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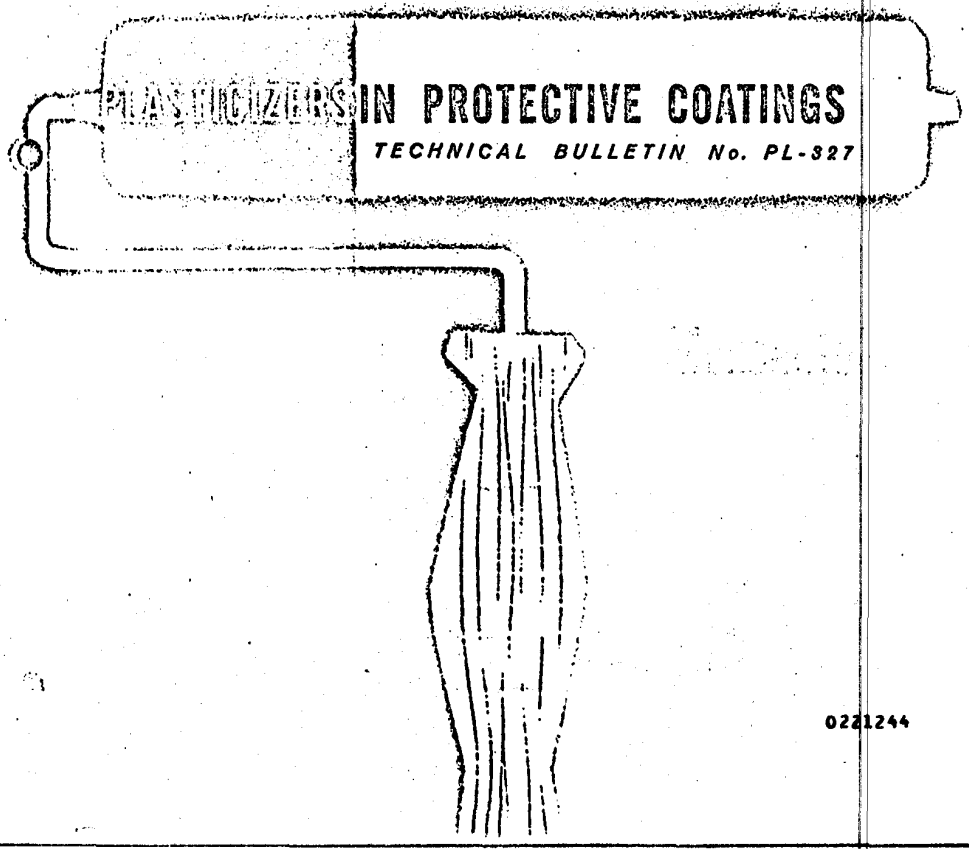
PLASTICIZERS IN PROTECTIVE COATINGS

TECHNICAL BULLETIN No. PL-327



0221244

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.

CONTENTS

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%.

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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 (¼-sec.)[d]	--	100	100
R.S. Nitrocellulose (½-sec.)[d]	60	--	--
R.S. Nitrocellulose (5-6 sec.)	30	--	--
Maleic Resin (38% 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.

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	4a	5b	6c
	Parts by Weight		
Nitrocellulose (¼-sec.)d	--	--	100
Nitrocellulose (½-sec.)	100e,f	100d	--
Non-Drying Coconut Alkyd	80f, g	56g	75
Blown Soya Oil	--	43	--
SANTICIZER 160 or Dibutyl Phthalate	--	--	24
Dioctyl Phthalate	--	13	--
Tricresyl Phosphate	9f	--	--
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.

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

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.

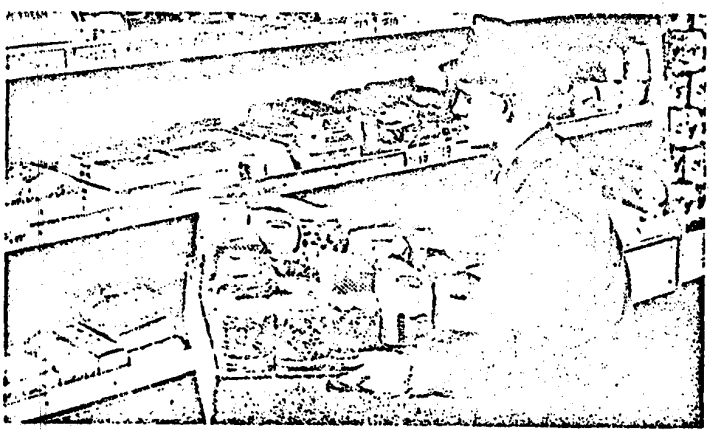
Ingredients	16[a]	17[b]	18[b]	19[c]
	Parts by Weight			
R.S. Nitrocellulose (½-sec.)	100	—	—	100
S.S. Nitrocellulose (½-sec.)	—	100	100	—
Blacar® H-4055	—	—	—	—
Diethylene glycol ester of terpene dibasic acid	72	21	—	—
SANTICIZER 160 or Dibutyl Phthalate	28	6	30	50
Dicyclohexyl Phthalate	—	17	28	—
Damar 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 plasticizer 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.

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.

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

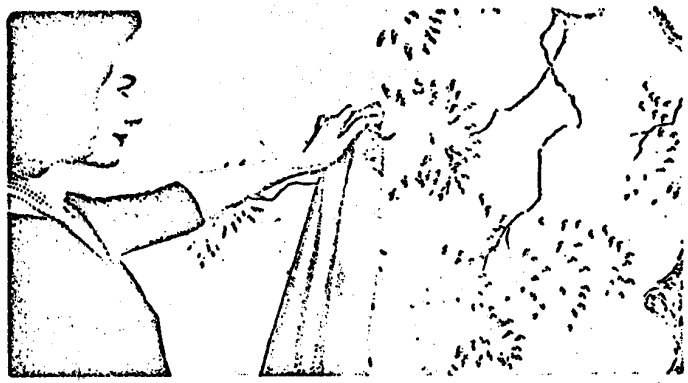
A wide variety of plasticizers is used with ethyl cellulose to develop its best properties to most satisfactorily meet the requirements of each particular application. Table II presents evaluations of various Monsanto plasticizers in ethyl cellulose with an ethoxy content of from 48 to 49.5 per cent:

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.



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	544	—	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.

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 Aroclor 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.

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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	2.3	—	—
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.

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.

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

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.

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]	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]	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.

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 (51.6 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	135	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]	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

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]
Dures 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) 52.5-53.5-% combined acetic acid, low viscosity

f) Add toluene slowly

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.

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.

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.

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

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

Ingredients	66[a]	67[b]
	Parts by Weight	
Part I		
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.

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

Ingredients	68 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 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.

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.

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 (%)	Water Immersion: Kerosene Extraction (% lost)	Hardness Shore "A"	Migration Linde Silica Days: 1 (%)	Migration Linde Silica Days: 3 (%)	Migration Linde Silica Days: 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

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

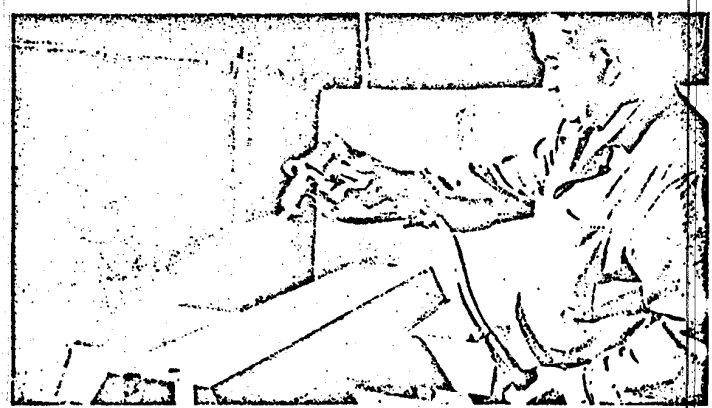
a) Air-dry or low-bake primer (200° - 300°F for a short time)

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.

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	330
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.

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)	5% Tide at 140°F (days)
10	—	120[a]	92	0.4	4	84	60	21
—	10	120[a]	168[a]	5	13	168[a]	90[b]	28
25	—	60	24	0.4	4	84	27	25
—	25	120[a]	120	0.4	14.5	120	90[a]	28
40	—	60	24	0.4	4	48	22	25
—	50	120[a]	96	0.4	11	100	60	28

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] Parts by Weight	83[c]
Blacer 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

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

Ingredients	84 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] 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	—	34	—
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

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.

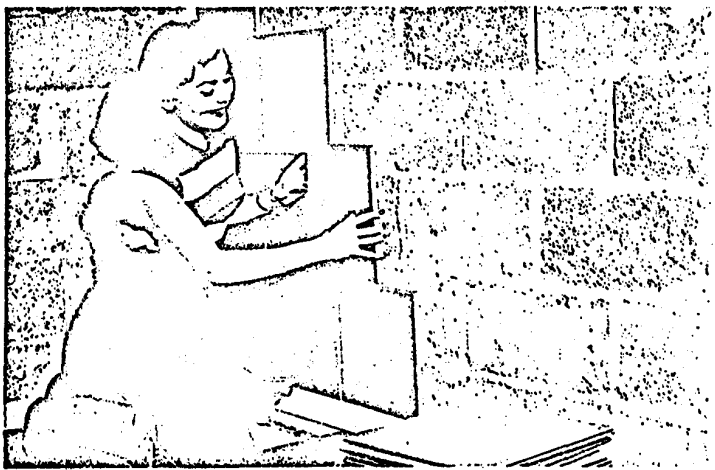
The use of vinyl chloride-vinylidene chloride copolymer latexes in fire-retardant, intumescent coatings for wallboard and acoustic tile is shown below. The use of the solid plasticizer, diphenyl phthalate, improves the viscosity stability of formulation 91.

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	47-54	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.

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	Sward 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:

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	—	—	—	—	—
Epichlorohydrin	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

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.

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	15	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.

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:

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Ingredients	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:

108

Ingredients	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.

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*

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.

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[a]
Aroclor 5460 (50% in mineral spirits)	22.5[a]
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[a]
Mineral Spirits #10	11.5

a) Solids contents

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

** Trademark of Baker Castor Oil Co.

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	—
APA† 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.

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

Ingredients	123[a] Parts by Weight	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

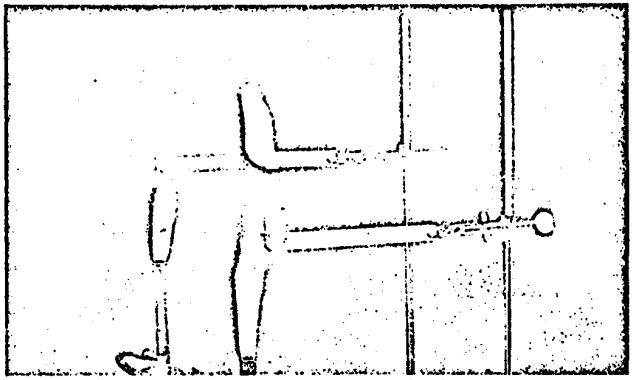
Many Monsanto plasticizers are usable in rubber-based surface coatings, although dibutyl phthalate, dioctyl phthalate, SANTICIZER 160, and tricresyl phosphate are most commonly used. Plasticizers improve gloss and flexibility in most cases.

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.



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.

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.

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 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 Parts by Weight	128	129
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

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

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

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

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).

Ingredients	150 Coating	151 Enamel	152 Paint
	Parts by Weight		
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.

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 "fish-eyes", 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.

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.

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

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

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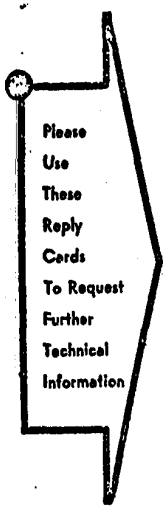

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Gentlemen:

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-_____

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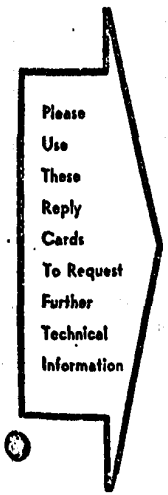

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