTECTIVE COATINGS

### RESIN ADDITIVES

SANTOLITE MHP and SANTOLITE MS-80% are widely used to modify synthetic resins to give films with improved water resistance, brilliance, and adhesion to many surfaces. They are compatible with a great variety of resins. Usually they are compounded with liquid plasticizers, such as SANTICIZER 160 or dibutyl phthalate, but in special cases they are used without liquid plasticizers.

The resinous AROCLOR compounds, widely used as synthetic-resin extenders, impart improved adhesion, chemical and oxidation resistance, and flame retardance and usually lower the formulation cost. AROCLOR 4465, 5442, and 5460 are compatible in most synthetic resins and are soluble in the common low-cost solvents.

### COATING MODIFIER

A variety of significant benefits is imparted to many surface coatings systems by the addition of a small quantity (usually between 0.1 and 2.0 per cent of the resin solids) of MODAFLOW*, Monsanto's new, novel coating modifier. A complex polymeric material, MODAFLOW functionally modifies surface tension and viscosity. Among its many benefits are improvement of flow, levelling, adhesion to substrates, recoatability, and drying uniformity and reduction of "fisheyes", brushmarks, "cratering", and poor flow-out.

### ANTIOXIDANTS

Extremely small concentrations of SANTONOX, SANTONOX R, and SANTOWHITE Powder Refined antioxidants have proved to be very effective for many synthetic resins used in protective coatings.

### CATALYST/CLARIFIER

In the production of alkyd and polyester resins and bodied oils, the presence of triphenyl phosphite shortens the processing time and results in lighter, clearer products. The processing time for a maleic anhydride-ethylene glycol polyester resin was reduced from 95 to 80 minutes, and the color was lightened from 20-25 to 15-20 APHA by the addition of 0.5-per cent triphenyl phosphite. A soya oil-pentaerythritol alkyd resin was cloudly (APHA 6.7) when produced without triphenyl phosphite but clear (APHA 5) in the presence of 0.5-per cent of the clarifier. Similarly, the addition of 0.5-per cent triphenyl phosphite soon after alcoholysis and the addition of maleic anhydride or fumaric acid to soya, linseed, or tall oils gives bodied oils with improved color.

* MODAFLOW: Monsanto Chemical Company Trademark. Registered in U.S. Patent Office.

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## ODOR-MASKING AGENTS

SANTOMASK* II overcomes the disagreeable odors imparted to many protective coatings by the solvent. Highly effective even in small concentrations, the product masks the foul odor with a pleasant scent. Methyl salicylate, coumarin, and vanillin are other odor-masking agents produced by Monsanto to sweeten the odor of protective-coatings formulations.

## PRESERVATIVES

Monsanto's complete line of industrial preservatives includes SANTOBRITE*, Penta (pentachlorophenol), and technical sodium benzoate, which prevent fungus attack on coatings that contain natural materials susceptible to fungus.

## FLATTING AND THICKENING AGENTS

SANTOCEL 62 imparts dull, semi-dull, flat, and eggshell surfaces when used in lacquers and solvent-based finishes. SANTOCEL Z is a thickening and thixotropic agent in polyvinyl chloride plastisols.




New plasticizer materials and new plasticizing applications are under constant development and evaluation by Monsanto, producer of the greatest volume and variety of plasticizers in the world. Supplementing this laboratory research and development work is a staff of technical specialists in plasticizer technology. This technical-consultation service is available to help protective-coatings manufacturers select the best plasticizing systems for their synthetic resins. Many coatings-formulation problems are solved through the cooperative efforts of Monsanto's plasticizer technologists working with the resins and coatings technologists of the protective-coatings producer.




Most Monsanto plasticizers are shipped in bulk in either tank cars or tank trucks from six wide-spread manufacturing centers and in tank trucks within established delivery zones from six more strategically located bulk-storage stations. As producer of more kinds of plasticizers than anyone else in the world (*more than 80!*) Monsanto offers added savings through mixed shipments of different plasticizers (compartmented tank cars and tank trucks or mixed truck-lots of drums) for all of your plasticizer needs.

* SANTOMASK and SANTOBRITE: Monsanto Chemical Company Trademarks. Registered in U.S. Patent Office.



DSW 322018

STLCOPCB4073668

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

| Product | Classification | Standard Containers (net weight, lb.) 5-gal. cans | 55-gal. drums |
|---|---|---|---|
| Dimethyl phthalate | Dimethyl phthalate | 40 | 530 |
| Dibutyl phthalate | Dibutyl phthalate | 40 | 475 |
| Dioctyl phthalate | Dioctyl phthalate | 40 | 445 |
| Diisodecyl phthalate | Resin plasticizer | -- | 440 |
| Dicyclohexyl phthalate | Resin plasticizer | -- | 350 |
| Diphenyl phthalate | Resin plasticizer | -- | 400 |
| SANTICIZER 160 | Butyl benzyl phthalate (Resin plasticizer) | 40 | 500 |
| SANTICIZER 165 | Resin plasticizer | 40 | 445 |
| SANTICIZER 213 | Resin plasticizer | 40 | 450 |
| Dioctyl adipate | Resin plasticizer | 40 | 420 |
| Diisodecyl adipate | Resin plasticizer | 40 | 415 |
| SANTICIZER 409 | Resin plasticizer | 45 | 450 |
| Triphenyl phosphate | Resin plasticizer | -- | 225[a] |
| Tricresyl phosphate | Resin plasticizer | 45 | 530 |
| SANTICIZER 140 | Resin plasticizer | 50 | 545 |
| SANTICIZER 141 | Resin plasticizer | 45 | 495 |
| SANTICIZER M-17 | Resin plasticizer | 50 | 550 |
| SANTICIZER E-15 | Resin plasticizer | 45 | 535 |
| SANTICIZER B-16 | Resin plasticizer | 40 | 500 |
| SANTICIZER 1-H | Resin plasticizer | -- | 380[a] |
| SANTICIZER 3 | Resin plasticizer | -- | 400 |
| SANTICIZER 8 | Resin plasticizer | 45 | 530 |
| SANTICIZER 9 | Resin plasticizer | -- | 250[a] |
| SANTOLITE MHP | Synthetic resin | 60[b] | --- |
| SANTOLITE MS-80% | Synthetic resin | 45 | 540 |
| SANTOMASK II | Chemical, NOIBN | 45 | 250[c] |
| SANTONOX | Chemical, NOIBN | -- | 150[a] |
| SANTOWHITE Power Refined | Chemical, NOIBN | -- | 150[a] |
| AROCLOR 1221 | Synthetic resin | 50 | 520 |
| AROCLOR 1242, 1248, 1254, 1260, 1262 | Synthetic resins | 50 | 600 |
| AROCLOR 4465 | Synthetic resin | 50 | 500 |
| AROCLOR 5460 (flaked) | Synthetic resin | -- | 100[d] |
| HB-40 | Resin plasticizer | 40 | 450 |
| MOD-EPOX | Chemical, NOIBN | 45 | 510 |
| Triphenyl Phosphite | Resin plasticizer | 45 | 500 |

a) Fiber drum

b) 7-gallon can

c) 33-gallon drum

d) Bag



DSW 322019

STLCOPCB4073669

## 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.

| Title | Technical Bulletin No. |
|---|---|
| *Phthalate Plasticizers* | |
| Diethyl Phthalate and Dimethyl Phthalate | PL-303 |
| Dibutyl Phthalate | PL-302 |
| Di-(2-ethylhexyl) Phthalate (DOP) | PL-318 |
| Diisodecyl Phthalate | PL-300 |
| Dicyclohexyl Phthalate | PL-312 |
| Diphenyl Phthalate | PL-319 |
| SANTICIZER 165 | PL-165 |
| SANTICIZER 160 (butyl benzyl phthalate) | PL-160 |
| SANTICIZER 213 | PL-213 |
| *Adipate Plasticizers* | |
| Dioctyl Adipate | PL-304 |
| Diisodecyl Adipate | PL-308 |
| *Polymeric Plasticizer* | |
| SANTICIZER 409 | PL-409 |
| *Phthalyl Glycollate Plasticizers* | |
| SANTICIZER M-17 (Methyl phthalate ethyl glycollate) | PL-17 |
| SANTICIZER E-15 (Ethyl phthalate ethyl glycollate) | PL-15 |
| SANTICIZER B-16 (Butyl phthalyl butyl glycollate) | PL-16 |
| *Phosphate Plasticizers* | |
| SANTICIZER 140 | PL-140 |
| SANTICIZER 141 | PL-141 |
| Triphenyl Phosphate | PL-301 |
| Tricresyl Phosphate | PL-305 |
| *Sulfonamide Plasticizers* | |
| SANTICIZER 1-H | PL-1-H |
| SANTICIZER 3 | PL-3 |
| SANTICIZER 8 | PL-8 |
| SANTICIZER 9 | PL-9 |
| *AROCLOR Plasticizers* | |
| AROCLOR Plasticizers | PL-306 |
| *Other Plasticizers* | |
| HB-40 (partially hydrogenated terphenyl) | PL-40 |
| MOD-EPOX (epoxy-resin modifier) | PL-313 |
| *Resin Additives* | |
| SANTOLITE MHP and SANTOLITE MS-80% (Monsanto industrial resins) | PL-320 |
| *Coating Modifier* | |
| MODAFLOW | CS-16 |
| *Catalyst/Clarifier* | |
| Triphenyl Phosphite | PL-317, PL-322 |
| *Preservatives and Stabilizers* | |
| SANTOBRITE and Penta for the preservation of paints | SC-2 |
| SANTONOX and SANTONOX R, antioxidants for polyethylene | PL-324 |
| SANTOWHITE Powder Refined | Technical Data Sheet |
| Sodium Benzoate, Technical | Technical Data Sheet |
| *Odor-Masking Agents* | |
| SANTOMASK II, Odor-Control Agent | PL-325 |
| "Coumarin Monsanto" | folder |
| "Methyl Salicylate Monsanto" | folder |
| "Vanillin Monsanto" | folder |



DSW 322020

2-2932-0969-6 LITHO IN U.S.A.

STLCOPCB4073670

Please Use These Reply Cards To Request Further Technical Information

_____ (date)

Gentlemen:

For further detailed information about the use of your plasticizers in protective coatings, I would appreciate copies of the following technical bulletins:

PL-_____ PL-_____ PL-_____

PL-_____ PL-_____ PL-_____

Comments_____

_____

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____

State_____

_____ (date)

Gentlemen:

For further detailed information about the us your plasticizers in protective coatings, I w appreciate copies of the following technical b tins:

PL-_____ PL-_____ PL-_____

PL-_____ PL-_____ PL-_____

Comments_____

_____

Name_____

Title_____

Company_____

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City_____ Zone_____

State_____

Please Use These Reply Cards To Request Further Technical Information

_____ (date)

Gentlemen:

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PL-_____ PL-_____ PL-_____

Comments_____

_____

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____

State_____

_____ (date)

Gentlemen:

For further detailed information about the u your plasticizers in protective coatings, I v appreciate copies of the following technical i tins:

PL-_____ PL-_____ PL-_____

PL-_____ PL-_____ PL-_____

Comments_____

_____

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____

State_____

DSW 322021

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PLASTICIZER COUNCIL, Dept. PL-327-A
Organic Chemicals Division
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St. Louis 66, Missouri

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Organic Chemicals Division
800 North Lindbergh Boulevard
St. Louis 66, Missouri

*PLEASE REQUEST SAMPLES ON YOUR COMPANY LETTERHEAD*

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