ORGANIC COATING TECHNOLOGY

VOLUME I

Oils, Resins, Varnishes, and Polymers

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combination may be modified somewhat with coumarone-indene resins and rosin esters. The coatings may be heat-sealed at 275–300°F; they have excellent resistance to water vapor. They can be formulated to be non-blocking at temperatures up to 130°F. Although the cyclized Pliolite NR has given good results for paper coatings it is not generally used in chemical-resistant paints. Pliolite S-5, described in the next section, is preferred for this purpose.

HIGH STYRENE-BUTADIENE RUBBER RESINS

The high styrene-butadiene resins are copolymers which usually contain 85% or more of styrene. Pliolite S-5 of the Goodyear Tire & Rubber Co. is a typical example. These resins have a structure similar to that shown for GR-S rubber in Fig. 1, except that the ratio of styrene is very much higher. They may be made by the emulsion polymerization process described in Formula 1, and the product may be obtained as the solid resin, or it may be used as the latex. A careful selection of emulsifying agents and stabilizers is necessary when the latex is to serve as the vehicle for pigmented coatings.

Pliolite S-5 is available as light amber granules, with a specific gravity of 1.03, or 8.58 lb per gal. It produces clear films, free from taste or odor, and non-toxic. These films are resistant to acids, alkalies, alcohol, water, and mineral and vegetable oils. The tensile strength has been reported as 1450 psi with zero per cent elongation; this is lower than the values for chlorinated rubber shown on page 360. The resin is soluble in aromatic hydrocarbons, ketones, and esters. A mixture of aromatic and aliphatic hydrocarbons having the same boiling range, and adjusted for solvency to a kauri-butanol value of 60, is recommended for brushing enamels. This mixture is lean enough so that it will minimize the tendency of a second-coat application to soften the undercoat. The aliphatic component has a lower heat of vaporization than the aromatic; therefore it will evaporate more readily and the solvent will become richer as the film dries.

Pliolite S-5 is not generally compatible with alkyd resins or maleic resins and has only limited compatibility with drying oils. However, it has good compatibility with rosin and many of its modifications. It is also compatible with coumarone-indene resins, the Aroclors, chlorinated paraffins, and many of the chemical plasticizers. It is more stable to heat than the chlorinated rubber resins; it shows no apparent breakdown at 300°F for extended periods. However, it will support combustion, since it is a hydrocarbon; therefore it does not

have the fire-retardant properties of the chlorinated materials. There is a considerable difference in the weight per gallon of these resins; the chlorinated rubber resin weighs 13.65 lb, and the Pliolite S-5 is 8.58 lb per gal.

General Uses. The Pliolite S-5 type of rubber resins is used in fast air-drying finishes which are required to have good water and chemical resistance and good abrasion resistance. A series of color bases is available containing various pigments dispersed in the solid resin. These are described in Volume II, together with details of the pigmented paints. The general range of the binder composition may be seen from the data in Table 5.

Table 5. Typical Binder Composition

Per Cent by Weight, Solid Basis

Binders	Wall Sealer	Flat Paint	Stucco Traffic	Concrete Enamel	Aluminum Paint	Metal Primers	
Pliolite S-5	75	40	50	87	50	70	77
Aroclor 1254	..	20	..	...	..	..	..
Aroclor 5460	25	40	..	...	50	..	..
Clorafin 42	..	..	25	8.7	..	..	..
Chlorowax 70	..	..	25	...	..	..	..
Tung oil	..	..	..	4.3	..	..	..
Varnish base *	..	..	..	...	..	30	23

* 21 gal tung-oil-Bakelite BR-254 resin varnish in xylene.

CHLORINATED BIPHENYLS

A series of chlorinated biphenyls and polyphenyls is available from the Monsanto Chemical Co. under the trade name of Aroclors. They range from mobile liquids to brittle solids and are used as plasticizers and resins. The consistency increases with the chlorine content, as indicated in Table 6 for the pure chlorinated biphenyls. A partial list of the available Aroclors is given in Table 7.

Benzene may be polymerized in the vapor phase by passing it over a catalyst at about 800°C. A mixture of biphenyl, biphenyl benzene, and polyphenyls is formed which may be separated by distillation. For many commercial purposes it is not necessary to separate so closely as to obtain the individual compounds so long as uniform physical properties are obtained. The biphenyl and related compounds are chlorinated by passing chlorine through the molten materials. The chlorine atoms replace hydrogen atoms on the benzene

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Table 6 * Pure Chlorinated Biphenyls

	% Chlorine	Condition
Monochlorobiphenyl	18.8	Mobile liquid
Dichlorobiphenyl	36.8	Mobile liquid
Trichlorobiphenyl	41.4	Mobile liquid
Tetrachlorobiphenyl	48.6	Viscous liquid
Pentachlorobiphenyl	54.4	Viscous liquid
Hexachlorobiphenyl	59.0	Soft resin
Heptachlorobiphenyl	62.8	Soft resin
Octachlorobiphenyl	65.9	Semi-crystalline
Nonachlorobiphenyl	68.8	Crystalline
Decachlorobiphenyl	71.1	Crystalline

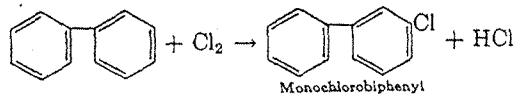
* *Protective and Decorative Coatings*, J. J. Mattiello, Ed., Volume I, page 486.

Table 7 * A Partial List of the Aroclors

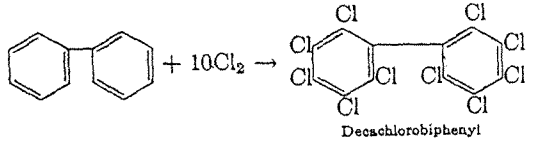
Properties	Aroclor						
	1242	1248	1254	1260	1270	4465	5460
Form	Colorless mobile liquid	Yellow mobile liquid	Yellow viscous liquid	Yellow sticky resin	White cryst. powder	Yellow brittle resin	Yellow brittle resin
Color, APHA (max.)	100	100	150	150	1.5 †	2.0 †	2.0 †
Acid number	0.015	0.015	0.015	0.015	0.175	0.05	0.07
Pounds per gallon at 25°C	11.50	12.08	12.83	13.50	16.24	14.28	14.50
Distillation range, °C	325–360	340–375	365–390	385–420	450–460	230–320 ‡	280–335 §
Pour point, °C	−19	−7	10	31	.....	.....	.....
Softening point, °C	.....	.....	.....	.....	249–300	60–66	100–105.5
Refractive index (av.)	1.628	1.630	1.640	1.648	.....	1.665	1.663

* Courtesy of the Monsanto Chemical Co.
† Color, NPA.
‡ At 4 mm Hg.
§ At 5 mm Hg.

rings, and hydrochloric acid is obtained as a by-product. The operating conditions determine the extent of chlorination.



Monochlorobiphenyl



Decachlorobiphenyl

The Aroclors are soluble in most organic solvents, partially soluble in the lower alcohols, and insoluble in glycerol, glycols, and water. They are compatible with drying oils and some varnish resins, the cellulosic polymers (except the acetate), chlorinated rubber, and the

rubber resins and vinyl resins. They are very resistant to oxidation, are heat stable up to 600°F, and are permanently thermoplastic. They have excellent chemical resistance, being practically unaffected by sodium hydroxide solutions, mineral acids, and water. They are non-flammable, in that they do not support combustion, and they decrease the flammability of mixtures in which they are used. They have low vapor pressures, and show practically no evaporation loss at 100°C and only very slight loss at 163°C for 6 hr. The liquid members are used as plasticizers, and the solid Aroclors as resins in a variety of coatings. Their use with rubber resins is indicated in this chapter and with other film-formers in other sections of this book. Further information is available from the Monsanto Chemical Co.

CHLORINATED PARAFFINS

The paraffinic hydrocarbons may be chlorinated by the catalytic vapor-phase process, or by passing chlorine through a molten bath of the solid members of the series. The chlorinated paraffins are available commercially in two degrees of chlorination, containing approximately 40% and 70% chlorine respectively. At 40% chlorination the chlorinated paraffins are viscous liquids, and at 70% they are brittle solids. They are similar in most respects to the chlorinated biphenyls discussed in the previous section, but they are not as stable to heat or ultraviolet radiation. At elevated temperatures dehydrochlorination takes place with the formation of unsaturated compounds and the liberation of hydrogen chloride. The polyvinyl chloride resins are also susceptible to this type of degradation. The liberated hydrogen chloride catalyzes the reaction; therefore it must be removed by the acid-acceptor type of stabilizer. The types of stabilizers which are available are discussed on page 495. In general the 70% chlorinated paraffins are more stable than the 40% type, but stabilizers should be incorporated if these materials are used at temperatures of 275°F or higher.

The chlorinated paraffins are soluble in most organic solvents, but are insoluble in glycerol, the glycols, lower alcohols, and water. They have good compatibility with the standard film-forming materials; the liquid type may be used as a plasticizer, and the solid type as a hard resin. They do not support combustion, and consequently they reduce the flammability of compositions in which they are used. They are non-oxidizing and remain permanently thermoplastic. The vapor pressure of the 40% type is comparable to that of tricresyl phosphate, and considerably lower than that of dibutyl phthalate. The chlorinated paraffins have excellent resistance to acids, alkalies, and al-

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h nd impart these characteristics to formulations in which they e used. They do not detract from exterior durability in pigmented mpositions.

Two commercial types of chlorinated paraffins are referred to earlier this chapter: the Clorafins of Hercules Powder Co. and the Chloro-axes of Diamond Alkali Co. The general characteristics of these aterials are shown in Tables 8 and 9.

Table 8 * Physical Properties of Clorafins 42 and 70

	42	70
Form	Amber liquid	Yellow solid
% chlorine	42–43	69–72
Viscosity, poises, at 25°C	22.5–31.5	.....
Softening point,† °C	.....	90–100
Color, Gardner 1933	12 max.	.....
Pounds per gallon at 25°	9.72–9.82	13.33–13.75
Stability, max. % HCl liberated, 4 hr at 175°C	0.80	Approx. 0.27

Non-flammable—cannot be ignited by direct contact with gas flame.

* Courtesy of Hercules Powder Co.
† Ring and ball method.

Table 9 * Physical Properties of Chlorowaxes 40 and 70

	40	70
Form	Amber liquid	Cream powder
% chlorine	40–42	68–73
Average formula	$C_{24}H_{43}Cl_7$	$C_{24}H_{29}Cl_{21}$
Average molecular weight	570	1060
Viscosity, poises, at 25°C	20–28	.....
Softening point,† °C	....	95–110
Pounds per gallon at 25°C	9.6	13.75
Stability, max. % HCl liberated, 4 hr at 175°C	0.50	0.50

* Courtesy of Diamond Alkali Co.
† Ring and ball method.

The use of chlorinated paraffins with the various rubber resins is scribed earlier in this chapter, and their use with the cellulosic and ıyl polymers will be discussed in later chapters. A solution of the gh-chlorine-content chlorinated paraffin will serve as a fire-retardant ating on wood. This type of coating may be used on wood which s been impregnated with water-soluble fire-retardant salts. It re-ces the leaching of the salts and presents a satisfactory surface : further coats of paint. Since its pigmented coatings have good

exterior durability it may also be used as a fire-retardant material in shingle stains. A suggested formulation is as follows:

Formula 2 * Fire-Retardant Shingle Stain

	Pounds	Gallons
Red iron oxide	140	3.26
Antimony trioxide	100	2.09
Barium sulfate	100	2.79
Asbestine	80	3.36
Aluminum stearate	4	0.40
Chlorowax 40	32	3.33
Chlorowax 70 (60% in MS)	217	22.77
Mineral spirits	403	62.00
	1076	100.00

* Courtesy of Diamond Alkali Co.

A variety of colored stains may be produced by proper pigment variation, and a fungicide may be added if desired. A wide variety of formulations is used as fire-retardant coatings on heavy textiles for awnings, tents, tarpaulins, etc. A combination typical of that used by the Quartermaster Corps during World War II is given in Formula 3.

Formula 3 * Fire-Retardant Textile Compound

	Pounds	Gallons
Chromium oxide	138	3.28
Synthetic yellow iron oxide	102	3.06
Red iron oxide (85%)	71	1.93
Phthalocyanine blue	8	0.58
Antimony trioxide	150	3.25
Calcium carbonate, ppt	300	13.40
Urea-formaldehyde resin (60%)	90	10.40
Chlorowax 40	300	30.10
Chlorowax 70 (70% in xylol)	193	18.00
Copper naphthenate (8%)	135	16.00
	1487	100.00

* Courtesy of Diamond Alkali Co.

This combination is reduced with a high-solvency hydrocarbon solvent for application, and it should be adjusted to provide for a pick-up on the textile of about 40–45%. The urea-formaldehyde resin modifier may be replaced with phenol formaldehyde resin, ethyl cellulose, chlorinated rubber, and other suitable film-formers. The color components were chosen to give the Army's olive drab color, but these may be replaced with others if desired.

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SYNTHETIC RUBBER RESIN LATEXES

During the past few years stabilized latexes of a variety of polymeric m-formers have been made available to the paint industry. These texes are the result of the emulsion polymerization of the polymeric aterials. Like all colloidal systems, the latexes must be used with re to prevent breaking the emulsion or coagulating the dispersed ıase. However, there need be no difficulty in this respect if the oper precautions are followed. The use of these latexes in interior ıd exterior architectural paints for plaster and concrete surfaces is panding rapidly because they have certain inherent advantages over l- and resin-base paints for these applications. Since the continuous ıase in the latexes and subsequent paints is water it will be realized at brush application is very easy. In fact, water-dispersible thick-ıers, such as casein, methyl cellulose, and alginates, are incorporated the paints to increase the consistency and stability. Another ad-ıntage of latex paints is their very fast drying property. When ırt of the water has evaporated the emulsion breaks, and the re-ainder of the water evaporates very rapidly, leaving the dry film paint. No oxidation or further polymerization is necessary. Latex terior flat paints will dry in 20–30 min and some of them may be coated the same day. Freedom from odor of solvent or the oxidation oils is another advantage. This is particularly important in hotels, ıspitals, etc., where it is desirable to occupy a room as soon as pos-ble after redecorating. The absence of organic solvents also reduces e fire hazard connected with the use of oil paints. The painter can ean his brushes easily with soap and water and also remove spots spilled paint in this manner.

The polymeric materials in the latexes have high molecular weight; erefore they are non-penetrating into porous surfaces. They are latively hard and have high cohesive strength; therefore they must properly plasticized to assure good adhesion, both originally and ter the film has aged. They may be plasticized in three ways: (1) ternally plasticized, whereby the plasticizer is a part of the copoly-eric molecule; (2) preplasticized, whereby the plasticizer is added ıring the polymerization and is incorporated in the latex; (3) post-asticized, whereby the plasticizer is emulsified separately and added the latex. Examples of each of the three types are available ımmercially.

From the discussion of synthetic rubbers in the first part of this ıapter, of the polyvinyl resins in Chapter 12, and of the acrylic ester sins in Chapter 13, it will be apparent that a wide range of copoly-

meric materials can be formulated for these latexes. Some of them would be eliminated on an economic basis, because low cost is important for materials used in architectural paints. The large-volume production and price advantage of styrene account for its wide use in these latexes. Since polystyrene is a hard material it requires plasticizing by one of the three methods cited above. It may be plasticized internally by copolymerizing with a reactive monomer such as butadiene. However, it would require the reverse ratio of that shown in Fig. 1 for GR-S rubber; for latex paints the styrene content may be as high as 85% with the butadiene about 15%. The use of butadiene introduces a small amount of unsaturation in the polymer which is subject to oxidation on aging with possible hardening and discoloration in the film. The unsaturation may be avoided by adding a non-oxidizing plasticizer to the polystyrene latex as indicated in methods 2 and 3 above.

Types Available. A series of butadiene-acrylonitrile copolymer latexes is available in which the ratio of butadiene to acrylonitrile is varied. This provides a range in relative hardness or flexibility of the films. Some types are suitable for use in latex paints, and others as

Table 10 Types of Commercial Synthetic Resin Latexes

1. Plasticized polystyrene:
   - BKS-92, BKS-114, and BKS-177; Bakelite Co.
   - Koppers polystyrene emulsion P; Koppers Co.
2. Unplasticized polystyrene:
   - BKS-90, BKSQ-227; Bakelite Co.
   - Dow latexes 579 and 580; Dow Chemical Co.
   - Lustrex X601; Monsanto Chemical Co.
   - Wallpol 9200; Reichhold Chemicals, Inc.
   - Koppers polystyrene emulsions F, M, and R; Koppers Co.
3. Styrene-butadiene copolymers:
   - Dow latex 762-W; Dow Chemical Co.
   - Chemigum 101 and 160; Goodyear Tire and Rubber Co.
   - Kralac 2724; Naugatuck Chemical.
4. Vinyl chloride-vinylidene chloride copolymers:
   - Dow latex 744-B; Dow Chemical Co.
5. Butadiene-acrylonitrile copolymers:
   - Chemigum 235; Goodyear Tire and Rubber Co.
   - Hycar latexes; B. F. Goodrich Chemical Co.
   - Amerite compounds; American Anode, Inc.
6. Plasticized vinylidene chloride-acrylonitrile copolymers:
   - Saran latexes F122 and A20; Dow Chemical Co.
7. Polyvinyl acetate:
   - Elvacet emulsions; du Pont Co.
   - Wallpol 9100; Reichhold Chemicals, Inc.
8. Polyacrylic copolymers:
   - Rhoplex AC-33; Rohm and Haas Co.

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ı ıaants for paper and for leather finishes which require a high egree of flexibility and toughness. A non-flammable copolymer of inyl chloride and vinylidene chloride is available from the Dow 'hemical Co.; it must be blended with plasticizers or other film-ɔrming materials since it does not form a continuous film on drying. t finds use in paper and textile coatings where non-flammability is equired. A partial list of the latexes available at present is given ı Table 10. However, this field is expanding so rapidly that many thers will no doubt be available when this book appears in print.

General Uses. A detailed description of the use of these latexes in rchitectural and industrial finishes is given in Volume II. However, 'ormulas 4, 5, and 6 are presented here to show the general principles

Formula 4 * Latex Paint Made with Dow Latex 762-W

Pigment Dispersion	Gallons per Pound	Pounds	Gallons
'itanium dioxide (rutile)	0.0286	250.00	7.14
ithopone	0.0279	100.00	2.79
lica, 325 mesh	0.0426	55.62	2.37
otassium tripolyphosphate (10% solution)	0.1101	12.25	1.35
Vater	0.1200	204.00	24.48
Vater	0.1200	61.15	7.34
rotein (15% solution, KOH cut)	0.1150	72.70	8.36
)owicide (50% solution)	0.0952	11.12	1.05
ntifoamer (as required)		1.82	0.22 approx.
)ow latex 762-W (48% solids)	0.1185	379.20	44.90
ynthetic thickener (as required)			
IH$_4$OH or KOH to *p*H of 9.5			
		1147.86	100.00

tormer viscosity, 70–80 KU
'er cent solids, 52.5
'igment volume concentration, 35%

Procedure

The equipment needed is a conventional change can mixer and a suitable ıeans to grind pigment, such as high-speed stone mill, roller mill, or pebble ıill.

Pigments are ground together with the phosphate dispersing agent and part f the protein solution. The amount of protein solution and water may vary ıith the chosen method of milling. The ground pigments and additional vater are blended with the protein, Dowicide, antifoamer, and latex in the hange can mixer.

Viscosity and *p*H are adjusted as indicated if necessary.

* Courtesy of Dow Chemical Co.

Formula 5 * Latex Paint Made with Alkyd-Modified Dow Latex 762-W

	Gallons per Pound	Pounds	Gallons
Pigment Dispersion			
Titanium dioxide (rutile)	0.0286	250.00	7.14
Lithopone	0.0279	100.00	2.79
Mica, 325 mesh	0.0426	42.90	1.84
Potassium tripolyphosphate (10% solution)	0.1101	11.82	1.30
Water	0.1200	196.60	23.60
Alkyd Emulsion			
Long-oil soya alkyd	0.1200	34.43	4.13
Cobalt naphthenate (6%)	0.1264	1.08	0.14
Lead naphthenate (24%)	0.0996	2.78	0.27
NH$_4$OH (28%)	0.1350	1.63	0.22
Non-ionic wetting agent	0.0953	3.43	0.33
Dowicide (50% solution)	0.0952	10.94	1.43
Protein (15% solution, KOH cut)	0.1152	83.10	9.56
Water	0.1200	108.60	13.04
Antifoamer (as required)		1.73	0.21 approx.
Dow latex 762-W (48% solids)	0.1185	287.00	34.00
Synthetic thickener (as required)			
		1136.04	100.00

Stormer viscosity, 70–80 KU
pH, 9.5
Per cent solids, 52.0
Pigment volume concentration, 35%
Alkyd/latex solids ratio by weight, 20/80

Procedure

The equipment needed is a conventional change can mixer and a suitable means to grind pigment, such as high-speed stone mill, roller mill, or pebble mill.

Pigments are ground together with the phosphate dispersing agent and part of the protein solution. The amount of protein solution and water may vary slightly with the chosen method of grinding.

The alkyd emulsion can be prepared in a change can mixer. The ingredients are added with stirring in the order listed, allowing enough time between additions to obtain thorough mixing.

The ground pigments and additional water are blended with the alkyd emulsion followed by addition of the antifoamer and latex.

Viscosity is adjusted as indicated if necessary. The NH$_4$OH in the alkyd emulsion is adjusted to obtain the *p*H indicated.

* Courtesy of Dow Chemical Co.

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ed in their formulation. It will be understood that many variations of the formulations and procedures are possible.

The wetting agents facilitate the wetting of the pigments, and the equestering agents act as water softeners. The latter reduce the ctivity of soluble salts which may insolubilize the casein or react vith the emulsifying agents. The complex polyphosphates are suitble sequestering agents, and they include potassium tripolyphosphate nd tetrasodium pyrophosphate. In some cases methyl cellulose may e used instead of casein or soya protein as a protective colloid or tabilizer. See Chapter 13 for a brief discussion of the stability of mulsions, and for a formulation based on the acrylic resin latex, Rhoplex AC-33.

Formulas 6(*a*) and 6(*b*)* Semi-Gloss White Finishes

	6(*a*) Pounds	6(*b*) Pounds
Titanium dioxide (rutile)	250	250
Mica, water ground, 200/325 mesh	60	60
Water (soft)	260	260
Lustrex 820	30	20
Ammonium hydroxide (28% NH_3)	9	6
Foam suppressor †	10	10
Santicizer 160	83	..
Aroclor 1248	...	116
Water	56	30
Ethylene glycol	...	40
Thickener ‡	6.5	9
Lustrex 601-40	234	220
Yield, pounds	998.5	1021
Yield, gallons	91.03	89.69

Procedure

1. In a mixing vessel charge 260 lb of water, the pigments, and the foam uppressor and mix to wet out.
2. Add the ammonium hydroxide and continue mixing for a few minutes ntil viscosity breaks slightly.
3. Add the plasticizer (Santicizer 160 or Aroclor 1248 in the above examples) and mix in.
4. Add the balance of the water, the ethylene glycol (if indicated), the hickener, and finally the Lustrex 601-40 in that order, mixing in each before dding the next one.
5. Run the mix through a colloid mill or high-speed stone mill at the proper etting to yield the desired rate of through-put combined with good dispersion.

* Courtesy of Monsanto Chemical Co.
† Example used here: Glyceryl Monoricinoleate, S-grade, Glyco Products Co.
‡ Example used here: Acrysol GS New, Rohm and Haas Co.

Typical examples of formulations and method of handling the post-plasticized polystyrene system are given in Formulas 6(a) and 6(b). These are semi-gloss finishes, varying in the type of plasticizer.

Further details regarding the use of latexes in paints are given in Volume II. The latexes may be used as a sealer coat for paper and paperboard or other porous materials. Soft paper sheet which has been lightly beaten may be impregnated by immersion in the latex with subsequent withdrawal between squeeze rolls and drying. The latex pick-up may be adjusted to any desired amount. At about 100% pick-up the impregnated paper develops high tear and bursting strength, but retains its softness and flexibility. In this condition it makes an excellent base for coating with nitrocellulose lacquer or polyvinyl finishes. The latex may also be incorporated in the paper before sheet formation by special processes; see bulletin on Hycar latexes by the B. F. Goodrich Co.

The flexible type of latex also serves as an impregnant for low-cost textile sheeting materials to produce bases for artificial leather and similar compositions. It may be used on leather as a finishing material. Several applications are made by swabbing, and the finish is usually embossed under heat and pressure. The first application may be the straight latex, but subsequent applications usually contain casein, shellac, and other resins. The finish application usually contains a wax such as carnauba or candelilla.

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ve... types of calenders are available, some of which have more an three rolls.

Calendered Sheeting. An indication of the types of materials used th polyvinyl chloride resin to produce an unsupported blue sheeting itable for upholstery is given in Formula 1. Of course, considerable

Formula 1 * Calendered Blue Sheeting for Upholstery

	Parts by Weight
Geon 101 resin	100.0
Dioctyl sebacate	15.0
Octyl diphenyl phosphate	15.0
Polymeric plasticizer	7.0
Dioctyl phthalate	17.0
Calcium carbonate	15.0
Basic lead carbonate	3.0
Barium-cadmium laurate	1.0
Stearic acid	0.5
Phthalocyanine blue	2.0

* Courtesy of B. F. Goodrich Chemical Co.

ariation may be made to meet performance, color, or cost require-ents. Similar compounds may be made with the copolymer vinyl sins described in the following section. The formulation is mixed or ompounded in a Banbury mixer or on a two-roll rubber mill to a lastic mass, and is fed to the calender while quite warm so that it ill be relatively soft. The mixing time of the compound may be re-uced by using the EP-type resins in Table 3.

The four plasticizers in this compound are used to illustrate the prop-rties they impart. Dioctyl sebacate imparts low-temperature flexi-ility (see Table 4). It also improves the softness or "drape" and the elease action from the calender. Octyl diphenyl phosphate imparts ame resistance without decreasing low-temperature flexibility. The olymeric plasticizer may be used as a grinding medium for the pig-ent and stabilizer to ensure best dispersion of these materials in the ompound. A variety of polymeric plasticizers is available as indi-ated in Chapter 10. Calcium carbonate is a filler added to reduce aw-material cost. It should be kept to a minimum to avoid undue oss of tear strength and abrasion resistance. Basic lead carbonate is good heat stabilizer. Barium-cadmium laurate is a light stabilizer nd also protects the phosphate plasticizer during processing. Stearic cid is a lubricant to facilitate release from the rolls. The phthalo-yanine pigment imparts an excellent blue color which is quite stable o heat and light.

Recommendations regarding the use of vinyl chloride resins in extrusion and injection molding are available from the manufacturers. The use of the dispersion-type resins, such as Geon 121 and Geon 126 in Table 3, is similar to that of the copolymer dispersion resins described in the following section. This type of resin has made possible the economical use of vinyl chloride resins in spray, dip, and knife-coating applications.

VINYL CHLORIDE-VINYL ACETATE COPOLYMERS

At the present time the most important vinyl resins for surface coatings are the vinyl chloride-acetate copolymers. They are more soluble than the straight vinyl chloride resins, and they have better compatibility with plasticizers and other film-formers. These copolymers have high vinyl chloride content and therefore retain their sensitivity to degradation by heat and light. They produce extremely strong, tough films having excellent resistance to abrasion and chemicals. They are thermoplastic; therefore they are softened or removed by true solvents and swollen by some non-solvents. Some of these resins may be blended with relatively small percentages of other resins to produce thermosetting films. Some types may be used with alkyd resins, nitrocellulose, etc., to impart increased toughness and chemical resistance to these materials. The copolymers range from slow burning to non-flammable, but the correct plasticizers are required to produce non-flammable coatings.

Commercial Types. The vinyl chloride-acetate copolymers known as "Vinylite * resins" and produced by the Bakelite Co. will serve to illustrate the commercial types. A selected group of the Vinylite copolymer resins is shown in Table 5, together with some of the polyvinyl acetate and polyvinyl butyral resins.

Variations in Composition and Characteristics. The vinyl resins in Table 5 fall into four groups based on composition. The first group contains three of a series based on straight polyvinyl acetate but varying in molecular weight as indicated by their intrinsic viscosities. The second group are hydrolyzed polyvinyl acetate resins and therefore contain some polyvinyl alcohol, depending on the degree of hydrolysis. The third group is the vinyl chloride-acetate copolymers. They show a range of acetate content from 3% to 38%. In addition one resin contains hydroxyl groups from hydrolysis of the acetyl groups, and another is modified by the incorporation of a dibasic acid such as

* Trade mark.

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