P.F. Davey 3708g 7/14/?8

R.N. Wheeler, Jr.
Vinyl Chleride No. #4

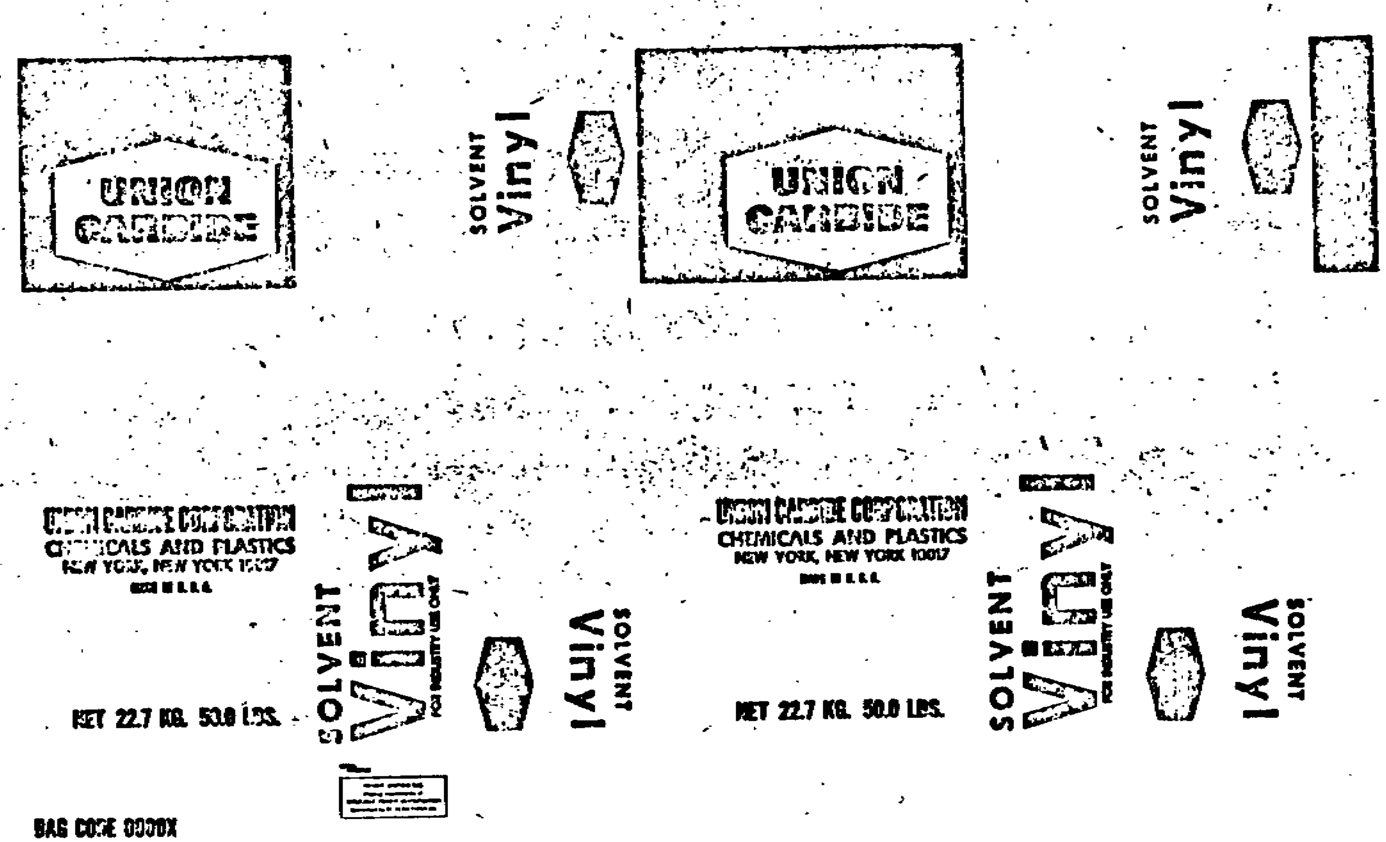
PVC - LABELS & REPORTS

Solvent Vinyl (plate CA) used 1976 - present
Vinyl (plate CB) used 1976 - present
Vinyl (plate AR) used 1976 -
Vinyl (plate AS) used 1973 - 1976

BAKELITE Vinyl (plate AL) used 1970 - 1972
Vinyl (plate AM) used 1970 - 1972
Vinyl (plate A) used 1966 - 1970

BAKELITE Vinyl Resins For Solution Coatings & Adhesives
Vinyl Product Date - BAKELITE Vinyl Solution Resin VYMM
BAKELITE Vinyl Solution Resin VYMH For Coatings
BAKELITE Vinyl Solution Resin VYNS - 3 For Coatings
BAKELITE Vinyl Solution Resin VYNS For Coatings
Product Information - BAKELITE Vinyl Solution Resin VYNS

PLATE CA



ATTACHMENT II

YEAR OF USE 1976 - PRESENT

7-23-76

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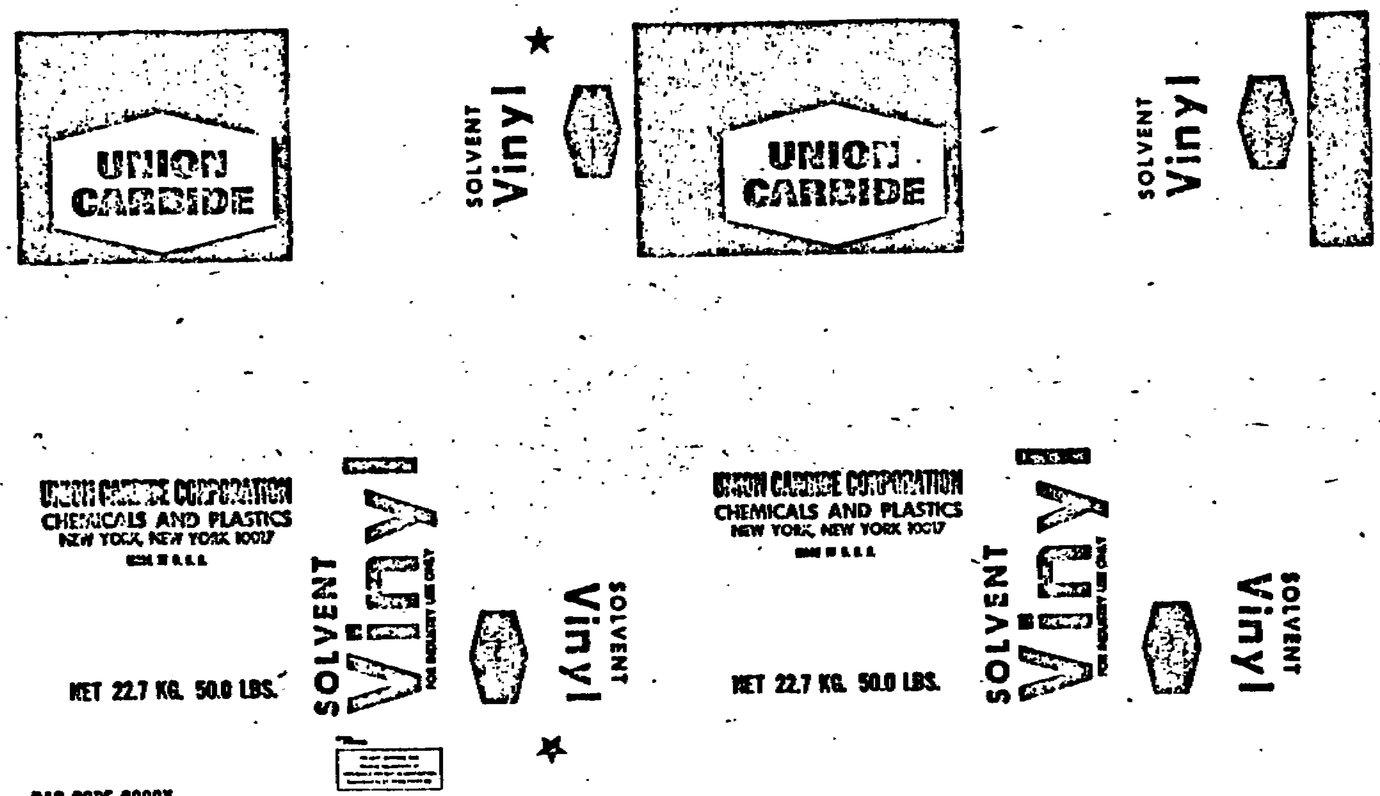
PLATE CB



YEAR OF USE 1976 - PRESENT

7-23-76

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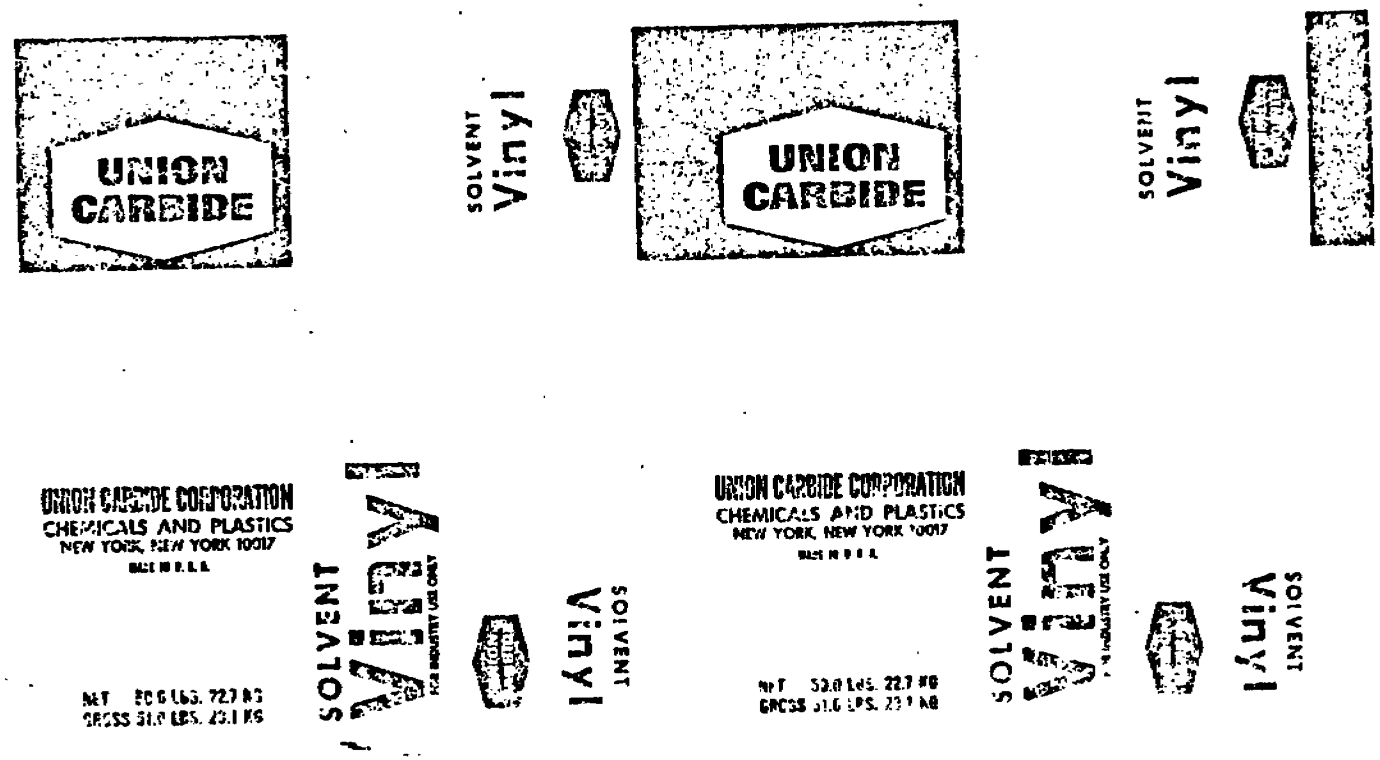

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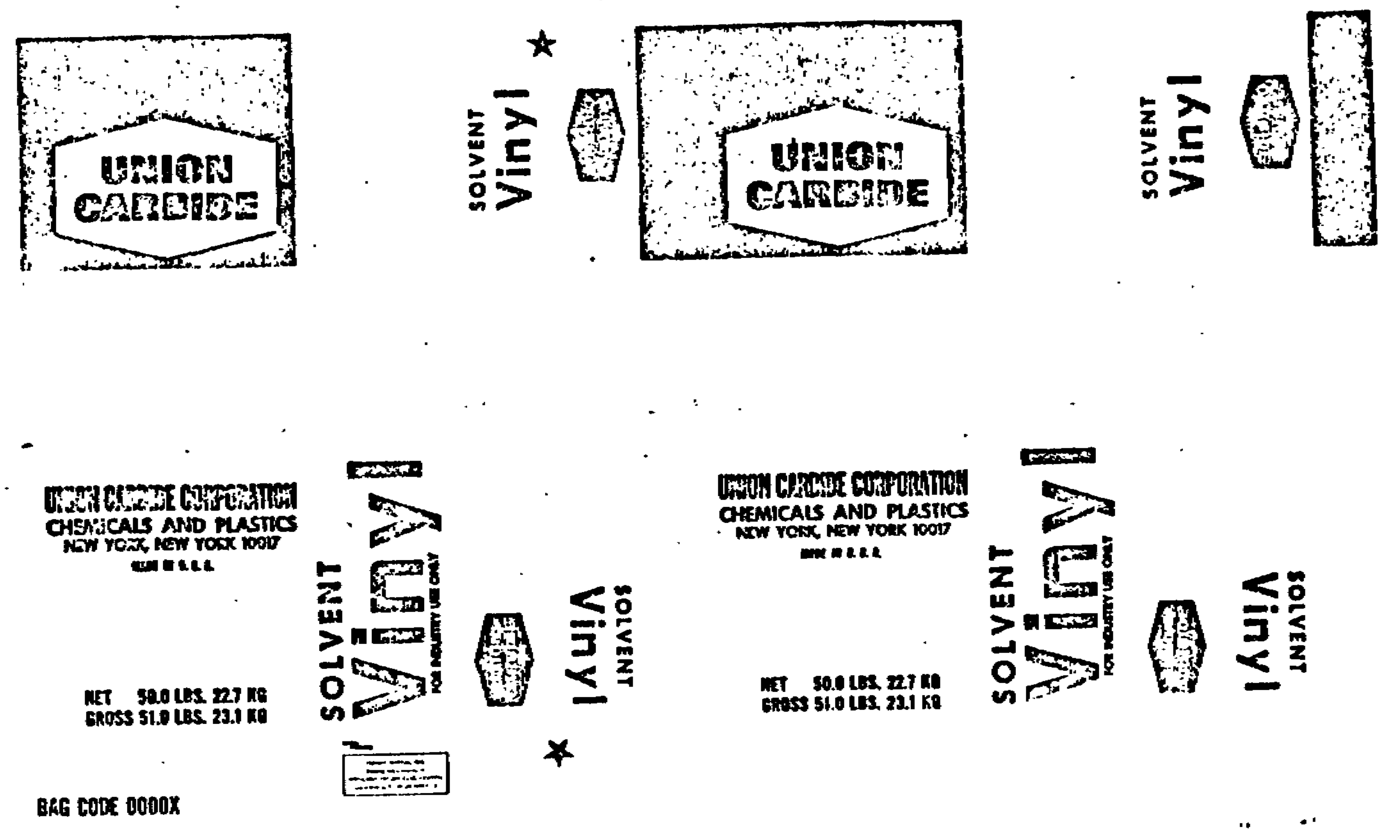
Plate AS



YEAR OF USE 1973 - 1976

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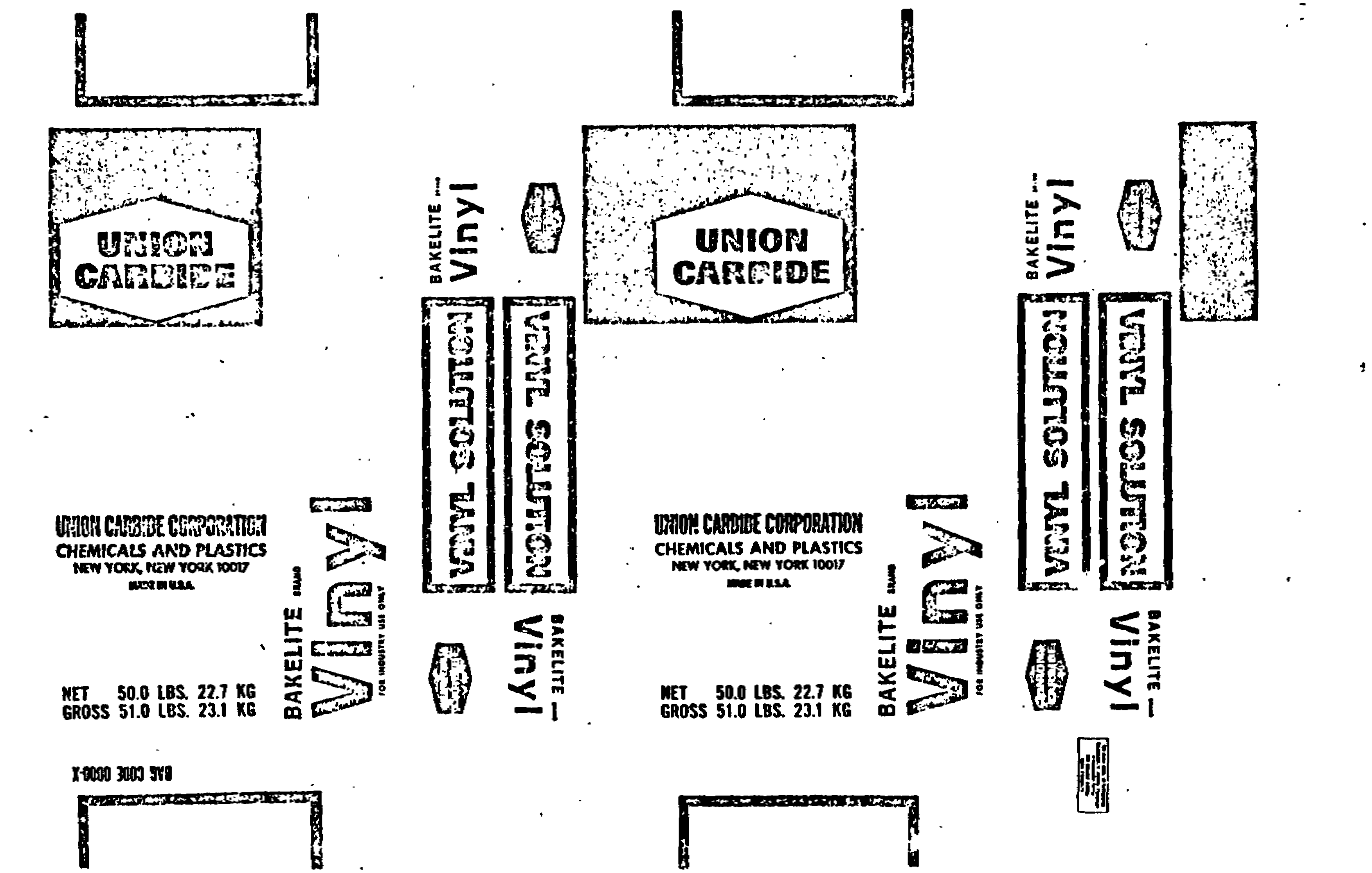
Plate AI



4-5-72

YEAR OF USE 1970 - 1972

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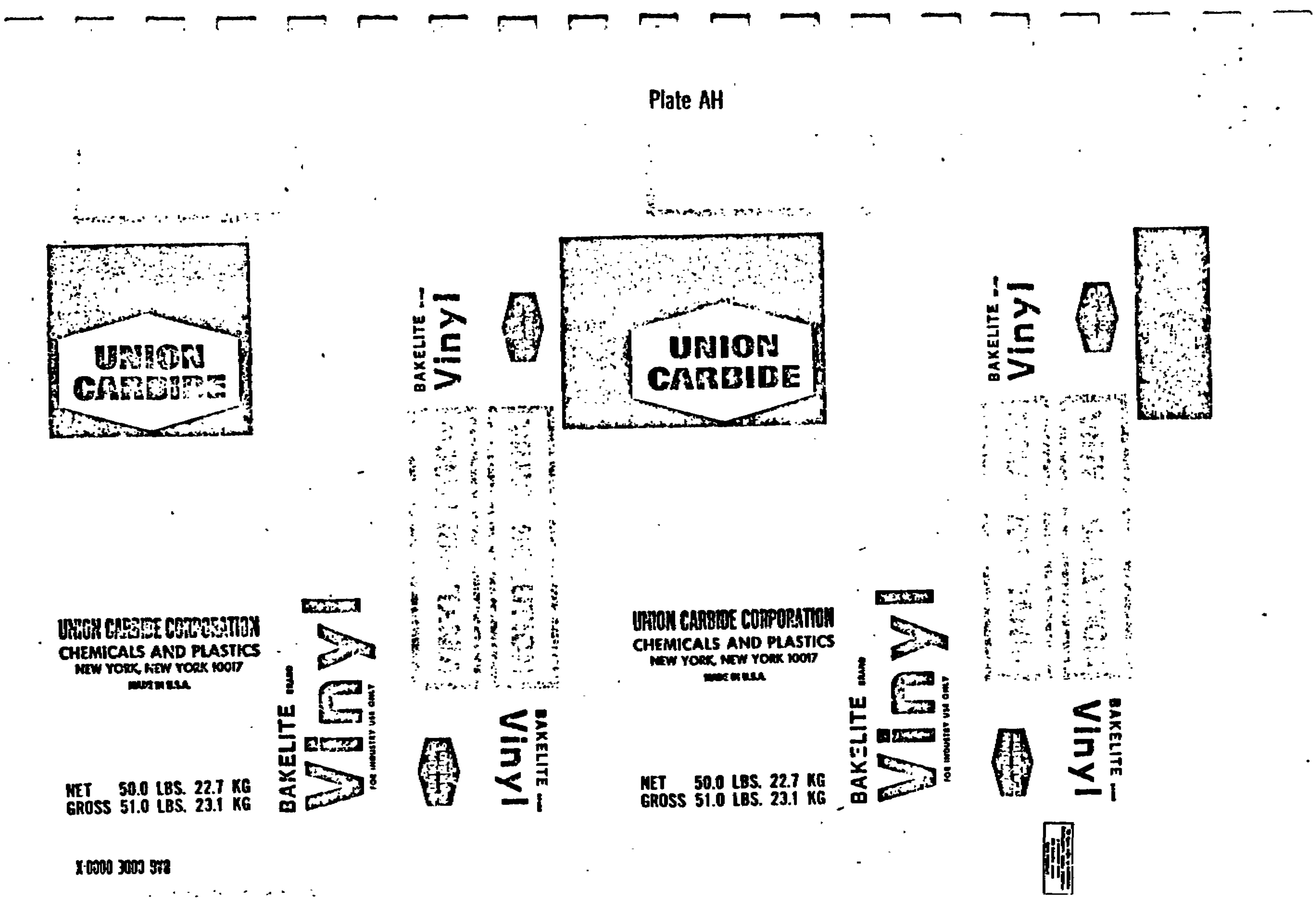
Plate AH



4-5-72

YEAR OF USE 1970 - 1972

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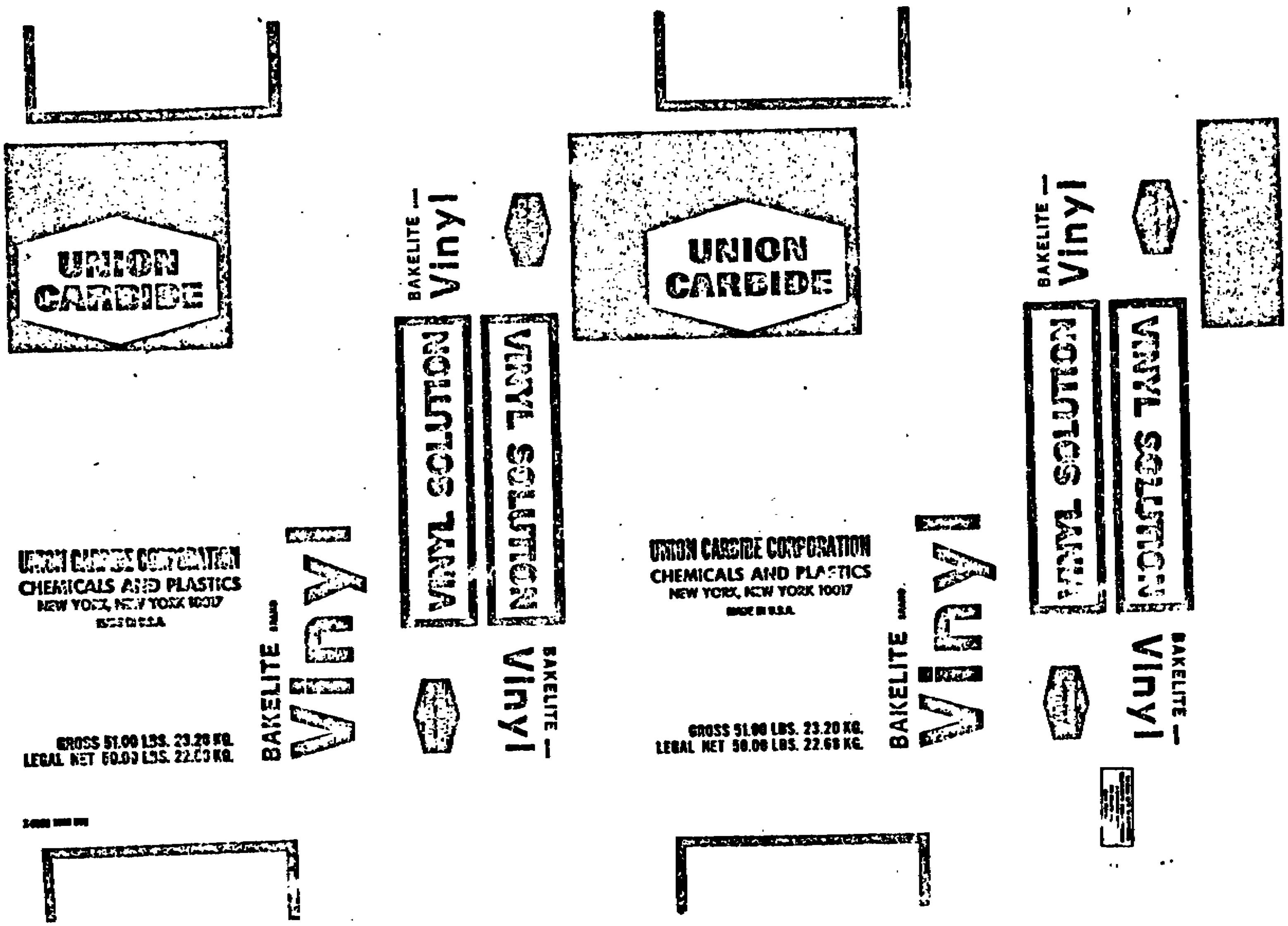
Plate A



YEAR OF USE 1965 - 1974

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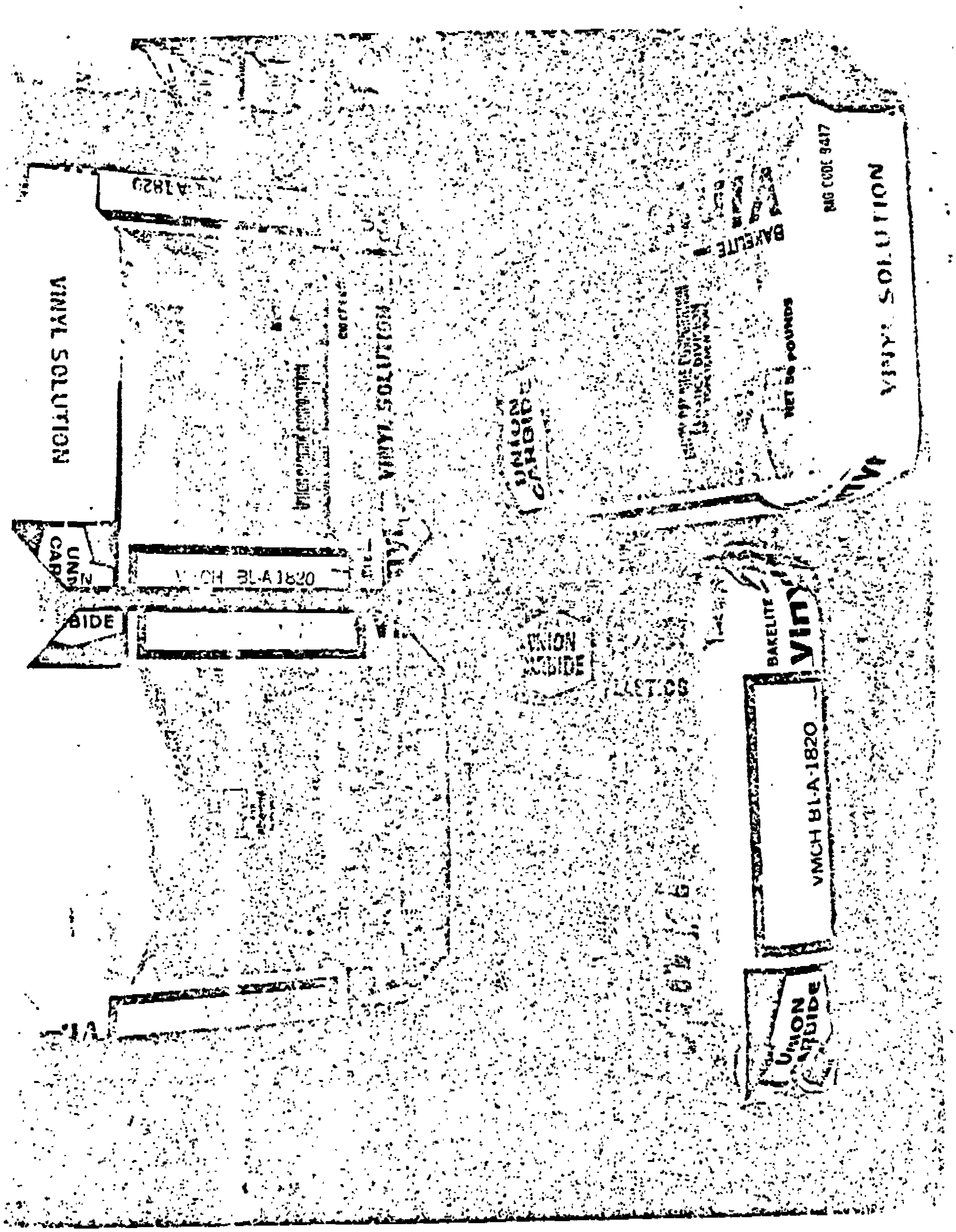
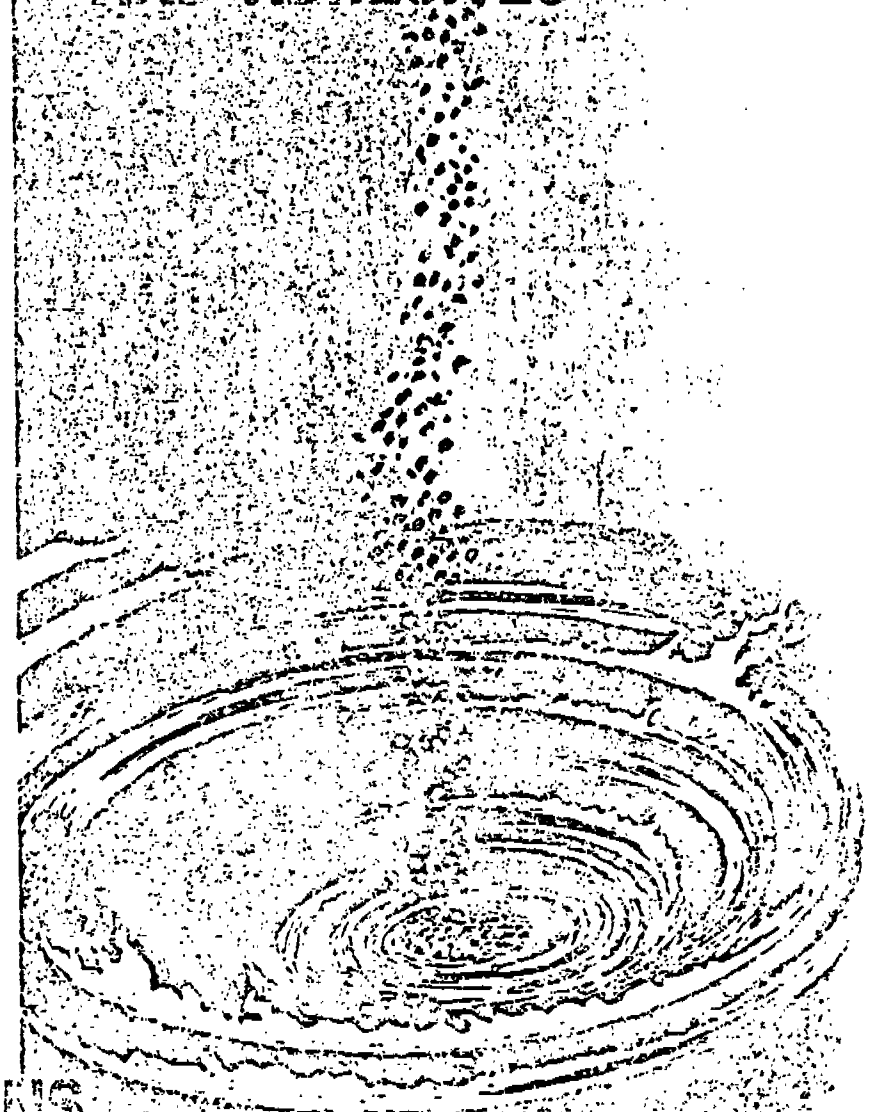

VINYL SOLUTION
VMCH BL-A 1820
UNION CARBIDE
BAKELITE
VINYL SOLUTION
VMCH BL-A 1820
UNION CARBIDE
BAKELITE
BAG CODE 9417
VINYL SOLUTION

ATTACHMENT IV

Rml

from ...

BAKELITE VINYL RESINS FOR SOLUTION COATINGS AND ADHESIVES



UNION CARBIDE RESINS

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CONTENTS

INTRODUCTION

BAKELITE vinyl solution resins present a unique combination of outstanding properties with an impressive service record of more than 20 years of proven performance. The versatility inherent in vinyl resins makes them particularly suitable for a wide range of surface coating applications, making it possible to select a specific resin for the desired coating performance requirements.

The principal monomer of BAKELITE vinyl solution resins is vinyl chloride. Because of its low solubility, vinyl chloride alone is of little use in solution coatings. The solubility in organic solvents is increased by copolymerizing vinyl chloride with 3% to 14% vinyl acetate. Variations in the ratio of these two constituents and the degree of polymerization determine the copolymer resin properties. Resins with a high molecular weight and a high vinyl chloride content are less soluble and produce high solution viscosity, but these resins yield films of higher strength and toughness, and optimum water, abrasion and chemical resistance.

Copolymerization of these vinyl chloride-vinyl acetate resins with maleic acid provides air-dry adhesion to metal, as well as crosslinking possibilities. Alcohol groups may be added to promote compatibility with many other types of film forming materials such as alkyd, acrylic, amino, epoxy, polyamide and polyketone resins, urethane prepolymers and certain urea-formaldehyde and melamine resins.

Many BAKELITE vinyl solution resins are listed in the Adhesives Regulation 121.2520 and also in the Resinous and Polymeric Coatings Regulation 121.2514 for coatings used as food contact surfaces when applied to metal substrates. This list is referred to in the regulation 121.2526 for coatings for paper and paperboard. They may also be used in closures with sealing gaskets for food containers, Food Additive Regulation 121.2550.

Vinyl solution resins are used for maintenance paints; can, tube and closure linings; industrial and factory applied coatings; prefinished aluminum and wood panels for house siding; and paper, metal foils, cloth and many other high-performance coatings.

PERFORMANCE PROPERTIES OF VINYL SOLUTION RESINS

BAKELITE vinyl solution resins are neutral and non-oxidizing. They are characterized by absence of color, odor and taste. Films of these resins are not affected at normal temperatures by alkalies, mineral acids, alcohols, greases, oils, or aliphatic hydrocarbons.

ADDITIONAL OUTSTANDING COATING PROPERTIES ARE:

- Excellent weather resistance. Commercially used pigmented vinyl coatings, baked or air-dried, have now shown excellent durability for 20 years of continuous exterior service.
- Water resistance. Films based on vinyl resins possess both low moisture vapor transmission and absorption rate. Since 1948, the metal gates and under-water structures of a navigation channel on the Mississippi River have been protected from corrosion by a vinyl-based maintenance system. This coating meets U. S. Army Corps of Engineers Specification. Other specifications based on these resins are widely used in marine applications.
- Excellent toughness and flexibility. Metal sheets and coil can be precoated at the factory. They will not crack, mar or lose adhesion while being shipped or fabricated into various end-products. Wood products of great durability and utility can be factory finished.
- Flame retardant. Vinyl resins will not support combustion.
- Water-white color and good clarity. These properties make possible clean whites and tints in pigmented coatings, and brilliant films in clear finishes.
- Ease of application. Vinyl coatings can be formulated for application by conventional methods such as spraying, dipping, tumbling and knife, roller or curtain coating. Vinyl solutions can be sprayed hot or cold without "stringing" or "cobwebbing."
- Thermoplasticity. Coatings or films of vinyl resins can be readily heat-sealed. The thermoplasticity of the resins can be controlled to produce finishes which reflow on baking to eliminate sanding scratches.
- Vinyl copolymer coatings, once freed of residual volatiles, show no embrittlement or shrinkage upon aging.
- Excellent exterior durability on plywood and hardboard. A coating system* using a vinyl-urethane primer over medium density phenolic overlaid plywood has recently been certified by the American Plywood Association as a Qualified Coating.

*This coating is covered by U. S. Patent 3,024,216, granted to Union Carbide Corporation. Licenses are readily available to paint manufacturers; write to Manager Patents and Licenses, Union Carbide Corporation, Plastics Division, 270 Park Avenue, New York, N. Y. 10017.

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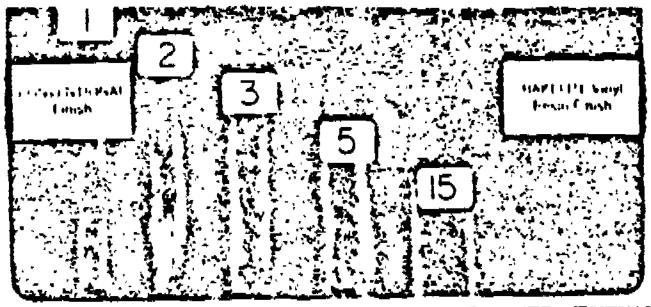
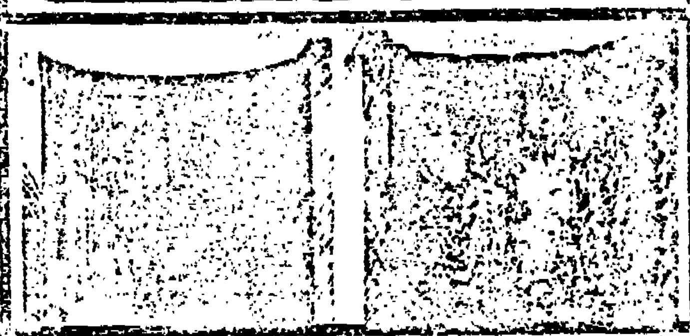
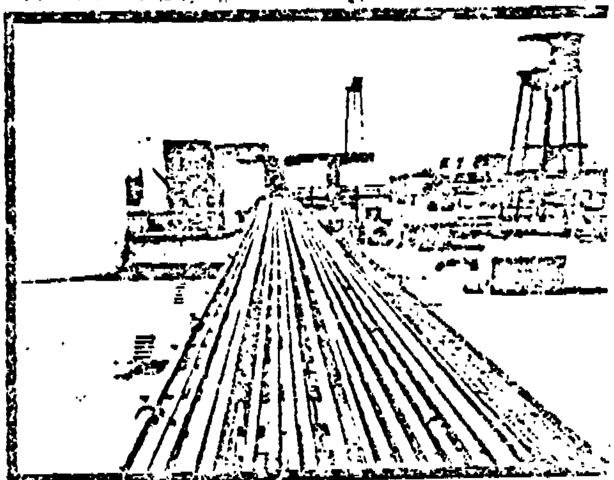


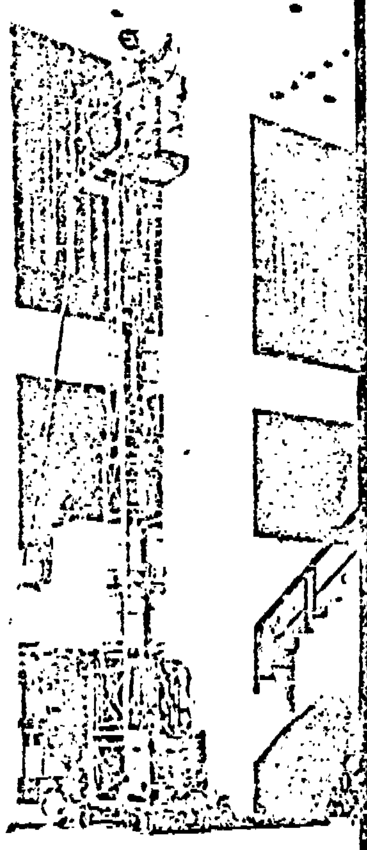
Both of these oil well pipe sections were removed after [illegible] months exposure. Pipe at left was coated with vinyl resins and shows no signs of corrosion. Pipe at right was uncoated.



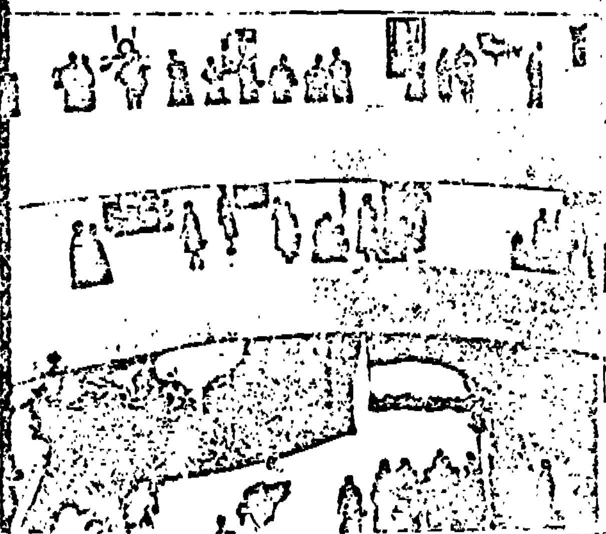
After 11 years of blistering Texas heat and humidity, plus the corrosive attacks of chemical fumes, these pipes are still being protected by vinyl-based maintenance paints.



A 20 mil coating is being applied to the columns at the U.N. Protection from fingerprints and scuff marks, moisture and abrasion is long-lasting.



BAKELITE vinyl resins were also used on many of the interior areas of the Guggenheim Museum—the cooking and counter areas of the cafeteria, the washrooms, the decorative pools and the entrance lobby. All these areas demand the tough, water and abrasion resistant finish provided by vinyls.



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COMPOSITION AND CHARACTERISTICS OF VINYL RESINS

There are three major classes of BAKELITE vinyl copolymer solution resins:

- Vinyl chloride-vinyl acetate
- Vinyl chloride-vinyl acetate, maleic acid modified
- Vinyl chloride-vinyl acetate, hydrolized (contains OH groups)

Variation in the ratio of vinyl chloride to vinyl acetate and the degree of polymerization produce a wide range of vinyl copolymers with distinct properties. The amount of vinyl acetate present will mainly influence the solubility of the copolymer. An increase in the acetate content widens the range of solvents which can be used. Resins with a high vinyl chloride content produce strong, tough films with excellent water and chemical resistance. Adhesion of straight vinyl chloride-vinyl acetate resins to bare metal surfaces develops only after baking. Air-dry adhesion to metal may be obtained by blending straight vinyl chloride-vinyl acetate resins with a maleic acid modified vinyl resin. If adhesion to vinyl butyral wash primers or other resinous primers is desired, hydroxyl modified vinyl resins should be used as the blending resin.

The degree of polymerization affects the viscosity and resin properties. High molecular weight resins produce higher solution viscosities, and yield films of maximum strength and higher softening point than the low molecular weight classes of resins.

Further modification of vinyl chloride-vinyl acetate resins with alcohol groups increases compatibility with other types of film-forming materials, particularly with alkyd resins, and with a number of oleoresinous vehicles, polyamides, polyketones, urethane prepolymers and certain urea-formaldehyde and melamine resins. This compatibility makes it possible to improve the properties of other types of surface coating materials by fortifying them with a hydroxyl modified vinyl copolymer. Conversely, it is possible to increase the "build" and "flow" of vinyl resin finishes by the use of modifying alkyds. These vinyl-alkyd combinations can be hardened by the addition of urea and melamine resins. The greater compatibility of these hydroxyl modified vinyl resins has opened up broader fields of end-use applications. Another important quality of these modified vinyl resins is good air-dry adhesion to different types of finishes, particularly to vinyl butyral resin-based wash primers, or metal conditioners.

BAKELITE vinyl chloride-vinyl acetate resins modified with maleic acid have excellent adhesion to clean metal as an air-dry or baked primer or topcoat. The carboxyl groups introduced into vinyl copolymer resins also provide points of reactivity for cross-linking reactions. The adhesion of other BAKELITE vinyl resins can be improved with the addition of these maleic acid modified resins.

This booklet presents only general information and performance properties of BAKELITE vinyl solution resins. A more specific description and discussion of each resin is presented in the appropriate Product Data Sheet available from Union Carbide's Plastics Division.

SOLUBILITY

BAKELITE vinyl solution resins are readily dissolved into a clear solution at room temperature by ketones, nitroparaffins, certain esters and chlorinated hydrocarbons. Solvents such as keto-ethers, ether-esters, polyethers, and certain other types of compounds have varying degrees of solvent action on these vinyl resins. Aromatic hydrocarbons, like xylene or toluene, tend to swell and in some instances partially dissolve the resins, especially at higher temperatures. Water and aliphatic hydrocarbons are strong precipitants for vinyl resins. Alcohol also will precipitate vinyl resins, except for the hydroxyl modified type which tolerates alcohols as a small proportion of the diluent.

Ketones are the most suitable primary solvents for vinyl resins. Compared to other solvents, they will yield higher resin concentration solutions without gelling, and lower solution viscosities at equivalent total solids content; they tolerate greater dilution with non-solvents and exhibit good storage stability.

Some of the chlorinated hydrocarbons are excellent solvents and are especially valued for their non-flammability. Methylene chloride, ethylene dichloride, or trichloroethylene are generally used to prepare non-flammable solvent mixtures. It should be noted that chlorinated solvents are very selective in their solvent strength for vinyl copolymer resins. Carbon tetrachloride, for example, is a non-solvent for these resins. These solvents also are highly toxic and utmost care should be taken in handling them. Chlorinated hydrocarbons should only be used in applications where effective ventilation is maintained.

Nitroparaffins, nitroethane and nitropropane, are also very effective solvents for vinyl resins. They do not yield as low a viscosity as ketones but have a slower evaporation rate and a mild odor.

Because of their low solvent power, esters are generally used in a mixture with another active solvent. In special cases, solutions formulated with esters may result in a slight cost saving. They also have a milder odor than ketones. However, all esters used for vinyl resin solutions should always be of high purity (alcohol-free).

In formulating thinners for vinyl surface coatings, many factors other than solvent power must be considered. Evaporation rate, toxicity, flammability, package stability and current market prices will have a decisive effect on the final solvent mixture selected for a vinyl solution.

The ratio of active solvent to diluent will vary with the solution viscosity and evaporation rate desired for a specific application. Suitable thinner mixtures for spray application may consist of methyl ethyl ketone, methyl isobutyl ketone and methyl isoamyl ketone as solvents, with toluene and xylene as diluents. Methyl ethyl ketone has excellent solvent power and is available at low cost; however, the amount used should be carefully balanced with an appropriate amount of diluent. In a humid atmosphere, a high proportion of methyl ethyl ketone in the thinner will cause blushing of the coating, and blistering before and during baking in warm weather. Methyl isoamyl ketone tends to eliminate blushing and blistering. It retards drying of the coating, improving flow-out. Small proportions of isophorone can be used for the same purpose. Other types of solvents and diluents, such as nitroparaffins, small portions of esters or high-solvency naphthas, may sometimes be used in certain spraying thinners.

Paper and cloth coatings may be formulated with highly volatile solvents such as acetone and methyl ethyl ketone. The use of high-volatile solvents in this application presents no problems.The lower heat capacity and rate of heat transfer of paper and cloth diminish the possibility of moisture-blushing, and controlled drying conditions prevent blistering. Under these conditions, it is feasible to use mixtures such as acetone and toluene. Even though a large amount of the active solvent portion evaporates soon after application, this loss in solvent power of the solvent mixture is counterbalanced by an increase in solvent power of the toluene at elevated oven temperatures.

Application by roller coaters requires slow-evaporating solvents and diluents. Isophorone has particular merit in such thinners because it combines slow evaporation rate and an excellent solvent action on vinyls. High-boiling coal-tar and hydrogenated-petroleum naphthas normally serve as diluents.

Thinners for brush application also call for relatively slow evaporating solvents, such as CELLOSOLVE acetate, methyl isoamyl ketone, mesityl oxide and cyclohexanone, in order to obtain ease of application and good flow-out. The active solvent proportions should be carefully balanced with a sufficient amount of diluent to minimize the tendency of topcoats to redissolve and "pick-up" undercoats.

SOLUTION CHARACTERISTICS

The major criteria for evaluating solvents and solvent-diluent mixtures for vinyls are the viscosity characteristics of the resultant solutions. Solutions of vinyl copolymer resins exhibit three distinct types of viscosity behavior that should be thoroughly understood to obtain best results. As the resin concentration of the solution increases, the consistency changes from fluid to thixotropic and then to a gel. These consistency-phase changes may be influenced by solution concentration, active solvent used, ratio of active solvent to diluent, and solution temperature. In any given solvent mixture, there is a prolonged time lag (one week or more) for the solution to reach a "true" or equilibrium viscosity at a given temperature.

PLASTICIZATION

The flexibility inherent in vinyl chloride-vinyl acetate copolymers is further increased by the addition of one or more suitable plasticizers. The selection of an appropriate plasticizer presents no difficulty. A large variety of monomeric chemical plasticizers and polymeric resinous plasticizers is available to coatings formulators. The plasticizer used should have a solvent action on the vinyl resins. Complete solubility of the resin in the plasticizer will promote better retention of the latter in the film, reducing chance of exudation on aging and possible migration of the plasticizer.

The addition of a solvent-type plasticizer to the coating will also minimize solvent retention in the film. An unplasticized coating will often retain as much as 4 to 5 per cent solvent in the film, even after long air-drying or forced-drying at 160°F to 175°F. This solvent retention occurs particularly in spray-type coatings. It is believed to be associated with the relatively slow diffusion of the solvent to the surface of the coating, which permits the film surface to harden, trapping some of the solvent. When 10 to 25 per cent of a solvent-type plasticizer is present in the film, this surface hardening is retarded, allowing the solvent to evaporate completely.

Vinyl solution resins exhibit best compatibility with chemical or monomeric plasticizers and fair compatibility with polymeric resinous materials. Sometimes, polymeric plasticizers may be substituted for a portion of the monomeric types to meet special requirements such as low extractability or migration.

Where vinyl coatings require baking, it is important to know the evaporation rates of plasticizers to be used. Many plasticizers, especially the monomeric chemical types, partially volatilize at the elevated temperatures required for baking the vinyl finish and thus result in a lower ratio of plasticizer than designed in the original formula.

Other important characteristics, such as toxicity, non-flammability, color, odor and taste must also be carefully considered before selecting a suitable plasticizer for a particular application. For the ultimate combination of properties, it will often be necessary to formulate coatings with more than one plasticizer.

The proportion of plasticizer in the coating will depend on the vinyl solution resin used and the performance properties desired.

COMPATIBILITY WITH OTHER RESINS

Unmodified vinyl chloride-vinyl acetate copolymers have a very low order of compatibility with most other resin types. They may be blended with carboxyl modified vinyl copolymers to obtain adhesion to bare metal. Carboxyl modified copolymers are also utilized to improve air-dry adhesion of many acrylic coatings. The hydroxyl modified vinyl copolymers have broad compatibility with other resinous materials such as alkyd resins, urethane prepolymers, phenolics, polyketones, acrylics, urea and melamine resins. Table 1 shows a listing of suitable modifiers and the properties imparted by each.

TABLE [illegible] MODIFYING RESIN[illegible]

Modifier	Typical Examples	Supplier*	Remarks
Alkyd	"Beckosol" P-296-70	4	Improves gloss and gloss retention.
	"Duraplex" ND-77-B	5	Increases solids. Some sacrifice in
	"Paraplex" D-65-A	5	chemical and other severe exposure
			atmospheres.
Acrylic	"Acryloid" B-66	5	Increases hardness, [illegible] and gloss
	"Acryloid" B-72	5	retention. Reduces [illegible] stability and
	"Acryloid" AT-50	5	flexibility. Tends to [illegible] prolonged
			exposure.
Epoxy	BAKELITE Epoxy Resin ERL-2772	6	Improves adhesion, [illegible] stability, and
Bisphenol A type	BAKELITE Epoxy Resin ERL-2774	6	flexibility. [illegible] the epoxy [illegible]. Excessive
	BAKELITE Epoxy Resin ERL-2795	6	chalking on exposure.
Peracetic acid type	UNOX Epoxide 221	7	
	UNOX Epoxide 259	7	
Butoxy	"Buton" 100	2	Improves adhesion and increases solids
	"Buton" 200	2	at some sacrifice in flexibility and color
	"Buton" 300	2	retention.
Phenolic	BAKELITE Phenolic Resin BKR-2620	6	Increases adhesion, solids and hardness.
	BAKELITE Phenolic Laminating Material CLS-3112	6	Suggested for baking primers for vinyl topcoats.
Wax	"Cardis" Polymer	8	Improves chip and mar resistance.
	BAKELITE Polyethylene Resin DYDT	6	Used in small quantities for paper
	Paraffin		coatings.
Polyketone	BAKELITE Polyketone Resin 251	6	Increases solids, compatibility, adhesion
	BAKELITE Polyketone Resin 252	6	and hardness. Some sacrifice in flexibility.
Amine	"Cymel" 300	1	For baking types. Increases gloss and
	"Resimene" 872	3	gloss retention, hardness. [illegible] loss in
	"Resimene" U-933	3	flexibility on aging.
	"Uformite" F-240	5	

*Key to Suppliers:

1. American Cyanamid Co., Plastics & Resins Division
2. Enjay Chemical Co.
3. Monsanto Co.
4. Reichhold Chemicals, Inc.
5. Rohm & Haas
6. Union Carbide Corporation, Plastics Division
7. Union Carbide Corporation, Chemicals Division
8. Warwick Chemicals Co.

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HEAT AND LIGHT STABILIZERS

Vinyl solution resins are degraded by prolonged exposure to ultraviolet light or by elevated temperatures. The degradation of vinyl copolymer films is minimized by the addition of suitable stabilizers and an adequate quantity of certain pigments. The amount and type of stabilizer to be used are dependent upon the vinyl resin itself, the plasticizer and pigment, the baking schedule, and the end-use application of the coating. The best heat stabilizers for vinyl copolymer resins are compounds that are slightly basic in nature and, at the same time, are insoluble in water. For clear films the stabilizer used must be clear and colorless. In such cases, some of the organic compounds of calcium, barium, cadmium, tin and lead are effective heat stabilizers. Epoxy resins in combination with the above metallic organic derivatives provide maximum stability.

Small amounts of urea-formaldehyde or melamine-formaldehyde resins (between 1 and 3 phr), also effectively stabilize clear films. Such films tend to develop checking or other discontinuities during baking, but these can be prevented by adding to the coating small amounts (approximately 1 phr) of long-oil, drying-type alkyds, or non-drying or semi-drying oils.

Substrates such as zinc, iron and tin plate accelerate decomposition of the coating during baking. Therefore, prior to the coating's application, the surface of these metals should be made passive by chemical treatment, such as by phosphate treatment, or by use of a varnish or oil-type primer.

FORMULATING OF CLEAR COATINGS

Clear coatings consisting exclusively of BAKELITE vinyl solution resins provide the maximum chemical inertness that can be obtained from any surface coating based on these resins. Consequently, unmodified vinyl solutions are applied wherever exceptional chemical and abrasion resistance is required.

Clear coatings can be modified for specific requirements by additions of plasticizers, dyes, heat and light stabilizers. These modifiers may influence the overall performance properties of the coating. Therefore, the characteristics of modifiers should be well understood, before a specific modifier for a certain coating performance is selected.

The selection of plasticizers, solvents and stabilizers for vinyl solution coatings has been discussed in general in preceding sections of this booklet. Clear coatings which must withstand direct sunlight or weathering require the addition of an ultraviolet light stabilizer to screen the film-degrading ultraviolet rays of the sun. If the coating requires baking, a combination heat and light stabilizer, such as a barium-cadmium-epoxy complex has to be used. The addition of small amounts of propylene oxide will prevent discoloration of clear coatings during preparation and storage.

PREPARATION OF SOLUTIONS

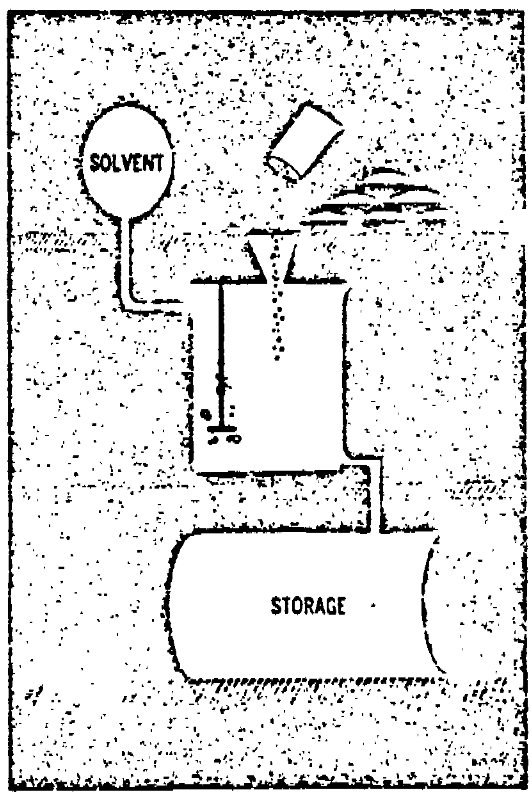
The preparation of solutions of BAKELITE vinyl resins in solvents or solvent-thinner mixtures can be easily carried out with the proper mixing equipment and technique. In general, the mixer should be capable of producing a high degree of sheer, and in viscous solutions this calls for a considerable power input. Slow-speed paddle-type agitators ordinarily are not nearly as effective as higher speed propeller, disc or turbine-type mixers. Tanks should be equipped with tight-fitting covers, and the addition of side baffles often improves the turbulence and diminishes swirling. In general, aluminum or stainless steel is most satisfactory for the construction of this equipment.

Best results are usually obtained in dissolving the resins if the solvent or thinner is first placed in the mixer and then agitated. A solution can be made more rapidly if the resin is added only as fast as it dissolves. If added too quickly, the resin may lump together, and delay final solution. The resin can often be dissolved more rapidly in solvent-diluent mixtures than in pure solvent, primarily because of the decreased tendency to form lumps.

Another method frequently employed commercially, is quite satisfactory where considerable proportions of diluent are to be used. The resin and the diluent portion of the thinner are mixed until all of the resin is thoroughly wetted. Then, while this resin-diluent slurry is vigorously agitated, the active solvent is added slowly. Complete solution can often be effected within several minutes by this technique.

In case of accidental contamination in large-scale production of coatings, it is suggested that such solutions be filtered prior to use. The use of a special, heavy, open-type filter paper, inserted over the canvas cloth in the plate-and-frame-type press, gives improved results. The use of a small proportion of diatomaceous filter aid in the solution is recommended.

During preparation, most solutions become heated, especially when highly viscous solutions are being prepared. The solution temperature, however, should be kept as low as possible. It is also recommended that the solution should not be held for a long time under these conditions, because this might cause discoloration, especially when the solution is in contact with iron. Addition of a small amount (0.1-0.3%) of propylene oxide will eliminate this solution discoloration. The addition of propylene oxide is especially recommended for solutions stored in iron containers and/or containing large proportions of methyl ethyl ketone.



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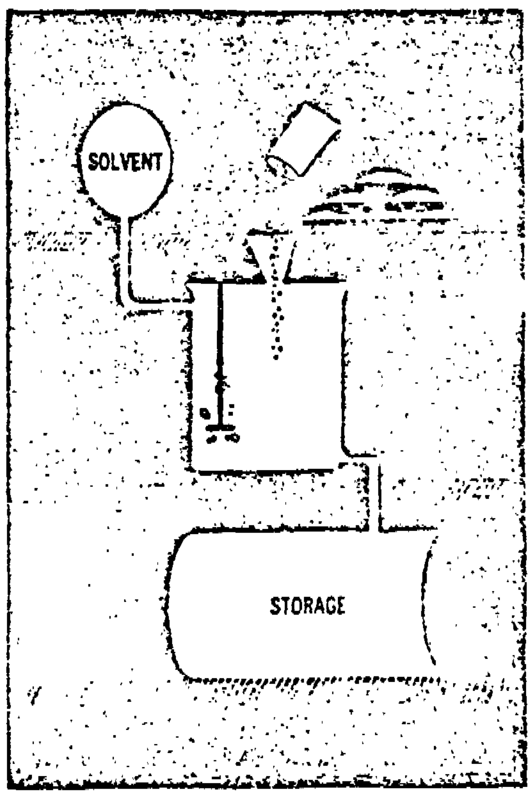


FORMULATION AND PREPARATION OF PIGMENTED COATINGS

The compounding of pigments in vinyl solutions presents no serious difficulties. A large list of suitable pigments and pigment pastes for vinyl copolymers is available to the coating formulator. Paints can be prepared to meet the specifications for a particular application. The ingredients selected for the final formulation and the number of coats to be used, will depend on the coating performance properties required, the substrate to be coated, the method of application and curing, and also the cost limitations. After selecting a suitable pigment, the ratio of pigment to binder has to be determined for maximum hiding power and durability of the coating. For exterior finishes, the pigment concentration should be slightly higher than the optimum amount required for sufficient color and hiding. The higher pigment concentration serves to protect the vinyl resin from degradation by ultraviolet rays. However, the amount of pigment used should not be so large as to cause excessive chalking. Improved chalk resistance can be obtained by replacing one out of ten parts of titanium dioxide with antimony oxide. Finishes not requiring exceptional resistance to exterior exposure have less limitations on degree and type of pigmentation. The emphasis with these coatings is often on other film characteristics, such as resistance to marring, abrasion or moisture, or freedom from toxicity.

Pigments are readily dispersed in vinyl solutions on conventional compounding equipment such as the two-roll mill, pebble mill, sand mill or high-speed impeller mixer. The various dispersing methods will be discussed in more detail in following sections.

BAKELITE vinyl resins have found many applications in the coating field. Applications are too varied for any detailed discussion of their formulations. A number of starting point formulations for many types of vinyl coatings are available from Union Carbide's Plastics Division. Usually, it has been found that each specific application requires its own modifications. Pigment types most generally used in solution coatings based on BAKELITE vinyl resins are presented in Table 2. The amounts suggested are based on the quantity of each pigment necessary to ensure good hiding and adequate ultraviolet light protection of the coating.

[illegible]

SELECTION OF PIGMENTS

General pigment characteristics which must be considered are hiding power, ultraviolet light protection, purity, ease of wetting and dispersion in the vehicle, and resistance to solvent bleed, chemicals, and heat.

Titanium dioxide, manufactured by the sulfate process, should be used for white coatings where maximum durability is desired. Traces of natural iron contamination will increase the chalking rate and discoloration. Such contamination from any source should be avoided. Pigments containing unstable forms of natural iron or zinc will also adversely affect the heat stability of vinyl resins. For baking formulations, proper stabilizers should be added to minimize the adverse effects of some metal contaminants. Iron (Prussian) blue should be avoided in all coatings since it will promote both heat and light breakdown of the vinyl resin. This prohibition would include so-called "chrome greens" which are blends of Prussian blue and lead chromate. Chromic oxide green, however, is an excellent pigment.

Replacing 10% of titanium dioxide with antimony oxide will enhance gloss retention in whites and tints. Antimony oxide functions in a dual capacity; it serves as an ultraviolet light screening agent and as a good stabilizer for vinyl solution resins. Inert or extender pigments may be included in formulations for economy. High purity grades of calcium carbonate, mica, or other nonfibrous extenders are often used. Small amounts of flatting agents such as the silica gel type may be added where desired.

With but few exceptions, most common pigments can be used successfully with vinyl solution resins. A list of pigments recommended for use with BAKELITE vinyl resins is shown in Table 3. There are undoubtedly other pigments fully as satisfactory as those suggested and the rapid advances in color manufacturing assure a steady increase in these materials.

[illegible]

[illegible]

PYRANTHRONE [illegible]

ORANGES

[illegible]

[illegible] ORANGE [illegible]

CADMIUM ORANGE [illegible]

Cadmium Lithopone

Cadmium Toner

ANTHANTHRONE

VAT ORANGE [illegible]

BLUES

PHTHALOCYANINE BLUES

Phthalocyanine Blues (non-crystallizing, [illegible])

COBALT BLUE [illegible]

VAT BLUE [illegible]

[illegible]

[illegible]

[illegible]

DISPERSION OF PIGMENTS

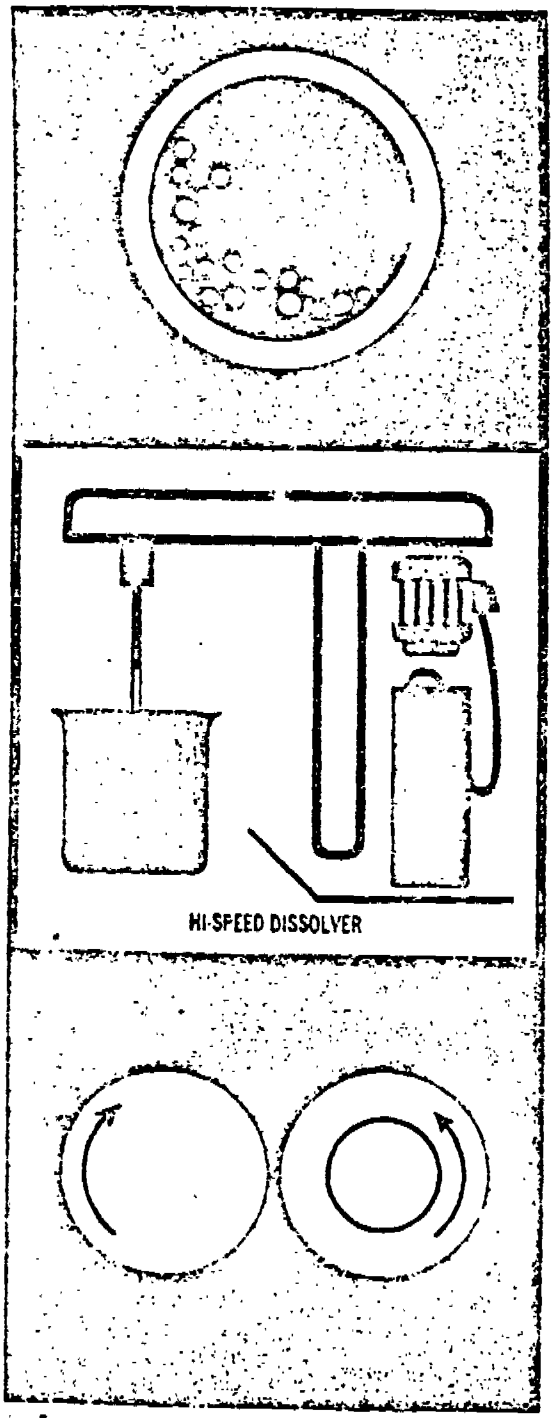
The pigment is directly dispersed in the vinyl resin solution or in the plasticizer by means of grinding mills or high-speed stirring equipment. For easier and faster dispersion, a wetting agent may be used. The degree of dispersion is checked with a fineness of grind gauge.

For pigment dispersion by means of a pebble mill, wetting agents should be included in the formulation. The development of suitable surfactants, such as "Nuodex"-NA and "Lexinol" AC-1, has mitigated most of the undesirable aspects previously encountered with this grinding procedure. It is now possible to improve greatly the pigment-wetting characteristics of the vinyl copolymer resins with minimum degrading side effects. Pigment dispersion and gloss are improved, paste fluidity is substantially increased, and grinding time is decreased.

The paint is prepared by charging the pigment or pigment combination to a pebble mill in the usual dry form. The pigment concentration is dependent upon the type of pigment used. It usually varies from 25-70 per cent of the coating formulation, except for carbon black. The remainder of the charge consists of a small proportion of the vinyl resin solution, plasticizer, surfactant, and just enough thinner to give a good grinding consistency. The entire mixture is milled for 16 to 20 hours (based on one-quart size mill charges; time should be less for production-size mills). The concentrated pigment paste thus prepared is cut back with the remaining resin solution to the final paint formulation.

The technique of dispersing pigments by means of a two-roll mill is relatively simple. The rolls of the mill are heated with steam to a temperature between 50 and 75°C. Above this temperature, the performance of the final coating may be adversely affected. Furthermore, by keeping the "stock" as cool as possible, greater shear stresses are set up and an extremely fine pigment dispersion is obtained.

In formulating roll-mill stocks, it is usually desirable to use the maximum amount of pigment in proportion to resin that is consistent with good dispersion, easy handling on the mill, and high gloss in the resulting finish. The workable pigment concentration can be greatly increased by a small addition of plasticizer.



For this grinding procedure, the premixed resin-pigment stock is fed through the mill and folded back and forth until a satisfactory dispersion is obtained. During the last portion of the milling, the rolls are set as closely together as practical to intensify the shear stresses and to complete the dispersion. The stock is then sheeted off the rolls and left to cool. For ease of handling, the stock is broken into chips after cooling.

High-speed impellers provide a simple and fast method of preparing paints. The Cowles dissolver, designed with a disc-type impeller, is the most widely used. With this high-speed mixer, easy-dispersing pigments may be directly dispersed in the vehicle to a satisfactory fineness. In this blending method, a high consistency pigment-vehicle mixture will result in a faster and better pigment dispersion. Therefore, depending on the viscosity of the vehicle, the pigment is often dispersed only in part of the vehicle and, after complete dispersion of the pigment, let down with the remaining vehicle. The use of high-speed equipment eliminates the necessity of transferring the premixed batch to and from a mill. It also minimizes loss of paint and cleaning of equipment. Some loss of solvent may occur during mixing.

Another simple and also economical grinding method is the sand grinder. In brief, the sand grinder consists of a cylindrical container filled with sand. A centered shaft with flat impellers rotates the sand and produces the required shearing action necessary for a satisfactory pigment dispersion. The pigment-vehicle mixture is pumped into the sand grinder, milled through the sand and then screened into a storage container. This grinding method lends itself especially to a continuous operation. Once the grinding procedure is completed, the sand grinder may be easily cleaned with solvent while the sand, because of its expendability, may be discarded.

PIGMENT PASTES

Pigment pastes are commercially available or may be prepared from roll mill stock chips. The chips are soaked in part of the solvent-thinner mixture for a few hours in a closed mixer fitted with a powerful agitator. After the chips have softened, the agitator is started slowly and the ingredients are mixed to form a smooth paste. An increase in temperature will hasten the dissolving process. The paste may be reduced with a suitable thinner. For best dispersion, the thinner should be added in small amounts and stirred slowly into the paste. The amount of solvent or solvent-thinner mixture to be used is dependent upon the proportion of resin present in the stock-chips, the particular solvents employed, and the tendency of the particular pigment to cause "bodying" or viscosity increase. The paste should have sufficient "body" to prevent settling of the pigment, and yet should be fluid enough to mix readily with the remaining ingredients of the formulation. For a solvent-thinner mixture, consisting of methyl isobutyl ketone and toluene, the vinyl resin content of the final solution should be approximately 20 to 25 per cent.

Instead of dissolving the stock in a solvent, it is often dissolved directly in the resin solution. This dissolving process is slower, but *the slower dissolving* action of the resin solution assures a better dispersion in the final coating. This method is oftentimes more convenient for commercial production of pigmented coatings, since it eliminates the step of preparing a pigment paste in solvent.

CARBON BLACK CHIPS AND PASTES

The preparation of roll-mill chips and pigment pastes with carbon blacks needs special attention because of the possible occurrence of "seediness" and poor gloss in certain black finishes. The more intense blacks are particularly troublesome because of their extremely fine particle size and their tendency to absorb liquids and gases.

A preferred procedure for making stocks with the "high-color" blacks is to treat the pigment with ammonia prior to milling. This treatment can be carried out from aqueous solution, solution in alcohol, or by the dry gas itself. The use of a solution of ammonia in methanol has the advantage of providing at the same time an anti-dusting agent for the extremely fine pigment. During milling, the methanol evaporates readily. It is more difficult to drive the water of an aqueous ammonia solution completely out of the mill-stock.

The amount of ammonia to be applied should be the least required to yield high-gloss finishes. Excessive amounts of ammonia may cause gelling of the semi-paste upon storage. Preliminary tests should be made with the particular type of black to determine the most satisfactory amount of ammonia. For the treatment of "high-color" carbon blacks, an equal weight of pigment to 0.3 normal ammonia in methanol solution is suggested.

Ease of handling black pigments can also be improved by adding about 2 per cent (based on pigment weight) of a surfactant such as UNION CARBIDE Amine 220 to the stock before two-roll milling.

Aromatic hydrocarbons should be avoided in solvent-thinner mixtures for dissolving black chips because they have a particular deleterious effect on the gloss of carbon blacks. Once the black chips have been dissolved in pure solvents, aromatic hydrocarbons used in resin solutions for the paste let-down seem to have much less effect. Black chips usually give good results, also, if dissolved directly in a resin solution rather than in pure solvent. In this method, the influence of aromatic hydrocarbon diluents is less marked.

COMPOUNDING OF PIGMENTED FINISHES

Once the pigment pastes and the vinyl resin solutions are made up, the final paint may be readily prepared on a paint blender. During slow agitation, the pigment paste is first let down with the vinyl resin solution and then mixed with the remaining ingredients.

When any shading is necessary, it is suggested that the different pigment pastes be mixed to an approximate shade, slightly lighter than the final shade, before adding the remaining binder portion. The exact shade can then be adjusted by adding small amounts of a coating, containing the same binder but a stronger color.

After the paint has been mixed thoroughly, it is strained through a fine, lint-free cloth or a wire screen to remove any pigment agglomerates, gel lumps, or other foreign particles before it is used or packaged for shipment.

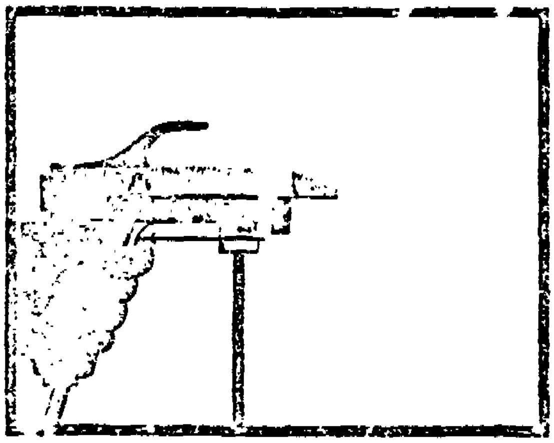
CONSISTENCY OF PAINTS

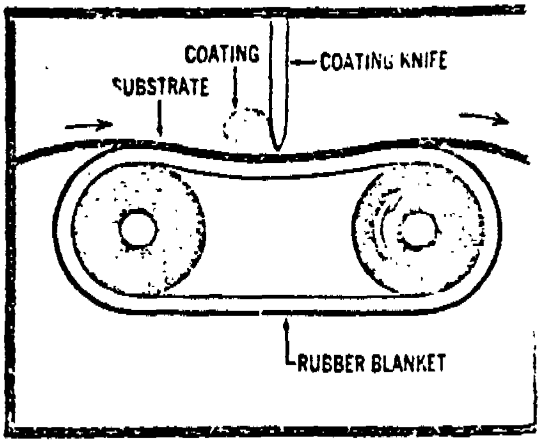
In the section on pigment-paste formulation, the need for fairly heavy-body pastes to prevent the pigment from settling was mentioned. This is also true for paints that are to be stored for long periods, although the much greater proportion of resin normally present minimizes pigment agglomeration and settling. Heavier-bodied paints in thinners, rich in active solvent, usually have the best storage stability.

Care has to be taken in adjusting the coating vehicle to the correct viscosity. Very viscous paints may gel on storage and will then be difficult to thin to a proper application viscosity. When gelling has occurred, the finish should be warmed and/or agitated until the gel has been broken down before thinning.

APPLICATION METHODS

BAKELITE vinyl solution resins may be readily applied by commonly used application methods, such as brushing, spraying, dipping, and knife coating. Films may also be applied by more specialized equipment, such as roller coaters, gelatine-roll metal coaters, forward and reverse roll paper coaters and curtain coaters. Of major consideration for all applications is the correct consistency of the coating and the proper evaporation rate of the solvent used in a particular application method.





ADHESION

Over most surfaces, maximum adhesion of vinyl coatings is obtained after baking at a temperature high enough to drive out residual solvent traces and to actually fuse the resin firmly to the surface. Baking improves adhesion particularly on smooth, impervious surfaces, such as metals, glass, and composition boards. Over more porous surfaces such as concrete, unfinished paper, and cloth, the mechanical adhesion obtained is usually sufficient without baking.

The degree of adhesion of vinyl solution resins will depend on the particular resin used. For example, unmodified vinyl copolymers develop adhesion to bare metal surfaces only after a bake of 325°F to 350°F; over primed surfaces, the temperature need only be high enough to drive out residual solvent (about 250°F); on rough surfaces, the mechanical adhesion developed may be sufficient without baking.

Maleic acid modified vinyl copolymer resins have excellent adhesion to clean metal as an air-dry or baking topcoat or primer. Unmodified vinyl solution resins also have good adhesion to these dibasic acid modified vinyl resins. This makes possible the formulation of two or three-coat systems exclusively based on BAKELITE vinyl solution resins.

Vinyl copolymers modified with hydroxyl groups show good adhesion to many other types of finishes such as vinyl butyral resin-based wash primers, and metal conditioners. Therefore, they can be used for many applications in which coatings based on unmodified vinyl resins will not adhere.

In all instances, maximum adhesion of coatings is obtained by cleanliness and proper surface preparation of the substrate.

METAL SURFACE PREPARATION AND PRETREATMENT

An important factor in the performance of a coating is proper surface preparation. The coating can develop good adhesion only to a surface which is free of any contamination such as rust, grease, and other foreign materials.

The cleaning method used to prepare a surface will depend on the particular substrate. Some of the most common cleaning methods for metals are solvent-wash, hand and power tool cleaning, vapor degreasing, chemical and flame treatment, white metal blast and commercial blast cleaning. Sandblasting to white metal is the most preferred procedure for steel, especially for corrosive environments. Different metals such as steel, aluminum, and copper alloys often require different treatments.

In addition to mechanical surface preparation, metal surfaces have to be passivated before baking vinyl finishes are applied. Metal surfaces may be passivated by chemical treatment, such as phosphate coating, or by use of wash primers which also serve as corrosion inhibitors.

PRIMERS

Primers based on vinyl solution resins have shown excellent coating performance. As mentioned in preceding sections, a dibasic acid modified vinyl copolymer should be used where direct adhesion to bare metal is required. Other commercial primers, based on urea formaldehyde resins, different types of oils or varnishes also perform satisfactorily. The latter primers have to be used with a topcoat based on hydroxyl-modified copolymers to assure intercoat adhesion. The use of the hydroxyl modified vinyls with alkyds, urea-formaldehyde, polyketone resins, etc. make excellent wood seal primers for many wood coating lacquers, particularly for the catalyzed-type topcoats.

BAKING

The temperature schedule should be carefully controlled for baking vinyl finishes. Certain minimum temperatures are required for adequate adhesion. Overbaking will have adverse effects on the coating. The oven should be sufficiently ventilated, and the temperature distribution should be uniform to avoid any locally overheated or underbaked areas.

VINYL RESIN FINISHES

BAKELITE vinyl resin based coatings have found extensive and diversified applications in the coating field because of their unique properties. Vinyls have provided the answers to many difficult coating problems which ordinary film forming ingredients cannot handle. The development of special vinyl formulations has made possible the manufacture of new products and cost-saving changes in established plant procedures.

Vinyl copolymer resins comply with the Food Additive Regulations for coatings, adhesives and closures. Vinyl coatings have been used for years for lining food and beverage containers, and for coating all types of articles that come in contact with food or beverages, such as caps, closures, food wrappers, food and beverage dispensers and the like.

The inherent toughness, flexibility and adhesion of vinyl finishes permit the post forming of precoated metal. Vinyl solution resins make excellent coatings for use on modern coil coating equipment.

Because of their exceptional resistance to most corrosive chemicals, vinyls are used to line containers for many chemical products, for protecting processing vats, as coatings for laboratory [illegible], for lining sewers and pipes handling corrosive materials, exterior coatings in corrosive atmospheres, and a host of similar applications. Their alkali resistance allows their use over concrete, [illegible], plaster, or alkaline wallboards without any special precaution.

Vinyl resins have proven very successful in an exterior coating system for [illegible] softwood grades of medium density [illegible] overlaid plywood (CS-45-60). This system has met the qualification tests of the American Plywood Association. The system* consists of a pigmented primer based on BAKELITE vinyl resin and a [illegible] copolymer. The topcoat is based on two BAKELITE vinyl solution resins.

Vinyls are resistant to most chemicals, greases, oils, alcohols, to abrasion and moisture, and hence find extensive use as a coating for hospital and kitchen furniture, medicine cabinets, [illegible] fixtures, cosmetic jars and tubes, refrigerators and the like. Since vinyl coatings resist cracking, checking, peeling, and chalking over long-term exterior exposure, these finishes are ideally suited for use on metal signs, aluminum siding, garden furniture and other objects exposed to the weather.

Pigmented finishes knife-coated onto cloth produce tough artificial leathers and coated cloths that are exceptionally resistant to weathering, as well as to other deteriorating influences. Clear coatings possessing high water resistance can be applied to silk, cotton, and other fabrics.

Vinyl solution coatings can be applied as decorative and protective varnishes over labels, foils, wrappers, and special papers where excellent appearance and resistance to moisture, food products, or corrosive materials are desired.

*This coating is covered by U. S. Patent 3,074,216, [illegible] Union Carbide Corporation. Licenses are readily available to paint manufacturers; write to: Manager Patents and Licenses, Union Carbide Corporation, Plastics Division, 270 Park Avenue, New York, N. Y. 10017.

Medium plasticized vinyl coatings, based on BAKELITE vinyl resins, provide the weatherability, adhesion and beauty required for use on exterior applications like the church roof shown in the photograph.

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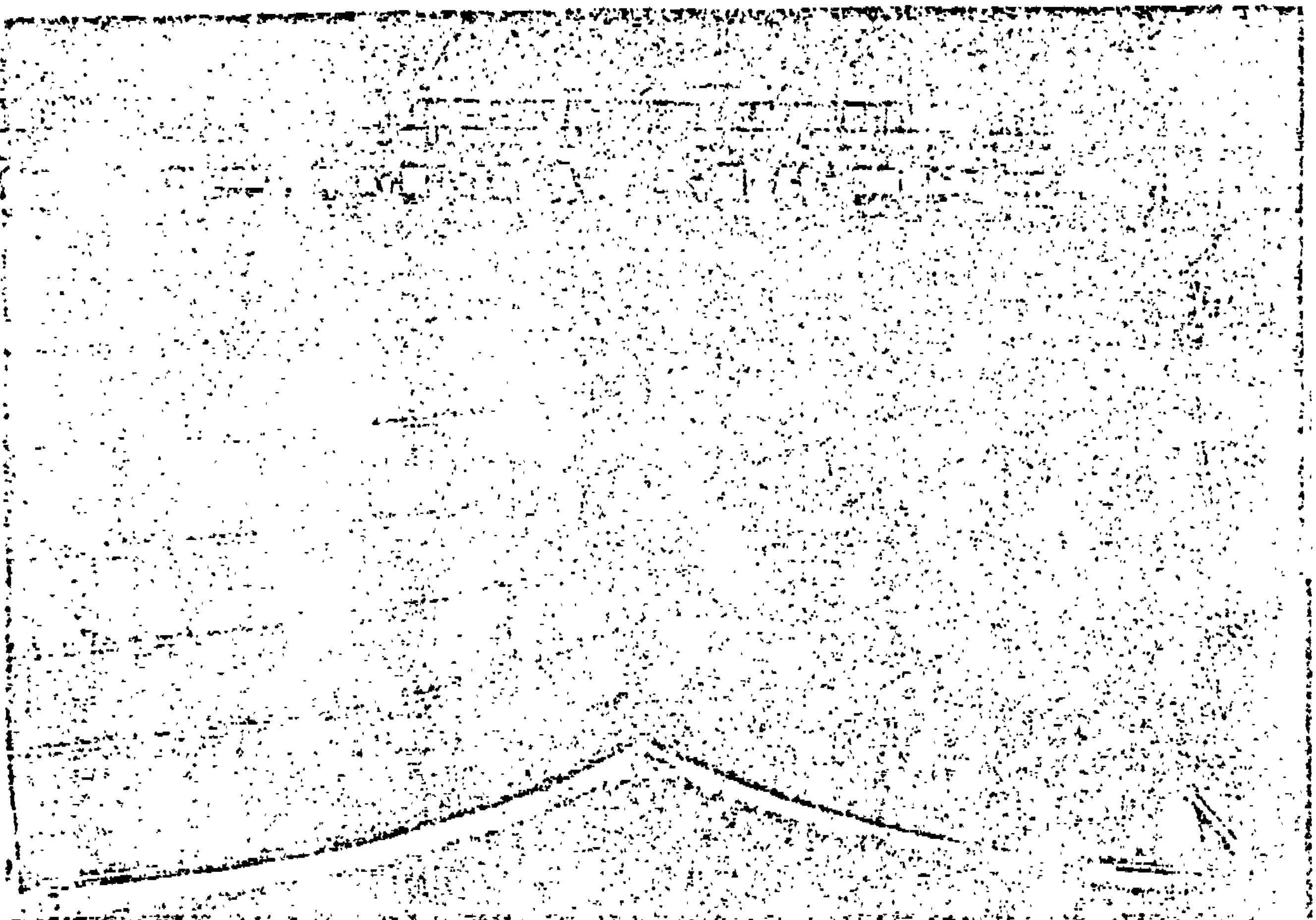
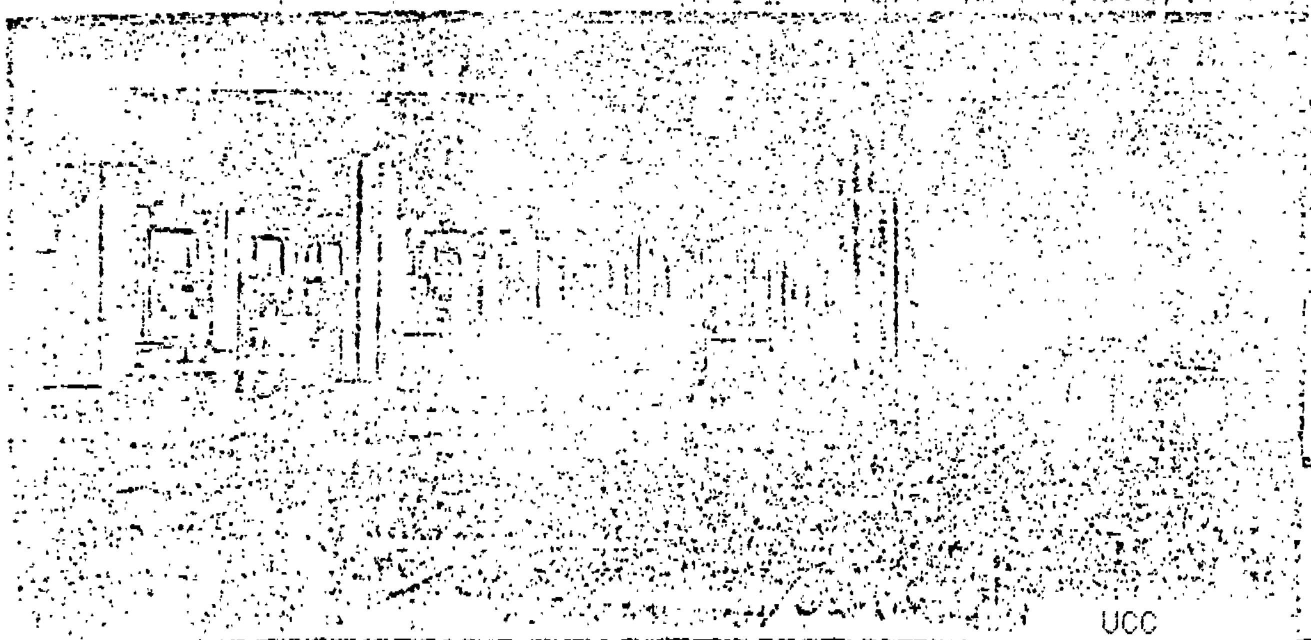


Shown above is one of six pairs of sector gates used in the St. Lawrence Seaway [illegible] from the Atlantic Ocean to the Great Lakes. All submerged and semi-submerged steel structures in the Canadian section of the [illegible] are protected by a durable coating system based on BAKELITE vinyl resins.

These charcoal gray and off-white vinyl coatings used on pillars in the United Nations [illegible] are well suited for architectural consideration because of their [illegible] and protective [illegible].



CAN, TUBE AND CLOSURE LININGS

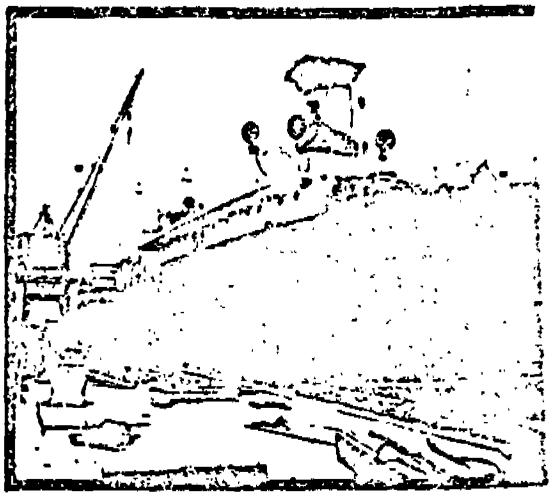
One of the oldest applications for vinyl solution resins is as a lining for cans, tubes and closures. The hydroxyl or carboxyl modified vinyl resins lend themselves especially to this application because of their outstanding adhesion and flexibility. Lack of taste and odor of the vinyl copolymers and their FDA compliance permit the utilization of these resins as food contact surfaces for metal substrates.

Lack of taste and odor make vinyl coatings ideal for coating the interior of food and beverage containers. Machines like the double seamer subject the cans to forming operations that make a tough coating a "must."

MAINTENANCE COATINGS

Vinyl solution resins have an excellent perfor ance record as maintenance coatings. Vinyl coa steel structures exposed to salt or river water, corrosive atmospheres, or to chemical liquids a fumes have performed well for many years witho touch-ups. Coatings perform equally well in tro or polar climates, and withstand the extreme co ditions of expansion and contraction of steel surfac during seasonal changes.

There are many Government specifications co ering the use of vinyl coatings. The classical vin maintenance system is based on a butyral wa primer WP-1 (MIL-C-15328B) for salt water UNION CARBIDE Formulation VP-2894 or VP-29 for fresh water exposure, coated with a primer bas on a hydroxyl-modified vinyl resin and topcoat with an unmodified vinyl copolymer. These coati systems have been in regular use for 20 years large chemical plants, on locks and dams of inla waterways, as fouling and corrosion protection f ships, and for off-shore oil drilling installatio Another very effective maintenance system whic withstands severe chemical attack or water imme sion is based on a carboxyl modified vinyl resi primer and an unmodified vinyl resin topcoat.



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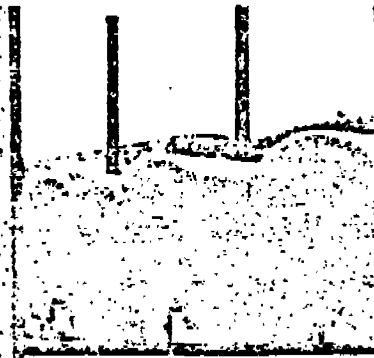


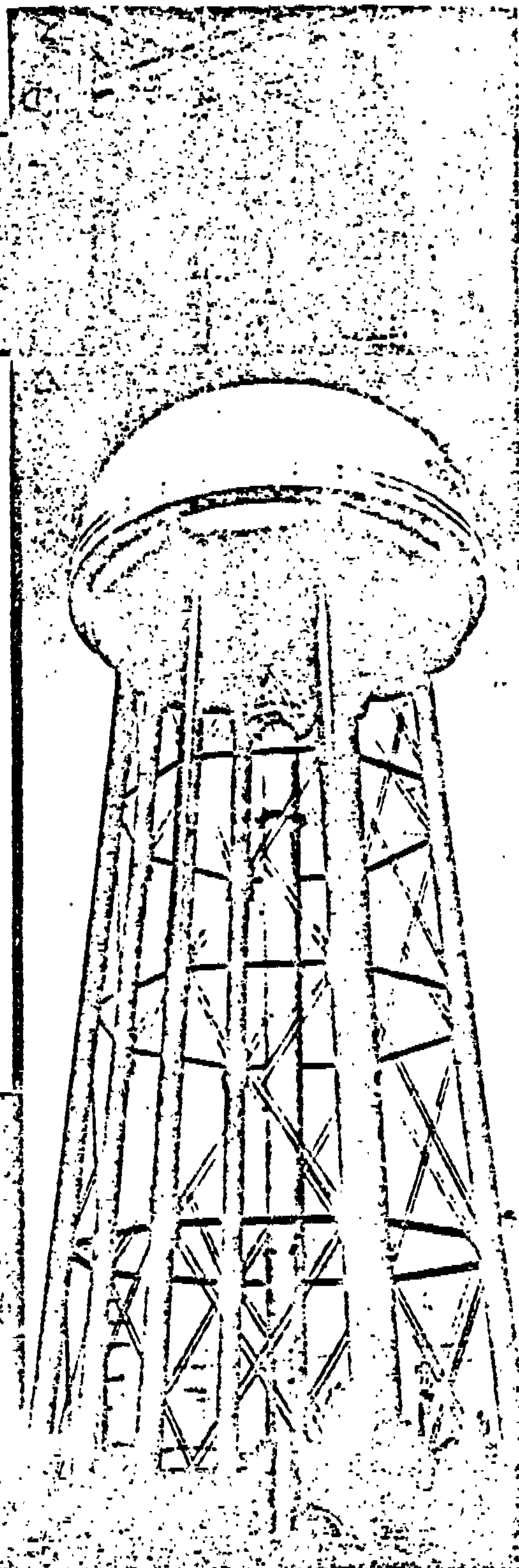
Eight years exposure on [illegible] age tanks. Wherever [illegible] resistance, maximum adhesion and toughness are needed, [illegible] vinyl coatings fill the [illegible]

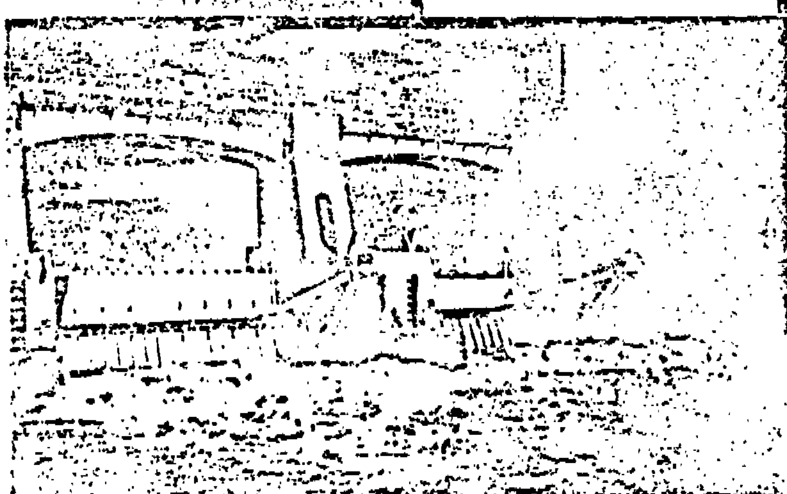
With only minor touch-ups in [illegible] and 1956, this sulfuric acid container [illegible] dences [illegible] from [illegible] has the original vinyl coating [illegible] in 1946.

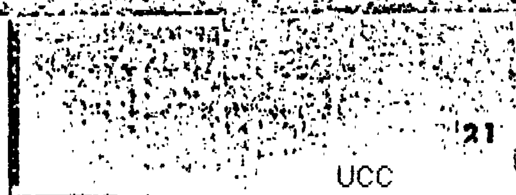
This steel water tank—30 feet [illegible] 60 feet in diameter—is protected [illegible] coating based on BAKELITE vinyl [illegible]. This non-contaminating finish [illegible] over 20 years of maintenance-[illegible] ice, performance typical of [illegible] lasting vinyl finishes.

For 16 years this freighter has had only routine touch-ups. The original vinyl coating applied in 1949 is still protecting the metal.

Long service life and quick drying time were two of the essential features of the coatings chosen for use on this dam, one of 27 built on the [illegible]. A special BAKELITE vinyl-based formulation provided both—assuring a minimum of [illegible] terrupted service. Since 194[illegible], this coating has protected the steel components from extreme weathering as well as constant abrasion from the churning [illegible]







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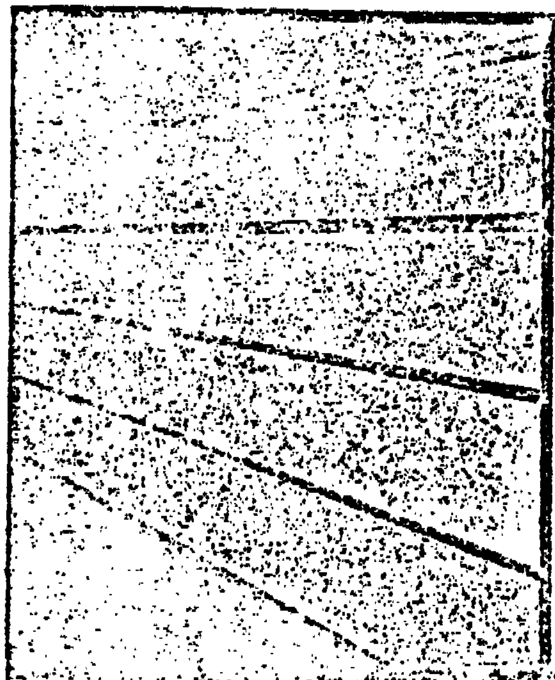
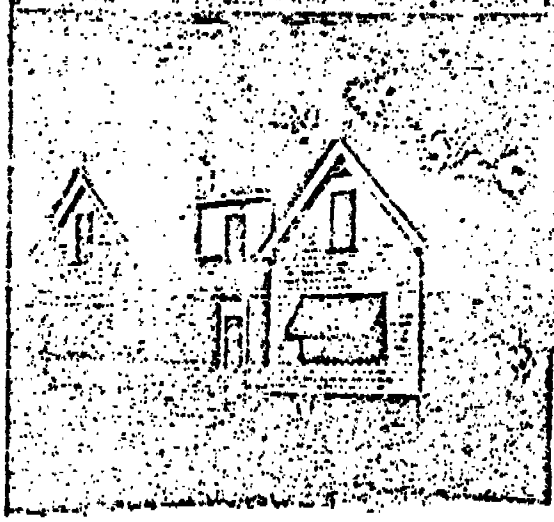


... um stock when vinyl coat- ... vinyl resins, this ... over 14 years ... of ...

... of metal siding ... vinyl coated aluminum ... despite ... [illegible]

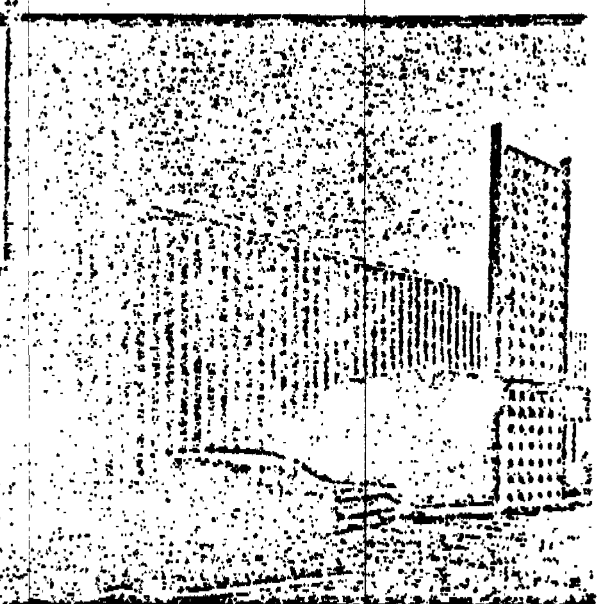


COIL COATING

Excellent flexibility, good adhesion, and resistance make vinyl resins unique finishes for coating aluminum, galvanized and cold rolled s in flat sheets or coil coating. Vinyl-based coat will withstand extreme drawing, stamping, bend and other forming operations without loss of ad sion, even after long periods of storage.

Metals precoated with vinyl finishes may be f ricated into products such as building panels a siding, office and outdoor furniture, window and d frames, rain gutters, downspouts, appliances, tele sion cabinets, bread boxes and canal mail box venetian blinds and trailer bodies.

Vinyl coated metal siding lends durable protection to this dustrial building. The ease of installation, the sun ability and weatherability, plus the aesthetic appeal, make t kind of siding popular. Maintenance is negligible, an occasi washing keeps the finish attractive.



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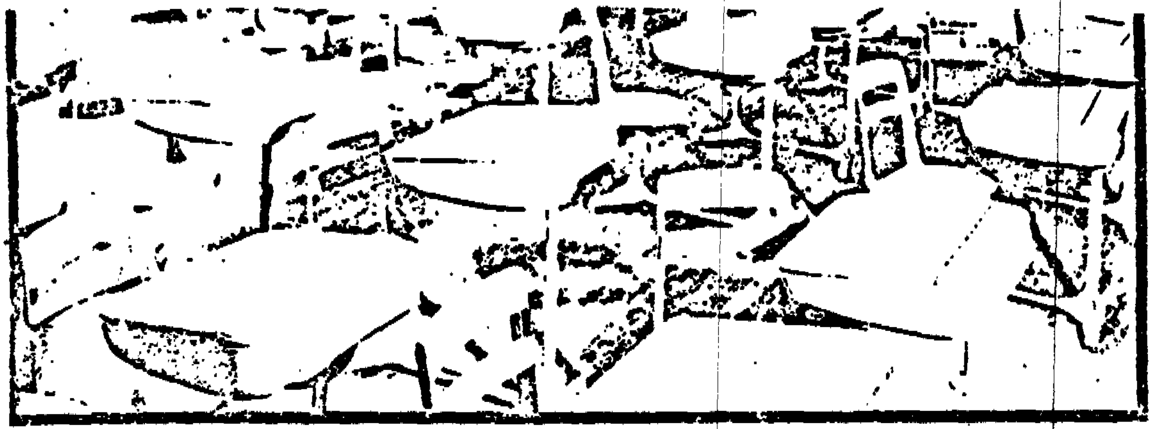


School, office and home furniture require a long-lasting finish that can be easily cleaned. A clear vinyl lacquer on these desks fills the bill. The coating has survived years of rough usage and many washings without showing signs of deterioration.

COATINGS FOR WOOD

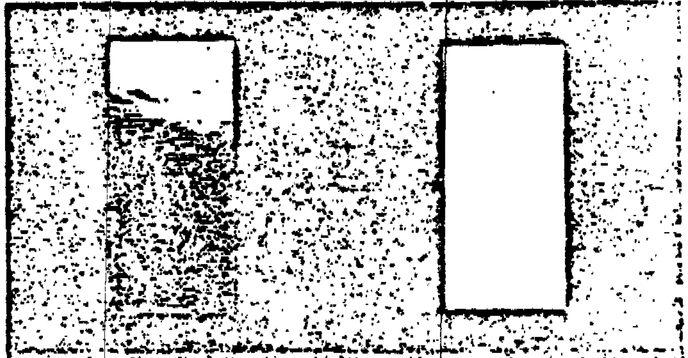
Vinyl resins are used for prepainting wood, a new trend in the lumber industry. The prepainted wood may be subsequently fabricated into panels for exterior house siding or interior decoration and into furniture.

Union Carbide's laboratories were successful in formulating an exterior coating system for prefinishing softwood grades of medium density phenolic overlaid plywood (CS-45-60). This system* has met the qualification tests of the American Plywood Association. The system consists of a pigmented primer based on a hydroxyl modified vinyl resin and a urethane prepolymer. The topcoat is a blend of a hydroxyl modified and unmodified vinyl copolymer. The system can also be used on appropriate grades of hardboard, solid lumber, hardwood plywood, and particle boards. Excellent adhesion and freedom from blistering combined with long term durability can be expected from this type of system.

Hydroxyl modified vinyl resins in combination with non-oxidizing alkyds and melamine resins are excellent clear coatings for interior grades of hardwood plywood panels and printed hardboard and chipboard. Wood finishes based on these vinyl resins can be sanded and polished more easily than will similar finishes based on unmodified vinyl resins. These finishes have excellent toughness, resistance to cold check, alcohol, acids, alkalies, and many household preparations and will wear long past the expected life of many other coatings.

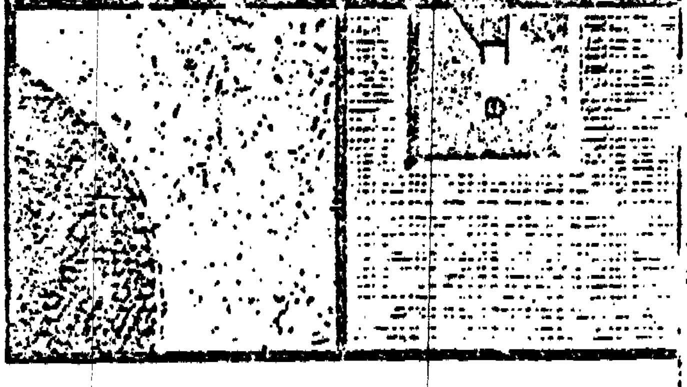
* [illegible] U.S. Patent [illegible] granted to Union Carbide Corporation, [illegible] Patents and [illegible], Park Avenue, New York, N.Y. [illegible]

Vinyl floor tiles finished with vinyl coatings are durable and resist staining and cracking, and scratches or dents from spike heels and furniture.



Basic [illegible] by [illegible] system [illegible] The American Plywood Association [illegible] Type [illegible] Density [illegible] described in [illegible] 45-60. The [illegible] backs of [illegible]

Clear or [illegible] finishes and [illegible] beauty [illegible] grain [illegible]



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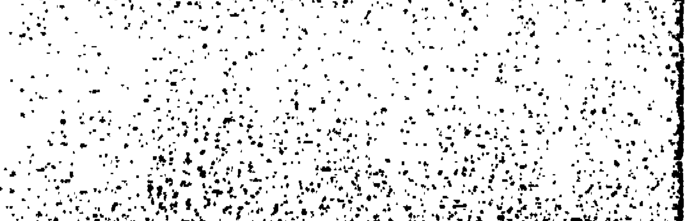
CLOTH COATINGS

Coatings based on BAKELITE vinyl copolymer resins may be applied to cloth and other textile products to obtain a variety of effects. Among these are the application of continuous films to protect, decorate, or waterproof fabrics; the impregnation of fabrics for stiffening that will withstand laundering; and the lamination of textile products by the heat-sealing characteristics of vinyl resins.

Many of the applications of these resins in the textile field are highly specialized and must be developed individually. The principles of plasticization, stabilization, and thinner formulation have been discussed, and these should be used as a starting point for individual formulations for specific applications. In general, the addition of pigment improves the performance of the copolymer resin coatings for cloth and textiles, since it improves the light resistance of the coating.

Books utilizing cloth covers coated with BAKELITE vinyl resins have a non-absorbent, waterproof, stain and smudge-resistant surface that lends itself to a wide variety of designs not otherwise obtainable.



PAPER AND FOIL COATINGS

The aluminum foil and paper industries us[e] considerable amount of vinyl coating because of [...] inherent flexibility, chemical resistance and g[...] heat sealability inherent in the vinyl chloride-vi[...] acetate resins. Good clarity and a relatively high [...] fractive index add eye appeal to the end-prod[...]

The good adhesion of hydroxyl modified vi[...] resin based coatings to oil-base letterpresses a[...] other types of inks is especially valuable in deco[...] tive and protective coatings for paper labels.

Paper and foil coatings based on BAKELITE vi[...] resins may be used for food-packaging; they [...] taste and odor-free and possess outstanding wat[...] alkali and grease resistance. The thinner formu[...] tions used in paper-coatings depend largely on t[...] type of coating machine to be employed. It is des[...] able to use the most rapidly evaporating combinati[...] that will avoid blistering as well as "ridging" or p[...] flow. Plasticizers should be of the type that do [...] contribute to the tackiness of the surface. Wh[...] maximum flexibility and film strength are requir[...] only the higher molecular weight copolymer res[...] should be used.

The viscosity of the coating as it is applied inf[...] ences to some extent the degree of penetration i[...] the paper, and also the gloss. Viscosity and to[...] solids should be kept as high as possible without a[...] verse influence on application, as this improv[...] durability and gloss.

Over relatively dense and impermeable pap[...] such as parchment, it is recommended that paraf[...] or other waxes be added to the vinyl formulation [...] lower the moisture-vapor transmission values. T[...] wax is not compatible with the resin or its solutio[...] but is held in suspension. After application and ba[...] ing, it yields a relatively clear, continuous film havi[...] excellent moisture-vapor transmission rates and go[...] heat-sealing properties. This procedure also may [...] used over porous papers if first a thin coat of vin[...] copolymer finish is applied to prevent penetration [...] the wax into the paper.

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FORTIFICATION OF OTHER VEHICLES

BAKELITE vinyl resins are known for their moisture resistance, toughness and flexibility, and these inherent characteristics are imparted to other vehicles when *fortified* with hydroxyl modified vinyl resins. Addition of small quantities of hydroxyl modified vinyl resins improves coatings, particularly baking types, based on alkyds, varnishes and other film-forming materials. Soft alkyd resins can be toughened; drying time of alkyds can be reduced; hard, brittle resins can be made more flexible. Fortified coatings will not only show improved film properties but also better durability. Service tests have shown that water troughs and metal showers lined with a varnish fortified with a hydroxyl modified vinyl resin were still in excellent condition after over two years of continuous service. Unfortified varnishes failed in less than one year.

Proper blending of the vinyl resin with the alkyd or other vehicle will yield optimum results. It is suggested that the vehicle to be fortified should be added slowly to the vinyl resin solution with agitation. Blends may be pigmented by dispersing the pigment first in the vinyl resin before addition of the vehicle to be fortified. The durability and attractiveness of the coating is generally improved by this blending method. Varnish cooks are an exception to this procedure. In this case, the vinyl resin is added during cooling of the varnish or as a cold-cut in order to avoid decomposition of the vinyl at prolonged high temperatures.

Any aliphatic solvents should be avoided in the fortified coatings because they will cause precipitation of the vinyl resin.

The use of an anti-skinning agent is recommended in all alkyd-vinyl blends. Many non-drying alkyds may become incompatible with the vinyl resin and semi-drying alkyds may gel on storage after a short time in the absence of anti-skinning agents.

TECHNICAL ASSISTANCE

Union Carbide Corporation, Plastics Division has highly trained engineers in the field ready to assist you. These Technical Representatives will be glad to discuss your individual problems and requirements.

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UNION CARBIDE COATINGS MATERIALS

BAKELITE® VINYL SOLUTION RESIN
VYHH
FOR COATINGS

PRODUCT STANDARDS

DESCRIPTION.

BAKELITE® VYHH is a medium-molecular weight vinyl chloride-vinyl acetate copolymer resin. It dissolves readily in ketones, esters, chlorinated hydrocarbons, and combinations of these with aromatic hydrocarbons.

APPLICATIONS

BAKELITE® VYHH is recommended for general coatings use.

FOOD ADDITIVE STATUS

BAKELITE Vinyl Solution Resin VYHH is cited by chemical identity in Food Additive Regulations § 175.300 (formerly § 121.2514) for Resinous and Polymeric Coatings and by reference in § 176.170 (formerly § 121.2526) for Components of Paper and Paperboard and in § 177.1210 (formerly § 121.2550) for Components of Closures.

Properties of
BAKELITE Vinyl Solution Resin VYHH

Property	Test Methods	Required Values
Appearance	Visual	White powder
Size, % by weight through a No. 20 USBS Sieve	WC-7-F	98, minimum
Heating Loss, 45 minutes at 105°C., % by weight	WC-160-H	3.0, maximum
Polyvinyl Chloride, % by weight	WC-294-B or D	85.0 - 86.5
22% solution of resin in 1:1 MIBK:Toluene		
Viscosity at 25°C., cps.	WC-31-W	200 - 400
Color, % light transmission at 475 mμ/600 mμ	WC-5-K-2	85, minimum
Turbidity, light transmission at 600 mμ, %	WC-5-K-2	85, minimum
10% solution of resin 1:1 MIBK:Toluene		
Insoluble Matter, % by wet volume	WC-322-C	0.03, maximum
Residual Vinyl Chloride Monomer, by weight	WC-326-G-1	Less than 1 ppm.

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TEST METHODS

Designated tests are made in accordance with current issues of Union Carbide (UC) testing methods. They are available from Union Carbide Corporation upon request.

LABELING

All containers of BAKELITE Vinyl Solution Resin VYHH are plainly marked with the product nomenclature, blend number, and net weight. Shipments will be so addressed as to provide complete delivery to the purchaser.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of BAKELITE Vinyl Solution Resin VYHH, precautionary labeling used on the containers is as follows:

FOR INDUSTRY USE ONLY

TOXICOLOGICAL PROPERTIES

BAKELITE Vinyl Solution Resin VYHH is a powdered resin which is essentially inert and non-toxic. Its dust is classed as a nuisance dust which is not known to cause lung disease. However, it is prudent not to exceed the recommended Threshold Limit Value for nuisance dust of 10 mg. per cubic meter of air or 30 million particles per cubic foot, whichever is the smaller.

EMERGENCY SERVICE

For help and emergencies such as a spill, leak, fire or exposure involving a Union Carbide chemical or plastic, call collect day or night:

304-744-3487

For any chemical emergency, call: CHEMTREC 800-424-9300

COATINGS MATERIALS

BAKELITE® VINYL SOLUTION RESIN VYHH

BAKELITE vinyl resin VYHH is one of a class of versatile vinyl chloride-vinyl acetate copolymer solution resins available from Union Carbide's Plastics Division. As a class, BAKELITE vinyl chloride-acetate copolymers for surface coatings are permanently thermoplastic, neutral, non-oxidizing and non-heat-reactive. They are characterized by absence of color, odor and taste. Films of these resins are not attacked at normal temperatures by alkalies, mineral acids, alcohols, greases, oils, or aliphatic hydrocarbons. Coatings based on BAKELITE vinyl chloride-acetate resins have low water vapor permeability, low water absorption, and excellent toughness and flexibility.

These copolymers are designed to dissolve in organic liquids such as ketones, certain esters and chlorinated hydrocarbons. They form a protective film by evaporation alone. Properly formulated coatings based on BAKELITE vinyl chloride-acetate resins can be applied by spraying, roller-coating, dipping and knife-coating.

This release presents only those properties and performance values specific to resin VYHH-based solution coatings. A more comprehensive description and discussion of vinyl solution coatings preparation, formulation, baking and fusing, and other end-use applications is presented in the booklet, "BAKELITE" Vinyl Resins for Solution Coatings" (J-2173C).

PROPERTIES

BAKELITE vinyl resin VYHH is the most widely used surface coating vinyl chloride-acetate resin. This copolymer has a medium molecular weight and a chemical composition of approximately 87 percent vinyl chloride and 13 percent vinyl acetate. These properties have been found to give a desirable balance between chemical resistance, solubility, film strength, and thermoplasticity. Vinyl resin VYHH, supplied as a dry white powder, is usually dissolved in a relatively strong solvent-diluent combination, such as 50 percent ketone solvent to 50 percent aromatic hydrocarbon diluent, to produce about a 15 to 20 percent solids resin solution. Pigments, plasticizers, and heat and light stabilizers can be used in a formulation to obtain the required end-use properties. Coatings based on vinyl resin VYHH develop adhesion to bare metal surfaces only after a bake of 325 to 350 deg. F.; over primed surfaces, the temperature need only be high enough to drive out residual solvent (about 250 deg. F.); on rough surfaces the mechanical adhesion developed may be sufficient without baking.

Marine antifouling paints, masonry and metal coatings, such as for steel and aluminum, lining for beer cans, coatings for paper, cardboard and foil, and maintenance and sanitary coatings are among the principal applications for finishes based on BAKELITE vinyl resin VYHH.

FORMULATIONS

A complete discussion of formulation techniques for producing both clear and pigmented vinyl solution coatings is presented in the general booklet, "BAKELITE" Vinyl Resins for Solution Coatings."

Table 1 gives a convenient starting point for the formulation of metal coatings based on vinyl resin VYHH. All suggested quantities are based on 15 parts by weight of vinyl resin VYHH. A partial list of suitable pigments, stabilizers and plasticizers along with a table on the solubility of resin VYHH in a number of commercial solvents are presented in Tables 2, 3, 4 and 5. A more complete list of pigments and dyes suitable for use with vinyl solution resins is presented in the general booklet.

July, 1968
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BAKELITE® VINYL SOLUTION RESIN VYHH

Specific formulations of vinyl solution coatings will depend on the actual application methods used and the end properties sought. A number of starting point formulations for many types of vinyl coatings are available through your Union Carbide Plastics Division.

TABLE 1

Typical Formulation for A VYHH Metal Topcoat

	Parts by Weight
BAKELITE vinyl resin VYHH	15
Plasticizer (phthalate or phosphate)	2 4
Pigments*	2 25
Methyl isobutyl ketone	30
Toluene or xylene	30
Propylene oxide	0 05 0.20
Fillers	0 60

* Percentages of pigments vary with the types and colors used

Pigments

The pigments most generally used in solution coatings based on BAKELITE vinyl resin VYHH are presented in Table 2. The amounts suggested are based on the quantity of each pigment that is necessary to ensure good hiding and adequate ultra-violet light protection for the vinyl resin.

TABLE 2

Suitable Pigments For Use in VYHH Solution Formulations

Pigment	Parts per 15 parts VYHH resin by Weight
Aluminum powder	6 8
Titanium dioxide	10 18
Titanium dioxide/antimony oxide (9:1)	10-18
Titanium dioxide zinc oxide-antimony oxide (3.2.1)	10 18
Phthalocyanine green	2 4
Phthalocyanine blue	2-4
Chromic oxide green	10 15
Carbon black	1
Blue lead sulphate	15 25
White lead sulphate	15 25
Red lead	20 25
Iron oxide yellow (synthetic)	8 15
Iron oxide red (synthetic)*	8 15
Iron oxide brown (synthetic)*	8 15
Iron oxide black (synthetic)*	8 15
Lead chromate	15 25
Strontium chromate	15 20
Cadmium reds	15 20
Chrome orange	15 20
Cadmium yellow	15 20

* All iron oxides should be used at bakes under 280 deg F. The use of these pigments should therefore be restricted to topcoats which require baking at 250 deg. F. to obtain good adhesion. Natural oxides are seldom satisfactory.

Stabilizers

The amount and type of stabilizer to be used in vinyl solutions are dependent upon the vinyl resin itself, the plasticizer, and pigments and the conditions of baking and exposure. Table 3 lists some of the commercially available stabilizers for use with vinyl resin VYHH along with the supplier of each stabilizer. In all cases careful attention must be paid to the proper choice of stabilizers, and they should be tested under the actual conditions of use. Recommendations of stabilizer suppliers should generally be followed.

Zinc stabilizers should be avoided due to extreme color development in relatively short periods of time, especially in low plasticizer systems.

TABLE 3

Several Commercial Stabilizers for Use With VYHH

Stabilizer	Supplier
"Advance" 17M	Advance Chemical and Solvent Co.
"Mark" LL	Argus Chemical Company
"Mark" KCB	Argus Chemical Company
"Ferro" 1720	Ferro Chemical Company
"Harshaw" 6 V-2	Harshaw Chemical Company
"Nuodex" V 138	Nuodex Chemical Company

Plasticizers

It is usually desirable to include certain portions of plasticizers in coatings of BAKELITE vinyl resins in order to obtain increased flexibility. As a guide to the selection of the proper plasticizer, Table 4 gives the compatibilities of resin VYHH with a number of commercially available plasticizers.

TABLE 4

Compatibility of BAKELITE vinyl resin VYHH with Commercial Plasticizers

	Compatibility Data Weight Ratio of Resin VYHH to Plasticizer			
Compound Designation	9:1	4:1	2:1	1:1
Acetyl tributyl citrate	C	C	C	C
Acetyl triethyl citrate	C	C	C	C
Amyl Phthalate	C	C	C	C
"Aroclor" 1242 chlorinated diphenyl	C	C	C	C
"Aroclor" 1254 chlorinated diphenyl	C	C	C	C
Butoxyglycol adipate	C	C	C	C
Butyl acetate ricinoleate	C	IC	IC	IC
Butyl cyclohexyl phthalate	C	C	C	C
Butyl phthalate	C	C	C	C
Butyl sebacate	C	C	C	C
Butyl stearate	IC	IC	IC	IC
Butyl tartrate	C	C	C	C
Dibutyl CELLOSOLVE phthalate	C	C	C	C
Dicapryl phthalate	C	C	C	C
Di (2 ethylhexyl) azelate	C	C	C	C
Diisoctyl phthalate	C	C	C	C
Di-n-octyl phthalate	C	C	C	C
Dioctyl sebacate	C	C	C	C
"Ethox" ethoxyglycol phthalate	C	C	C	C
Ethoxydiglycol phthalate	C	C	C	C
Ethylhexyl phthalate	C	C	C	C
Ethyl phthalate	C	C	C	C

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Compound Designation	Compatibility Data* Weight Ratio of Resin VYHH to Plasticizer 9:1	4:1	2:1	1:1
FLEXOL plasticizer DOP	C	C	C	C
FLEXOL plasticizer TOF	C	C	C	C
FLEXOL plasticizer 3GH	C	C	C	C
FLEXOL plasticizer 3GO	C	C	C	C
FLEXOL plasticizer 426	C	C	C	C
FLEXOL plasticizer 810	C	C	C	C
"KP 23" butoxyglycol stearate	SIC	IC	IC	IC
"KP 45" diglycol dipropionate	C	C	C	C
"Kronisol" butoxyglycol phthalate	C	C	C	C
"Methox" methoxyglycol phthalate	C	C	C	C
Methyl phthalate	C	C	C	C
"Nevinol" p coumarone indene polymer	IC	IC	IC	IC
"Olenresin" 91 phthalic anhydride castor oil reaction product	C	SIC	SIC	SIC
"Paraplex" G 60	C	C	C	C
"Paraplex" G 62	C	C	C	C
"Parol" 40PN chlorinated paraffin	C	C	SIC	IC
"P.H.P." phenol indene coumarone oil	C	C	C	C
Phenyl phthalate	C	C	C	C
"Plastolein" 9720	C	C	C	C
"Santicizer" 8	C	C	C	C
"Santicizer" E 15	C	C	C	C
"Santicizer" B 16	C	C	C	C
"Santicizer" 141	C	C	C	C

Compound Designation	Compatibility Data* Weight Ratio of Resin VYHH to Plasticizer 9:1	4:1	2:1	1:1
"Santicizer" 160	C	C	C	C
"Sipalin" AOM	C	C	C	C
Tributyl citrate	C	C	C	C
Tributyl acetylcitrate	C	C	C	C
Tributyl phosphate	C	C	C	C
Tricresyl phosphate	C	C	C	C
Tri 2-ethylhexyl phosphate	C	C	C	C
Triphenyl phosphate	C	C	C	C

NOTE: Data given in this table are based on tests conducted over a period of years by Union Carbide Corporation in its laboratories at South Charleston, West Virginia, on commercial compounds purchased in the open market or submitted by manufacturers. Every effort has been exerted to present only accurate, impartial information as a guide to surface coating formulators, but specific conditions and formula modifications may affect the characteristics of the various compounds in certain instances. Under no circumstances are the data in this table to be construed as a reflection on the grade, quality or purity of any of the compounds listed. In all cases formulators are urged to make their own tests, following their individual procedures, and to draw their own conclusions.

Compatibility data are based on operator's inspection of films deposited on glass plates after evaporation of solvents. Results were interpreted as follows.

C — Complete compatibility; film clear.

SIC — Slightly incompatible, faint haze or blush in film.

IC — Incompatible, film badly blushed, inhomogeneous, or oily.

SOLUBILITIES

BAKELITE vinyl solution resins such as VYHH are readily dissolved at room temperature by such solvents as ketones, nitro compounds, and certain esters and chlorinated hydrocarbons. Other solvents, for example, keto-ethers, ether-esters, poly-ethers, aldehydes, and certain other types of compounds, have varying degrees of solvent action on these resins. Aromatic or coal-tar hydrocarbons, such as toluene and xylene, tend to swell, and in some instances dissolve the resins, especially at higher temperatures. Water, alcohols, and aliphatic hydrocarbons (petroleum naphthas) are strong precipitants. The hydrogenated naphthas, containing large proportions of aromatics, are grouped between the last two classes.

The solubility of vinyl resin VYHH in a number of commercial solvents is given in Table 5. A thorough discussion on solvents and solution characteristics of BAKELITE vinyl solution resins is presented in the general booklet.

TABLE 5

QUALITATIVE SOLUBILITIES OF 10% BAKELITE® VINYL RESIN VYHH IN SYNTHETIC ORGANIC CHEMICALS

	VYHH 10% at 25 C.	95° C.*
Acetone	S	S
Acetonylacetone	S	S
Benzyl CELLOSOLVE	G	S
Butanol	I	I
n Butyl Acetate (98%)	S	S
Butyl CARBITOL	PS	S
Butyl CARBITOL Acetate	S	S
Butyl CELLOSOLVE	I	I
n Butyl Ether	I	I
Butyl Phthalate	S	S
CARBITOL Acetate	S	S
CARBITOL Solvent	I	I
CELLOSOLVE Acetate	S	S
CELLOSOLVE Solvent	I	I
Diacetone Alcohol	G	S
Dichlorethyl Ether	S	S
Dichloroisopropyl Ether	S	S
Diethyl CARBITOL	S	S
Diethylene Glycol	I	I
Diisobutyl Ketone	S	S
Dioxane	S	S
Dipropylene Glycol	I	I

	VYHH 10% at 25°C.	95° C.*
Ethanol (95%)	I	I
Ethyl Acetate	S	S
2 Ethylbutyl Acetate	S	S
Ethyl Ether	I	I
Ethyl Silicate	I	I
Ethylene Dichloride	S	S
Ethylene Glycol	I	I
2 Ethylhexanol	I	I
2 Ethylhexyl Acetate	S	S
Glycol Diacetate	G	PS
Heptadecanol	I	I
Hexanol	I	I
Isopropanol (Anhydrous)	I	I
Isopropanol (Technical)	I	I
Isopropyl Acetate (98%)	S	S
Isopropyl Ether	I	I
Mesityl Oxide	S	S
Methanol	I	I
Methyl Acetate (82%)	S CL	S CL
Methyl Amyl Acetate	S	S
Methyl Amyl Alcohol	I	I
Methyl n Amyl Ketone	S	S

	VYHH 10% at 25° C.	95° C.*
Methyl CARBITOL	I	I
Methyl CELLOSOLVE	S	S
Methyl CELLOSOLVE Acetate	S	S
Methyl Isobutyl Ketone	S	S
Methyl Phthalate	S	S
2 Nitropropane	S	S
Methyl Ethyl Ketone	S	S
Methyl Hexyl Ketone	S	S
Methyl Isoamyl Ketone	S	S
Cyclohexanone	S	S
Tetrahydrofuran	S	S
Dimethyl Formamide	S	S
Propylene Dichloride	S	S
Propylene Glycol	I	I
Propylene Oxide	S	S
Tetradecanol	I	I
Tetraethylene Glycol	I	I
Trichlorethylene	G	S
Triethylene Glycol	I	I
Triglycol Dichloride	S	S
Undecanol	I	I

S Soluble G Gels CL Cloudy solution
I Insoluble SW Swells P Partially

*Tests were made at temperatures slightly below the boiling points on those liquids which boil below 95 deg. C.

THE DISCOVERY COMPANY

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UNION CARBIDE CORPORATION • PLASTICS DIVISION

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BAKELITE® Vinyl Solution Resin VYHH

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This release presents only those properties and performance values specific to resin VYHH-based solution coatings. A more comprehensive description and discussion of vinyl solution coatings preparation, formulation, baking and fusing, and other end-use applications is presented in the booklet, "BAKELITE* Vinyl Resins for Solution Coatings," from Union Carbide's Plastics Division.

PROPERTIES

BAKELITE vinyl resin VYHH is the most widely used surface coating vinyl chloride-acetate resin. This copolymer has a medium molecular weight and a chemical composition of approximately 87 percent vinyl chloride and 13 percent vinyl acetate. These properties have been found to give a desirable balance between chemical resistance, solubility, film strength, and thermoplasticity. Vinyl resin VYHH, supplied as a dry white powder, is usually dissolved in a relatively strong solvent-diluent combination, such as 50 percent ketone solvent to 50 percent aromatic hydrocarbon diluent, to produce about a 15 to 20 percent solids resin solution. Pigments, plasticizers, and heat and light stabilizers can be used in a formulation to obtain the required end-use properties. Coatings based on vinyl resin VYHH develop adhesion to bare metal surfaces only after a bake of 325 to 350 deg. F.; over primed surfaces, the temperature need only be high enough to drive out residual solvent (about 250 deg. F.); on rough surfaces the mechanical adhesion developed may be sufficient without baking.

Marine antifouling paints, masonry and metal coatings, such as for steel and aluminum, lining for beer cans, coatings for paper, cardboard and foil, and maintenance and sanitary coatings are among the principal applications for finishes based on BAKELITE vinyl resin VYHH.

FORMULATIONS

A complete discussion of formulation techniques for producing both clear and pigmented vinyl solution coatings is presented in the general booklet, "BAKELITE* Vinyl Resins for Solution Coatings."

Table 1 gives a convenient starting point for the formulation of metal coatings based on vinyl resin VYHH. All suggested quantities are based on 15 parts by weight of vinyl resin VYHH. A partial list of suitable pigments, stabilizers and plasticizers along with a table on the solubility of resin VYHH in a number of commercial solvents are presented in Tables 2, 3, 4 and 5. A more complete list of pigments and dyes suitable for use with vinyl solution resins is presented in the general booklet.

Specific formulations of vinyl solution coatings will depend on the actual application methods used and the end properties sought. A number of starting point formulations for many types of vinyl coatings are available through your Union Carbide Plastics Division.

TABLE 1

Typical Formulation for A VYHH Metal Topcoat

	Parts by Weight
BAKELITE vinyl resin VYHH	15
Plasticizer (phthalate or phosphate)	2-4
Pigments*	2-25
Methyl isobutyl ketone	30
Toluene or xylene	30
Propylene oxide	0.05 0 20
Fillers	0 60

* Percentages of pigments vary with the types and colors used.

Pigments

The pigments most generally used in solution coatings based on BAKELITE vinyl resin VYHH are presented in Table 2. The amounts suggested are based on the quantity of each pigment that is necessary to ensure good hiding and adequate ultra-violet light protection for the vinyl resin.

TABLE 2

Suitable Pigments For Use in VYHH Solution Formulations

Pigment	Parts per 15 parts VYHH resin by Weight
Aluminum powder	6-8
Titanium dioxide	10-18
Titanium dioxide/antimony oxide (9 1)	10 18
Titanium dioxide/zinc oxide/antimony oxide (3.2.1)	10 18
Phthalocyanine green	2-4
Phthalocyanine blue	2-4
Chromic oxide green	10 15
Carbon black	1
Blue lead sulphate	15 25
White lead sulphate	15-25
Red lead	20-25
Iron oxide yellow (synthetic)*	8-15
Iron oxide red (synthetic)*	8-15
Iron oxide brown (synthetic)*	8 15
Iron oxide black (synthetic)*	8-15
Lead chromate	15 25
Strontium chromate	15 20
Cadmium reds	15 20
Chrome orange	15-20
Cadmium yellow	15-20

* All iron oxides should be used at bakes under 280 deg F. The use of these pigments should therefore be restricted to topcoats which require baking at 250 deg. F. to obtain good adhesion. Natural oxides are seldom satisfactory.

Stabilizers

The amount and type of stabilizer to be used in vinyl solutions are dependent upon the vinyl resin itself, the plasticizer, and pigments and the conditions of baking and exposure. Table 3 lists some of the commercially available stabilizers for use with vinyl resin VYHH along with the supplier of each stabilizer. In all cases careful attention must be paid to the proper choice of stabilizers, and they should be tested under the actual conditions of use. Recommendations of stabilizer suppliers should generally be followed.

Zinc stabilizers should be avoided due to extreme color development in relatively short periods of time, especially in low plasticizer systems.

TABLE 3

Several Commercial Stabilizers for Use With VYHH

Stabilizer	Supplier
"Advance" 17M	Advance Chemical and Solvent Co
"Mark" LL	Argus Chemical Company
"Mark" KCB	Argus Chemical Company
"Ferro" 1720	Ferro Chemical Company
"Harshaw" 6-V-2	Harshaw Chemical Company
"Nuodex" V-138	Nuodex Chemical Company

Plasticizers

It is usually desirable to include certain portions of plasticizers in coatings of BAKELITE vinyl resins in order to obtain increased flexibility. As a guide to the selection of the proper plasticizer, Table 4 gives the compatibilities of resin VYHH with a number of commercially available plasticizers.

TABLE 4

Compatibility of BAKELITE vinyl resin VYHH with Commercial Plasticizers

	Compatibility Data Weight Ratio of Resin VYHH to Plasticizer			
Compound Designation	9:1	4:1	2:1	1:1
Acetyl tributyl citrate	C	C	C	C
Acetyl triethyl citrate	C	C	C	C
Amyl Phthalate	C	C	C	C
"Aroclor" 1242 chlorinated diphenyl	C	C	C	C
"Aroclor" 1254 chlorinated diphenyl	C	C	C	C
Butoxyglycol adipate	C	C	C	C
Butyl acetate ricinoleate	C	IC	IC	IC
Butyl cyclohexyl phthalate	C	C	C	C
Butyl phthalate	C	C	C	C
Butyl sebacate	C	C	C	C
Butyl stearate	IC	IC	IC	IC
Butyl tartrate	C	C	C	C
Dibutyl CELLOSOLVE phthalate	C	C	C	C
Dicapryl phthalate	C	C	C	C
Di (2 ethylhexyl) azelate	C	C	C	C
Diisoctyl phthalate	C	C	C	C
Di n-octyl phthalate	C	C	C	C
Dioctyl sebacate	C	C	C	C
"Ethox" ethoxyglycol phthalate	C	C	C	C
Ethoxydiglycol phthalate	C	C	C	C
Ethylhexyl phthalate	C	C	C	C
Ethyl phthalate	C	C	C	C

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Compound Designation	Compatibility Data* Weight Ratio of Resin VYHH to Plasticizer 9:1	4:1	2:1	1:1
FLEXOL plasticizer DOP	C	C	C	C
FLEXOL plasticizer TOF	C	C	C	C
FLEXOL plasticizer 3GH	C	C	C	C
FLEXOL plasticizer 3GO	C	C	C	C
FLEXOL plasticizer 426	C	C	C	C
FLEXOL plasticizer 810	C	C	C	C
"KP 23" butoxyglycol stearate	SIC	IC	IC	IC
"KP 45" diglycol dipropionate	C	C	C	C
"Kronisol" butoxyglycol phthalate	C	C	C	C
"Methox" methoxyglycol phthalate	C	C	C	C
Methyl phthalate	C	C	C	C
"Nevinol" p coumarone indene polymer	IC	IC	IC	IC
"Oleoresin" 91 phthalic anhydride-castor oil reaction product	C	SIC	SIC	SIC
"Paraplex" G-60	C	C	C	C
"Paraplex" G 62	C	C	C	C
"Parol" 40PN chlorinated paraffin	C	C	SIC	IC
"P.H.P." phenol indene coumarone oil	C	C	C	C
Phenyl phthalate	C	C	C	C
"Plastolein" 9720	C	C	C	C
"Santicizer" 8	C	C	C	C
"Santicizer" E 15	C	C	C	C
"Santicizer" B 16	C	C	C	C
"Santicizer" 141	C	C	C	C
"Santicizer" 160	C	C	C	C
"Sipalin" AOM	C	C	C	C
Tributyl citrate	C	C	C	C
Tributyl acetylcitrate	C	C	C	C
Tributyl phosphate	C	C	C	C
Tricresyl phosphate	C	C	C	C
Tri 2-ethylhexyl phosphate	C	C	C	C
Triphenyl phosphate	C	C	C	C

NOTE: Data given in this table are based on tests conducted over a period of years by Union Carbide Corporation in its laboratories at South Charleston, West Virginia, on commercial compounds purchased in the open market or submitted by manufacturers. Every effort has been exerted to present only accurate, impartial information as a guide to surface coating formulators, but specific conditions and formula modifications may affect the characteristics of the various compounds in certain instances. Under no circumstances are the data in this table to be construed as a reflection on the grade, quality or purity of any of the compounds listed. In all cases formulators are urged to make their own tests, following their individual procedures, and to draw their own conclusions.

Compatibility data are based on operator's inspection of films deposited on glass plates after evaporation of solvents. Results were interpreted as follows:

C — Complete compatibility; film clear.

SIC — Slightly incompatible; faint haze or blush in film.

IC — Incompatible; fifilm badly blushed, inhomogeneous, or oily.

SOLUBILITIES

BAKELITE vinyl solution resins such as VYHH are readily dissolved at room temperature by such solvents as ketones, nitro compounds, and certain esters and chlorinated hydrocarbons. Other solvents, for example, keto-ethers, ether-esters, poly-ethers, aldehydes, and certain other types of compounds, have varying degrees of solvent action on these resins. Aromatic or coal-tar hydrocarbons, such as toluene and xylene, tend to swell, and in some instances dissolve the resins, especially at higher temperatures. Water, alcohols, and aliphatic hydrocarbons (petroleum naphthas) are strong precipitants. The hydrogenated naphthas, containing large proportions of aromatics, are grouped between the last two classes.

The solubility of vinyl resin VYHH in a number of commercial solvents is given in Table 5. A thorough discussion on solvents and solution characteristics of BAKELITE vinyl solution resins is presented in the general booklet.

TABLE 5

QUALITATIVE SOLUBILITIES OF BAKELITE VINYL RESIN VYHH IN SYNTHETIC ORGANIC CHEMICALS

Proportion of Resin in Liquid / Temperatures, deg. C. / Synthetic Organic Liquids	VYHH 10% 25	95*
Acetone	S	S
Acetonylacetone	S	S
Benzyl CELLOSOLVE	G	S
Butanol	I	I
n Butyl Acetate (98%)	S	S
Butyl CARBITOL	PS	S
Butyl CARBITOL Acetate	S	S
Butyl CELLOSOLVE	I	I
n Butyl Ether	I	I
Butyl Phthalate	S	S
CARBITOL Acetate	S	S
CARBITOL Solvent	I	I
CELLOSOLVE Acetate	S	S
CELLOSOLVE Solvent	I	I
Diacetone Alcohol	G	S
Dichlorethyl Ether	S	S
Dichloroisopropyl Ether	S	S
Diethyl CARBITOL	S	S
Diethylene Glycol	I	I
Diisobutyl Ketone	S	S
Dioxane	S	S
Dipropylene Glycol	I	I
Ethanol (95%)	I	I
Ethyl Acetate	S	S
2-Ethylbutyl Acetate	S	S
Ethyl Ether	I	I
Ethyl Silicate	I	I
Ethylene Dichloride	S	S
Ethylene Glycol	I	I
2-Ethylhexanol	I	I
2-Ethylhexyl Acetate	S	S
Glycol Diacetate	G	PS
Heptadecanol	I	I
Hexanol	I	I
Isopropanol (Anhydrous)	I	I
Isopropanol (Technical)	I	I
Isopropyl Acetate (98%)	S	S
Isopropyl Ether	I	I
Mesityl Oxide	S	S
Methanol	I	I
Methyl Acetate (82%)	S CL	S CL
Methyl Amyl Acetate	S	S
Methyl Amyl Alcohol	I	I
Methyl n-Amyl Ketone	S	S
Methyl CARBITOL	I	I
Methyl CELLOSOLVE	S	S
Methyl CELLOSOLVE Acetate	S	S
Methyl Isobutyl Ketone	S	S
Methyl Phthalate	S	S
2-Nitropropane	S	S
Methyl Ethyl Ketone	S	S
Methyl Hexyl Ketone	S	S
Methyl Isoamyl Ketone	S	S
Cyclohexanone	S	S
Tetrahydrofuran	S	S
Dimethyl Formamide	S	S
Propylene Dichloride	S	S
Propylene Glycol	I	I
Propylene Oxide	S	S
Tetradecanol	I	I
Tetraethylene Glycol	I	I
Trichlorethylene	G	S
Triethylene Glycol	I	I
Triglycol Dichloride	S	S
Undecanol	I	I

S Soluble G Gels CL Cloudy solution
I Insoluble SW Swells P Partially

* Tests were made at temperatures slightly below the boiling points on those liquids which boil below 95 deg. C.

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COATINGS AND PLASTICS MATERIALS

BAKELITE® VINYL SOLUTION RESIN VYHH

FOR COATINGS

PRODUCT STANDARDS

DESCRIPTION

BAKELITE VYHH is a medium-molecular weight vinyl chloride-vinyl acetate copolymer resin. It dissolves readily in ketones, esters, chlorinated hydrocarbons, and combinations of these with aromatic hydrocarbons.

APPLICATIONS

BAKELITE VYHH is recommended for general coatings use.

FOOD ADDITIVE STATUS

BAKELITE VYHH is chemically identified in Food Additive Regulations §121.2514 for Resinous and Polymeric Coatings and by reference in §121.2526 for Components of Paper and Paperboard and in § 121.2550 for Components of Closures.

Properties of

BAKELITE Vinyl Solution Resin VYHH

Properties	Test Methods	Required Values
Appearence	Visual	White powder
Size, per cent by weight, through a No. 20 USBS Sieve	WC-7-F	98, minimum
Heating Loss, 45 minutes at 105°C., per cent by weight	WC-160-H	3.0, maximum
Poly(vinyl chloride), per cent by weight	WC-294-B or D	85.0 - 86.5

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Solution Properties	Test Methods	Required Values
22 Per Cent Solution of Resin in 1:1 MIBK:Toluene		
Viscosity at 25°C., cps.	WC-31-W	200 - 400
Color, % transmission at 475 mμ/600 mμ	WC-5-K-2	85, minimum
Turbidity, light transmission at 600 mμ, per cent	WC-5-K-2	85, minimum
10 Per Cent Solution Resin 1:1 MIBK:Toluene		
Insoluble Matter, per cent by wet volume	WC-322-C	0.03, maximum

TESTING METHODS

Designated tests are made in accordance with current issues of ASTM or UNION CARBIDE (WC) Testing Methods. The former can be obtained from the American Society for Testing and Materials, Philadelphia, Pa., while the latter are available from Union Carbide Corporation upon request.

LABELING

All containers of BAKELITE Vinyl Solution Resin VYHH are plainly marked with the product nomenclature, blend number, and net weight. Shipments will be so addressed as to provide complete delivery to the purchaser.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of BAKELITE Vinyl Solution Resin VYHH, precautionary labeling used on the containers is as follows:

FOR INDUSTRY USE ONLY

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GENERAL PROPERTIES

Resin VMCH differs from resin VYHH in that it contains the reactive carboxyl groups of maleic acid which are responsible for the air-dry adhesion properties of the resin and its reactivity with basic pigments and certain resins. It is a tripolymer of vinyl chloride, vinyl acetate, and maleic acid in the ratio of 86:13:1. Resin VYHH is a copolymer of vinyl chloride-acetate in the ratio of 87:13. Both resins have comparable viscosities in solution.

VINYLITE Resin VMCH: Specifications

Appearance	Powdered White Solid
Size	At least 98% through 20 mesh
Heating Loss	2.0% maximum
Vinyl Chloride Resins	85.0-88.0%
Maleic Acid	0.70-1.00%
Specific Viscosity	0.536-0.567
(1.0 gm. in 100 ml. solution in methyl isobutyl ketone 20.0 deg. C.)	

Solubility - Both resins are about the same. See Table I for specific information.

Heat Stability - Heat stability of resin VMCH is substantially the same as that of resin VYHH in unstabilized films over metal. However, resin VMCH is primarily intended for use in air-dried and low-baked systems where heat stability is not a major requirement.

Light Stability - In properly pigmented systems, both resins are about the same. In clear, unstabilized films, resin VYHH is slightly superior.

Adhesion to clean metal - Air-dried: resin VMCH is very good, resin VYHH is poor. Baked at 250 deg. F.: resin VMCH is very good, resin VYHH is poor. Baked at 350 deg. F. in stabilized coatings: both resins are very good.

TABLE I

QUALITATIVE SOLUBILITY OF VINYLITE RESIN VMCH*

Synthetic Organic Liquids	Temperature, [illegible] 25	[illegible]**
Acetone	S	S c
Acetonyl Acetone	S	S
Benzyl CELLOSOLVE	G	S
Butanol	I	I
n-Butyl Acetate (98%)	S	S
Butyl CARBITOL	PS	S
Butyl CARBITOL Acetate	S	S
Butyl CELLOSOLVE	I	I
n-Butyl Ether	I	I
Butyl Phthalate	S	S
CARBITOL Acetate	S	S
CARBITOL Solvent	I	I
CELLOSOLVE Acetate	S	S
CELLOSOLVE Solvent	I	I
Diacetone Alcohol	G	S
Dichlorethyl Ether	S	S
Dichlorisopropyl Ether	S	S
Diethyl CARBITOL	S	S
Diethylene Glycol	I	I
Diisobutyl Ketone	S	S
Dimethoxy tetraglycol	S	S
Dimethyl Formamide	S	S
Dioxane	S	S
Dipropylene Glycol	I	I
Ethanol (95%)	I	I
Ethyl Acetate	S	S
2-Ethylbutanol	I	I
2-Ethylbutyl Acetate	S	S
Ethyl Butyl Ketone	S	S
Ethyl Ether	I	I
Ethyl Silicate	I	I
Ethylene Dichloride	S	S
Ethylene Glycol	I	I
2-Ethylhexanol (Octyl Alcohol)	I	I
2-Ethylhexyl Acetate	S	S
Glycol Diacetate	G	PS
Heptadecanol	I	I
Hexanol	I	I
Isopropanol (Anhydrous)	I	I
Isopropanol (Technical)	I	I
Isopropyl Acetate (98%)	S	S
Isopropyl Ether	I	I
Mesityl Oxide	S	S

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TABLE I (Cont'd)

Synthetic Organic Liquids	Temperature, [illegible] C. 25	[illegible]**
Methanol	I	I
Methyl Acetate (82%)	S-CL	S-CL
Methyl Amyl Acetate	S	S
Methyl Amyl Alcohol	I	I
Methyl CARBITOL	I	I
Methyl CELLOSOLVE	S	S
Methyl CELLOSOLVE Acetate	S	S
Methyl Isobutyl Ketone	S	S
Methyl Phthalate	S	S
Phenyl CELLOSOLVE	G	S
Propylene Dichloride	S	S
Propylene Glycol	S	I
Propylene Oxide	S	S
Tetradecanol	I	I
Tetraethylene Glycol	I	I
Tetrahydrofuran	S	S
Trichlorethylene	G	S
Triethylene Glycol	I	I
Triglycol Dichloride	S	S
Undecanol	I	I

S = Soluble G = Gels CL = Cloudy I = Insoluble
PS = Partially Soluble

* Resin concentration for all solubility tests, 10 per cent
** Determined at temperatures slightly below boiling point for liquids boiling below 95 deg. C.

NOTE: Although CELLOSOLVE solvent, CARBITOL solvent, toluene, xylene, and closely-related liquids do not dissolve resin VMCH when used above, certain combinations are effective solvents. Thus, a CELLOSOLVE solvent-toluene mixture in 1:1 to 1:4 ratios will form solutions of at least 15 per cent resin solids, with viscosity minimum at a ratio of about 1:3.

Resin VMCH adheres very well on air-drying to iron, steel, cadmium and brass. Over zinc, some loss of adhesion occasionally occurs by reason of excessive reactivity. A phosphate pretreatment of this metal is urged. (It is suggested that the formulator investigate the use of wash primers, based on vinyl butyral resin, for use on galvanized surfaces. Wash primers are described in the booklet "VINYLITE Vinyl Butyral Resins for Coatings.") A wash primer consisting of a dispersion of chromic phosphate in a VMCH resin solution has been noted to give outstanding performance on steel and other surfaces.

Compatibility - both resins are about the same. They are compatible with each other and with other vinyl chloride-acetate resins.

Reactivity with pigments - at room temperature, resin VYHH is non-reactive, but resin VMCH reacts with basic pigments to cause gelation of the composition. Both resins show thermal breakdown with zinc or certain iron pigments at bakes over 280 deg. F.

Heat-reacted coatings - Resin VMCH can be formulated to produce solvent-resistant coatings much more readily than can resin VYHH. (The formulator is advised to investigate this property in resin VAGH if he is interested in improved solvent resistance and somewhat better heat-resistant coatings.)

Formulation of Resin VMCH Coatings

VINYLITE resin coatings that are to be air-dried or baked at temperatures of 250 deg. F. or below are usually formulated with resin VMCH. These may be used as one coat finishes, or they may serve as primers for finishes based on resin VYHH alone. Such finishes are well suited for general-purpose coatings and for chemical and corrosion-resistant coatings involving either atmospheric exposure or fresh water immersion. Air-dry coatings for salt water immersion usually include the well known wash primers based on VINYLITE Resin XYHL.

While resin VMCH has the same high degree of chemical resistance as does resin VYHH, air-dry coatings may not display the same resistance as a VYHH resin coating baked at 350 deg. F. This is attributable to the greater permeability of air-dry coatings which may result from retained solvents. This factor must be considered in applications involving maximum chemical resistance.

The formulation of VMCH coatings is based on the principles outlined for resin VYHH in the book "VINYLITE Resins for Surface Coatings" and differs only in that resin VMCH is reactive with basic pigments, a property that is often utilized to formulate coatings of decreased solubility. Basic suggestions for formulating are as follows:

Solvents -- Base solutions are prepared at 20 per cent resin content in thinners containing equal proportions of ketones and aromatic hydrocarbons. Further dilution can be made with mixed thinners based almost completely on aromatic hydrocarbons. Aliphatic hydrocarbons and alcohols are strong precipitants, and are to be avoided in thinners. Propylene oxide to the extent of 0.2 to 0.5 per cent of the thinner is a desirable addition to insure neutrality in the solution. (NOTE: Care should be taken to follow manufacturers' recommended precautions in handling propylene oxide.)

Plasticizers -- Conventional vinyl plasticizers which are completely compatible are incorporated at 15 to 35 parts per 100 parts of resin. The higher proportion is required for coatings which are force dried, whereas the lowest proportion is desirable for underwater coatings. Di (2-ethylhexyl) phthalate and tricresyl phosphate are typical of the plasticizer types giving excellent performance. Replacement of a portion of these with chlorinated paraffins is often desirable for best performance under conditions of high humidity or fresh water immersion.

Stabilizers -- Heat stabilizers are not required for normal air-dry or low-bake coatings. Properly pigmented finishes do not require light stabilizers. Unpigmented finishes are not recommended for use outdoors or where exposed to ultra-violet light.

Added Resins -- Resin VMCH exhibits its greatest utility in improving the adhesion of other vinyl chloride-acetate resins. It is often used with resin VYHH since the latter is a convenient vehicle for pigment dispersions. In other instances, resin VAGH is used with resin VMCH coatings in order to improve the adhesion of the coating to surfaces covered with old paints, wash primers, and varnishes, surfaces to which resin VMCH does not normally adhere. Like other vinyl chloride-acetate resins, VMCH resin does not have sufficient compatibility to be used for reinforcing many other types of coatings. It has been useful, however, for improving the air-dry adhesion of many acrylic and methacrylic resin coatings.

For coatings involving extreme chemical resistance, blends of resin VMCH and VYDR are often used. Sometimes such blends gel, even though non-reactive pigments are used. This is caused by resin VYDR, solutions of which thicken rapidly in cold weather. Such gels are temporary. They can be broken and the coating restored to its original fluidity by warming the container, using a high-speed agitator to break the gel, or by a combination of both. Added solvent will hasten the process.

Pigments -- Essentially neutral pigments, such as titanium dioxide, chromic oxide, and precipitated iron oxides are well suited for general use in resin VMCH primers. It is advisable to formulate primers with a top limit of 20 to 25 per cent pigment by volume based on the dry films. A higher pigment content tends to decrease the air-dry adhesion of coatings based on VMCH resin. This is believed to result from a simple dilution effect, or the absorption on the pigment of a major portion of the carboxyl groups, leaving few to attach themselves to the surface being coated.

Resin VMCH formulations containing leafing aluminum pigments should seldom be stored since the solvents often dissolve the agents used to coat the aluminum powder to improve the leafing characteristics. These leafing agents are often fatty acids which interfere with the air-dry adhesion of resin VMCH when dissolved in the solvents of the coating.

Special precautions should be taken to avoid basic pigments in resin VMCH formulations that are to be stored before application. Most basic pigments react with resin VMCH in solution to form a gel or "liver." Pigments displaying this undesirable reactivity include zinc, strontium and lead chromates, zinc oxide and zinc dust, natural iron oxides, and most of the lead pigments. With the exception of neutral or acidic grades of some of these types, most of the pigments conventionally used to obtain anticorrosive properties in coatings are reactive. Because of the low solubility of water in the vinyl chloride-acetate resins, usually there is little value in mixing these rust inhibitive pigments in vinyl films. However, when needed, they can be incorporated by a mixing-lacquer technique to be described later.

Methods of Pigmentation -- When coatings in which resin VMCH is present are to be pigmented, it is customary first to disperse the pigments in another compatible vinyl resin, usually resin VYHH. This is done because: (1) The excellent adhesion of VMCH makes it difficult to "work" dispersions on a two-roll mill, often used to disperse pigments in vinyl resins. (2) A greater variety of pigments can be dispersed in other vinyl chloride-acetate resins than in resin VMCH, because basic pigments react with resin VMCH to form products which are difficult to dissolve.

The normal procedure for pigmenting coatings based on resin VMCH simply consists of dispersing the pigment in resin VYHH (or other vinyl chloride-acetate resins) on a two-roll rubber mill. The resulting chips are cut with thinner to form a pigment paste, according to procedures described in "VINYLITE Resins for Surface Coatings." The pigment paste is blended with a base solution of resin VMCH, plasticizers, and thinners as required to complete the formulation. If it is more convenient, the chips can be dissolved directly in the base solution, instead of preparing a separate pigment paste.

If ball mill dispersion is desired, resin VMCH can be used as the dispersing medium. If a gloss coating is required, it is necessary to mill the pigment with plasticizer, thinner and wetting agent and, after a dispersion is obtained, the VMCH resin or resin base solution is added to the mill. After further grinding, any remaining ingredients of the formula may be added. Special precautions must be taken to avoid reactive pigments in the formulation. Contamination with iron is also to be avoided, and it is advisable to use flint or porcelain pebbles and similar mill linings to eliminate its occurrence. If steel balls are used, the effect of traces of iron must be counteracted with [illegible] .thophosphate does well under such conditions.

Where it is desirable to incorporate basic pigments into resin VMCH coatings, it is necessary to use the mixing-lacquer technique, similar to the method used in preparing many conventional aluminum pigmented paints.

The mixing-lacquer technique is similar to the method of preparing many conventional aluminum-pigmented paints just prior to use. It involves keeping the reactive ingredients (pigment dispersion and solution of resin VMCH) apart until immediately prior to the application of the coating. Briefly the formulator follows these simple steps:

a. The composition of the coating is calculated, including thinner to reduce to spray viscosity, if spraying is to be followed.

b. The pigment is dispersed in resin VYHH or other copolymer VINYLITE resins, and a semi-paste is made of the dispersion.

c. The pigment semi-paste, plasticizer, and other ingredients, with the exception of the VMCH resin and the majority of the thinner, are mixed and packaged.

d. Dilute solution of resin VMCH in the balance of the thinner is packaged in another container. An anti-gelling agent may also be included.

e. Just prior to application of the coating, the contents of the two containers ("c")and("d"), are mixed. Since the coating now approx[illegible] application viscosity, it can be used immediately. [illegible] contact between the reactive ingredients. The mixed coating will keep for several hours without gelation, but, in many cases, it will not be usable after overnight storage.

With certain very reactive pigments such as the basic zinc chromates, it may be necessary to add very small proportions of anti-gelling agents. The most effective of these is n-butyl acid phosphate. Other anti-gelling agents such as maleic acid, tartaric acid, diphenyl guanidine, ammonia (most efficient if dissolved as a gas in the thinner) and amines, to name a few, are effective in preventing livering in solution, but generally these interfere with the air-dry adhesion of the coating. Their chief value is in formulations designed for low,or high bakes.

By the mixing-lacquer technique anti-corrosive pigments such as the zinc and strontium chromates may be used in primers containing resin VMCH. In these formulations the chromate pigment should not exceed 50 per cent of the resin by weight or 10 to 15 per cent of the dry film by volume. The excellent moisture resistance of films of vinyl chloride-acetate resins make it difficult for soluble chromates to pass freely from beneath the coating after moisture has penetrated to the primer. As a result, some blistering and loss of adhesion is likely to occur if the chromate pigment concentration in the primer is too high. However, the total pigment content may be advantageously raised by blending other pigments such as titanium dioxide with the chromate.

Of the rust inhibitive pigments, tri-lead orthophosphate and tetra-lead pyrophosphate have the least reactivity with resin VMCH. However, coatings containing these pigments with resin VMCH lose their ability to adhere on air drying if stored in solution for extended periods of time.

Recent studies indicate that chromic phosphate, either with or without added phosphoric acid, confers rust inhibitive properties on resin VMCH coatings. The coatings containing phosphoric acid often show some pigment flocculation on storage, so that it is advisable to withhold this ingredient until just before application. The phosphoric acid modified coatings are preferred for applications subject to salt water immersion.

Reactive Coatings -- Coatings of better solvent resistance and higher heat distortion temperature can be obtained by taking advantage of the reactivity of resin VMCH. This involves the reaction of the free carboxyl groups of the resin with basic pigments or other resins to introduce a measure of cross-linking.

Basic pigments such as blue basic lead sulphate are dispersed in VYHH resin, then blended with VMCH resin solutions. Livering or gelation is prevented by the addition of anti-gelling agents such as maleic, citric, or tartaric acids in very small proportions (0.01 to 0.5 per cent on VMCH resin). The coating is applied and then baked at temperatures around 350 deg. F. The baked coating has much better resistance to solvents than do resin VYHH coatings, and is often used as a primer under highly plasticized coatings, such as plastisols, because of its resistance to softening by plasticizers.

Various resins such as the melamine and urea-formaldehyde types react with resin VMCH during baking. Frequently, plasticizing alkyd resins are required in the formulation to retain flexibility and prevent check[illegible] coating. Such coatings combine [illegible] resistance, acid and alkali resistance with low solubility in many commonly used organic liquids.

Specific Uses

The usefulness of resin VMCH has been outlined in a general way earlier in this booklet. To illustrate more specifically some of the ways in which application can be made of this, the following suggestions are cited:

Frequently, there is a demand for maintenance finishing systems which must withstand more severe chemical attack or slightly higher surface temperature than systems containing resin VYHH can withstand efficiently. In such cases, a primer combining VINYLITE resins VMCH and VYDR, followed by finish coats based on resin VYDR, alone, will give excellent service. A system of this sort has been in regular use for ten years in a large chemical plant.

Long-lasting finishes for concrete are easily formulated when resin VMCH is a major portion of the vehicle. Tests made on both rough and smooth concrete panels half buried in wet sand and half exposed at 45 deg. to the horizontal facing south at South Charleston, W. Va., showed virtually no failures in such coatings after two years of exposure. Several concrete swimming pools in the same area were finished with similar systems and withstood more

VYNS-3
Issue 8
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VINYL RESINS HANDBOOK - CONFIDENTIAL
RESIN MANUFACTURING SPECIFICATION

"BAKELITE" VINYL CHLORIDE - ACETATE RESIN

VYNS-3

		Specification Limits	Method
1	Appearance	White, powdered solid	Visual
2	Size	98.0 per cent by weight, minimum, through a No. 20 USBS sieve	WC-7-F
3	Heating loss, 45 minutes at 105°C	1.5 per cent by weight maximum	WC-160-H
4	Polyvinyl chloride	88.5 to 90.5 per cent by weight	WC-294-B
5	Inherent viscosity 0.2 gm resin per 100 ml of cyclohexanone at 30°C	0.72 to 0.75	WC-31-B-4; ASTM D 124
6	Foreign matter, slurry rating	3, maximum	WC-15-P-1
7	Water content, per cent	DAR	WC-6-F-5
*8	Residual Vinyl Chloride Monomer	<1 ppm by wt.	WC-326-G-1

THE FOLLOWING REQUIREMENTS APPLY TO A 17 PERCENT BY WEIGHT SOLUTION OF THE RESIN IN 70:30 MEK:TOLUENE PREPARED ACCORDING TO WC-609-I:

9	Solution Viscosity at 25°C, centipoise	200 to 400	WC-31-W
10	Color	80, minimum	WC-5-K-2
11	Turbidity	85, minimum	WC-5-K-2

DAR Determine and report

* Denotes addition

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than six years of service before refinishing. In one case, the refinishing was done to change the color; in another case, remodelling of the pool necessitated the refinishing; in neither instance did the original coating show serious failure.

As described in the booklet, "VINYLITE Resins-Dispersion Coatings," it is possible to improve the adhesion of VINYLITE resin organosols for a wide variety of applications. This is done by preparing a solution such as the following:

XL-5338

VINYLITE resin VMCH	15.0
Methyl CELLOSOLVE solvent	21.0
Propylene oxide	0.2
Toluene	63.8
Percent by weight	100.0

In such a case, the solution is warmed to 125 deg. F. to insure complete solution. It will blend readily with nearly any organosol, but best results are obtained if blending is done just before use. Usually 5 to 30 parts of resin VMCH to 100 parts of resin VYNV will be sufficient. Obviously such a formulation is useful in other applications, as well.

The ability of resin VMCH to develop adhesion at lower baking temperatures than are necessary for resin VYHH makes it highly useful in many types of finishes, especially in one-coat applications. Bottle caps, wall tiles, metal cabinets, and many other surfaces have been commercially coated with such finishes for several years.

Summary

VINYLITE resin VMCH is basically a vinyl chloride-acetate resin with the outstanding advantage of adhering well to many surfaces when little or no bake is used. Excellent coatings can be formulated in which this resin is the major constituent, if the formulator is careful to (1) disperse the pigment properly (2) use the correct pigment concentration, and (3) control the reactivity of the resin.

UNION CARBIDE

BAKELITE™ VINYL SOLUTION RESIN
VYNS-3
FOR COATINGS

PRODUCT STANDARDS

DESCRIPTION

BAKELITE Vinyl Solution Resin VYNS-3 is a vinyl chloride-vinyl acetate copolymer resin of high-molecular weight. It provides the maximum in physical properties such as tensile strength, elongation, and abrasion resistance that can be obtained from a solution applied coating of practical solids content. BAKELITE® VYNS-3 requires essentially straight ketone solvents, and it can tolerate very high plasticizer concentrations without becoming tacky.

BAKELITE Vinyl Solution Resin VYNS-3 is recommended as an adhesive, ink, or topcoat for plasticized vinyl film or coated fabric.

FOOD ADDITIVE STATUS

BAKELITE Vinyl Solution Resin VYNS-3 is cited by chemical identity in Food Additive Regulations § 175.300 (1) for Resinous and Polymeric Coatings and by reference in § 176.170 (2) for Components of Paper and Paperboard and in § 177.1210 (3) for Components of Closures.

Properties of
BAKELITE Vinyl Solution Resin VYNS-3

Properties	Test Methods	Required Values
Appearance	Visual	White powder
Size, per cent by weight through a No. 20 USBS Sieve	WC-7-F	98, minimum
Heating Loss, 45 minutes at 105°C., per cent by weight	WC-160-H	1.5, maximum
Poly(vinyl chloride), per cent by weight	WC-294-B	88.5 - 90.5
Inherent Viscosity at 30°C., 0.2 g. in cyclohexanone	D 1243	0.72 - 0.75
Solution Properties, 17% solution of resin in 70:30 MEK:Toluene		
Viscosity at 25°C., cps.	WC-31-W	200 - 400
Color:% light transmission 475 mu/600 mu	WC-5K-2	80, minimum
Turbidity: light transmission 600 mu, per cent	WC-5K-2	85, minimum
Residual Vinyl Chloride Monomer, ppm. by weight	WC-326-G-1	1, maximum

Footnote:

(1) Formerly 121.2514
(2) Formerly 121.2526
(3) Formerly 121.2550

F-44632A
November, 1977

UNION CARBIDE CORPORATION · 270 PARK AVENUE, NEW YORK, N.Y. 10017

TEST METHODS

Tests are made in accordance with current issues of the ASTM or Union Carbide (WC) testing methods designated. The former can be obtained from the American Society for Testing and Materials, Philadelphia, Pa. 19103, while the latter are available from Union Carbide Corporation upon request.

LABELING

All containers of BAKELITE Vinyl Solution Resin VYNS-3 are plainly marked with the product nomenclature, blend number, and net weight. Shipments will be so addressed as to provide complete delivery to the purchaser.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of BAKELITE Vinyl Solution Resin VYNS-3, precautionary labeling used on the containers is as follows:

FOR INDUSTRY USE ONLY

SHIPPING AND STORAGE

BAKELITE Vinyl Solution Resin VYNS-3 is a stable material when kept in closed containers stored in a cool dry place.

EMERGENCY SERVICES

For help and emergencies such as a spill, leak, fire or exposure involving a Union Carbide Corporation chemical or plastic, call collect day or night 304-744-3487.

For any chemical emergency, call: CHEMTREC 800-424-9300.

BAKELITE® VINYL SOLUTION RESIN
VYNS-3
FOR COATINGS

PRODUCT STANDARDS

DESCRIPTION

BAKELITE Vinyl Solution Resin VYNS-3 is a vinyl chloride-vinyl acetate copolymer resin of high-molecular weight. It provides the maximum in physical properties such as tensile strength, elongation, and abrasion resistance that can be obtained from a solution applied coating of practical solids content. BAKELITE® VYNS-3 requires essentially straight ketone solvents, and it can tolerate very high plasticizer concentrations without becoming tacky.

BAKELITE Vinyl Solution Resin VYNS-3 is recommended as an adhesive, ink, or topcoat for plasticized vinyl film or coated fabric.

FOOD ADDITIVE STATUS

BAKELITE Vinyl Solution Resin VYNS-3 is cited by chemical identity in Food Additive Regulations § 175.300 (formerly § 121.2514) for Resinous and Polymeric Coatings and by reference in § 176.170 (formerly § 121.2526) for Components of Paper and Paperboard and in § 177.1210 (formerly § 121.2550) for Components of Closures.

Properties of
BAKELITE Vinyl Solution Resin VYNS-3

Property	Test Methods	Required Values
Appearance	Visual	White powder
Size, % by weight through a No. 20 USBS Sieve	WC-7-F	98, minimum
Heating Loss, 45 minutes at 105°C., % by weight	WC-160-H	2.0, maximum
Polyvinyl Chloride, % by weight	WC-294-B	88.5 - 90.5
Solution Properties, 17% solution of resin in 70:30 MEK:Toluene		
Viscosity at 25°C., cps. (Pa's)	WC-31-W	200 - 400 (0.200 - 0.400)
Color, % light transmission at 475 mμ/600 mμ	WC-5K-2	80, minimum
Turbidity, light transmission at 600 mμ, %	WC-5K-2	85, minimum
Residual Vinyl Chloride Monomer, by weight	WC-326-G-1	Less than 1 ppm.

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TEST METHODS

Designated tests are made in accordance with current issues of Union Carbide (WC) testing methods. They are available from Union Carbide Corporation upon request.

LABELING

All containers of BAKELITE Vinyl Solution Resin VYNS-3 are plainly marked with the product nomenclature, blend number, and net weight. Shipments will be so addressed as to provide complete delivery to the purchaser.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of BAKELITE Vinyl Solution Resin VYNS-3, precautionary labeling used on the containers is as follows:

FOR INDUSTRY USE ONLY

TOXICOLOGICAL PROPERTIES

BAKELITE Vinyl Solution Resin VYNS-3 is a powdered resin which is essentially inert and non-toxic. Its dust is classed as a nuisance dust which is not known to cause lung disease. However, it is prudent not to exceed the recommended Threshold Limit Value for nuisance dust of 10 mg. per cubic meter of air or 30 million particles per cubic foot, whichever is the smaller.

SHIPPING AND STORAGE

BAKELITE Vinyl Solution Resin VYNS-3 is a stable material when kept in closed containers stored in a cool dry place.

EMERGENCY SERVICE

For help and emergencies such as a spill, leak, fire or exposure involving a Union Carbide Corporation chemical or plastic, call collect day or night:

304-744-3487

For any chemical emergency, call: CHEMTREC 800-424-9300

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BAKELITE® VINYL SOLUTION RESIN VYNS

FOR COATINGS

PRODUCT STANDARDS

DESCRIPTION

BAKELITE VYNS is a vinyl chloride-vinyl acetate copolymer resin of high-molecular weight. It provides the maximum in physical properties such as tensile strength, elongation, and abrasion resistance that can be obtained from a solution applied coating of practical solids content. BAKELITE VYNS requires essentially straight ketone solvents, and it can tolerate very high plasticizer concentrations without becoming tacky.

BAKELITE VYNS resin is recommended as an adhesive, ink, or topcoat for plasticized vinyl film or coated fabric.

FOOD ADDITIVE STATUS

BAKELITE Vinyl Solution Resin VYNS is cited by chemical identity in Food Additive Regulations § 121.2514 for Resinous and Polymeric Coatings and by reference in § 121.2526 for Components of Paper and Paperboard and in § 121.2550 for Components of Closures.

Properties of

BAKELITE Vinyl Solution Resin VYNS

Properties	Testing Methods	Required Values
Appearance	Visual	White powder
Size, per cent by weight through a No. 20 USBS Sieve	WC-7-F	98, minimum
Heating Loss, 45 minutes at 105°C., per cent by weight	WC-160-H	1.5, maximum
Poly(vinyl chloride), per cent by weight	WC-294-B	88.5 - 90.5
Inherent Viscosity at 30°C., 0.2 g. in cyclohexanone	D 1243	0.72 - 0.75
Solution Properties, 17% solution of resin in 70:30 MEK:Toluene Viscosity at 25°C., cps.	WC-31-W	200 - 400
Color: % light transmission 475 mμ/600 mμ	WC-5K-2	80, minimum
Turbidity: light transmission 600 mμ, per cent	WC-5K-2	85, minimum

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F-44632

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TEST METHODS

Tests are made in accordance with current issues of the ASTM or UNION CARBIDE (WC) testing methods designated. The former can be obtained from the American Society for Testing and Materials, Philadelphia, Pa., while the latter are available from Union Carbide Corporation upon request.

LABELING

All containers of BAKELITE Vinyl Solution Resin VYNS are plainly marked with the product nomenclature, blend number, and net weight. Shipments will be so addressed as to provide complete delivery to the purchaser.

SHIPPING AND STORAGE

BAKELITE Vinyl Solution Resin VYNS is a stable material when kept in closed containers stored in a cool dry place.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of BAKELITE Vinyl Solution Resin VYNS, precautionary labeling used on the containers is as follows:

FOR INDUSTRY USE ONLY

F-44632
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Printed in U.S.A.

UNION CARBIDE COATINGS MATERIALS

PRODUCT INFORMATION

BAKELITE® VINYL SOLUTION RESIN VYNS

BAKELITE Vinyl Resin VYNS is a versatile vinyl chloride-vinyl acetate copolymer solution resin. As a class, BAKELITE vinyl chloride-acetate copolymers for surface coatings are permanently thermoplastic, neutral, non-oxidizing, and non-heat-reactive. They are characterized by absence of color, odor, and taste. Films of these resins are not attacked at normal temperatures by alkalies, mineral acids, alcohols, greases, oils, or aliphatic hydrocarbons. Coatings based on BAKELITE vinyl chloride-acetate resins have low water vapor permeability, low water absorption, and excellent toughness and flexibility.

These copolymers are designed to dissolve in organic liquids such as ketones, certain esters, and chlorinated hydrocarbons. They form a protective film by evaporation alone. Properly formulated coatings based on BAKELITE vinyl chloride-acetate resins can be applied by spraying, roller-coating, dipping, and knife-coating.

This data sheet presents only those properties and performance values specific to resin VYNS-based solution coatings. A more comprehensive description and discussion of vinyl solution coatings preparation, formulation, baking and fusing, and other end-use applications is presented in the special booklet, "BAKELITE Vinyl Resins for Solution Coatings" (J-2178C).

PROPERTIES

BAKELITE Vinyl Resin VYNS has a medium-high molecular weight and a chemical composition of approximately 90 per cent vinyl chloride and 10 per cent vinyl acetate. These properties have been found to give a high degree of chemical resistance, film strength, and thermoplasticity.

Vinyl Resin VYNS, supplied as a dry white powder, is usually dissolved in relatively strong solvents, such as methyl ethyl ketone and methyl isobutyl ketone, to produce resin solutions of 12 to 18 per cent solids. Pigments, plasticizers, and heat and light stabilizers can be used in a formulation to obtain the required end-

F-42270
(replaces J-2301A)

PROPERTIES (Continued)

use properties. Coatings based on Vinyl Resin VYNS are rarely used over bare metal surfaces because of the high baking temperatures required to achieve good adhesion; over primed surfaces, the temperature need only be high enough to drive out residual solvents (about 250°F.); over rough surfaces the mechanical adhesion developed may be sufficient without baking.

Overlacquers for vinyl film and sheeting, strippable and cobweb type coatings for protecting finished products during storage and shipment, high chemical and moisture resistant coatings, and architectural finishes over primed masonry, wood, and steel are among the principal applications for finishes based on BAKELITE Vinyl Resin VYNS.

FORMULATIONS

Table 1 gives convenient starting points for the formulations based on 15 parts by weight of Vinyl Resin VYNS. A partial list of suitable pigments, stabilizers, and plasticizers are presented in Tables 2, 3, and 4. A more complete list of pigments and dyes suitable for use with vinyl solution resins is presented in the general booklet.

TABLE 1
TYPICAL VYNS FORMULATIONS

Overlacquer	Parts by Weight
BAKELITE Vinyl Resin VYNS	50 to 75(1)
Methyl Methacrylate Resin	25 to 50
Cellulose Acetate-Butyrate Resin(2)	2 to 4
Methyl Isobutyl Ketone (MIBK)	60(3)
Methyl Ethyl Ketone (MEK)	40(3)

(1) Toughness, flexibility, and adhesion are improved as the vinyl content of the formula is increased.

(2) May be omitted if surface slip or anti-blocking characteristics are not required or may be replaced with amorphous silica gel for low gloss overlacquer.

(3) As required for application viscosity or solids content.

TABLE 1

TYPICAL VYNS FORMULATIONS (Continued)

Strippable Coating	Parts by Weight
BAKELITE Vinyl Resin VYNS	10
BAKELITE Vinyl Resin VYHH	5
Plasticizer	4
Methyl Ethyl Ketone (MEK)	27
Methyl Isobutyl Ketone (MIBK)	27
Toluene	27

Cocoon Coating(1)	Parts by Weight
BAKELITE Vinyl Resin VYNS	16
Aluminum Powder	6
Plasticizer	·8
Methyl Ethyl Ketone (MEK)	70

(1) For bridging large areas (18" x 18"), replace 2 parts of VYNS with high molecular weight polyvinylidene chloride resin.

Specific formulations of vinyl solution coatings will depend on the actual application methods used and the end properties sought. A number of starting point formulations for many types of vinyl coatings are available through your Union Carbide Coatings and Adhesives technical representative.

PIGMENTS

The amounts of pigments suggested in Table 2 are based on the quantity of each pigment that is necessary to provide good hiding and adequate ultra-violet light protection for the vinyl resin.

TABLE 2

SUITABLE PIGMENTS FOR USE IN VYNS SOLUTIONS FORMULATIONS

Pigment	Parts per 15 parts VYNS resin by weight
Aluminum Powder	6 to 8
Titanium Dioxide	10 to 18
Titanium Dioxide/Antimony Oxide (9:1)	10 to 18
Titanium Dioxide/Zinc Oxide/Antimony Oxide (3:2:1)	10 to 18
Phthalocyanine Green	2 to 4
Phthalocyanine Blue	2 to 4
Chromic Oxide Green	10 to 15
Carbon Black	1
Blue Lead Sulfate	15 to 25
White Lead Sulfate	15 to 25
Red Lead	20 to 25
Iron Oxide Yellow (synthetic)*	8 to 15
Iron Oxide Red (synthetic)*	8 to 15
Iron Oxide Brown (synthetic)*	8 to 15
Iron Oxide Black (synthetic)*	8 to 15
Lead Chromate	15 to 25
Strontium Chromate	15 to 20
Cadmium Reds	15 to 20
Chrome Orange	15 to 20
Cadmium Yellow	15 to 20

* Natural iron oxides are seldom satisfactory.

STABILIZERS

In general, stabilizers are not necessary with Vinyl Resin VYNS in pigmented coatings. Clear coatings, even with stabilizers, are not generally suitable for exterior exposure. If stabilizers are desired, the amount and type are dependent on the plasticizer and pigments and the conditions of baking and exposure. Table 3 lists some of the commercially available stabilizers for use with Vinyl Resin VYNS, along with the supplier of each stabilizer. In all cases, careful attention must be paid to the proper choice of stabilizers, and they should be tested under the actual conditions of use. Recommendations of stabilizer suppliers may be useful.

Zinc stabilizers should be avoided; they cause extreme color development in relatively short periods of time, especially in low plasticizer systems.

TABLE 3

SEVERAL COMMERCIAL STABILIZERS FOR USE WITH VYNS

Stabilizer	Type	Supplier
"Advance" 17 M	Tin	Advance Chemical and Solvent Co.
BAKELITE Epoxy Resin ERL-2774	Epoxy	Union Carbide Corporation
BAKELITE Epoxy Resin ERL-4221	Epoxy	Union Carbide Corporation
"Ferro" 1720	Ba-Cd-Zn Chelator	Ferro Chemical Company
"Mark" LL	Ba-Cd	Argus Chemical Company
"Mark" KCB	Ba-Cd-Zn	Argus Chemical Company
"Nuodex" V-134	Ba-Cd-P	Nuodex Division of Tenneco

PLASTICIZERS

Plasticizers are in coatings of BAKELITE vinyl resins to obtain increased flexibility. Because of the high molecular weight and vinyl chloride content, Vinyl Resin VYNS will tolerate up to 40 per cent plasticizer content without becoming tacky. As a guide to the selection of the proper plasticizer, Table 4 gives the compatibilities of Vinyl Resin VYNS with a number of commercially available plasticizers.

SOLUBILITIES

BAKELITE vinyl solution resins such as VYNS can be dissolved at room temperature by such solvents as ketones, nitro compounds, and certain esters and chlorinated hydrocarbons. Ether-esters, polyethers, and certain other types of solvents have varying degrees of solvent action on these resins. Aromatic or coal-tar hydrocarbons, such as toluene and xylene, tend to swell the resin. Water, alcohols, and aliphatic hydrocarbons (petroleum naphthas) are strong precipitants. The hydrogenated naphthas, containing large proportions of aromatics, are grouped between the last two classes. Generally, Vinyl Resin VYNS is used in ketone solutions with little or no aromatic hydrocarbon diluent present, because of the lower order of tolerance for hydrocarbons as compared to VYHH.

Typical solubility curves for VYNS appear in Figure 1. A thorough discussion of solvents and solution characteristics of BAKELITE vinyl solution resins are given in the general booklet (J-2178).

TABLE 4
COMPATIBILITY OF BAKELITE® VINYL RESIN VYNS WITH COMMERCIAL PLASTICIZERS

Compound Designation	Compatibility Data* Weight Ratio of Vinyl Resin VYNS to Plasticizer			
	9 to 1	4 to 1	2 to 1	1 to 1
Acetyl Tributyl Citrate	C	C	C	C
Acetyl Triethyl Citrate	C	C	C	C
"Aroclor" 1242 Chlorinated Diphenyl(1)	C	C	C	C
"Aroclor" 1254 Chlorinated Diphenyl(1)	C	C	C	C
Butyl Acetyl Ricinoleate	C	I	I	I
Dicapryl Phthalate	C	C	C	C
Di-n-octyl Phthalate	C	C	C	C
Dioctyl Sebacate	C	C	C	C
FLEXOL Plasticizer DOP(2)	C	C	C	C
FLEXOL Plasticizer DIOP(2)	C	C	C	C
FLEXOL Plasticizer EPO(2)	C	C	C	C
FLEXOL Plasticizer TOF(2)	C	C	C	C
FLEXOL Plasticizer PEP(2)	C	C	C	C
FLEXOL Plasticizer EP-8(2)	C	C	C	C
FLEXOL Plasticizer 426(2)	C	C	C	C
FLEXOL Plasticizer 810(2)	C	C	C	C
FLEXOL Plasticizer Z-88(2)	C	C	C	C
"KP-23" Butoxyglycol Stearate(3)	SI	I	I	I
"KP-45" Diglycol Dipropionate(3)	C	C	C	C
"Kronisol" Butoxyglycol Phthalate(3)	C	C	C	C
"Plastolein" 9720(4)	C	C	C	C
"Santicizer" 8(1)	C	C	C	C
"Santicizer" E-15(1)	C	C	C	C
"Santicizer" B-16(1)	C	C	C	C
"Santicizer" 141(1)	C	C	C	C
"Santicizer" 160(1)	C	C	C	C
Tributyl Citrate	C	C	C	C
Tributyl Phosphate	C	C	C	C
Tricresyl Phosphate	C	C	C	C
Triphenyl Phosphate	C	C	C	C

* Compatibility data are based on operator's inspection of films deposited on glass plates after evaporation of solvents. Results were interpreted as follows:

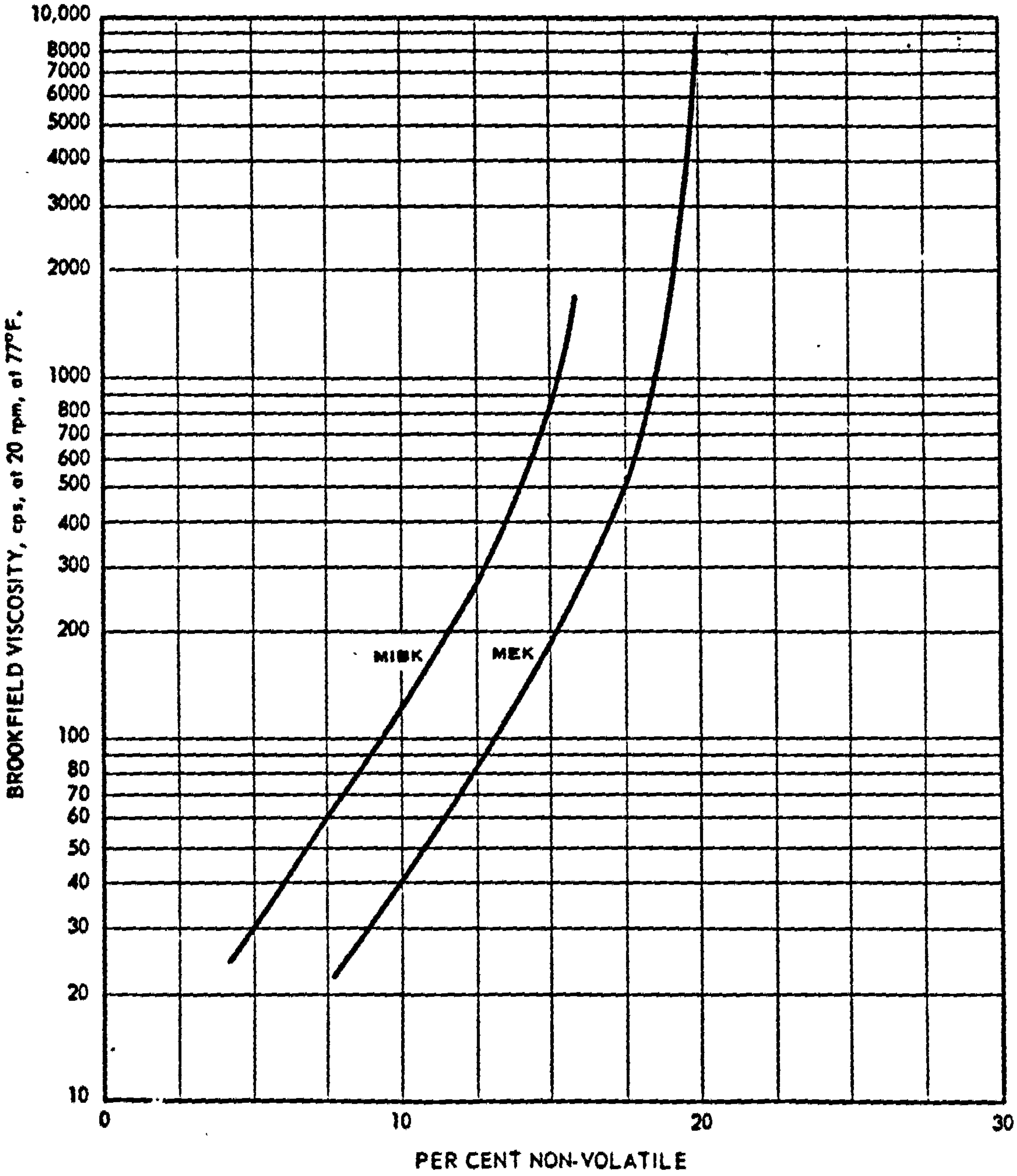
C – Completely compatible; film clear
SI – Slightly incompatible; faint haze or blush in film
I – Incompatible; film badly blushed, inhomogeneous, or oily

List of Plasticizer Suppliers:

(1) Monsanto Company
(2) Union Carbide Corporation
(3) Food Machinery and Chemical Corp.
(4) Emery Industries, Inc.

FIGURE 1

SOLUBILITY OF VINYL RESIN VYNS IN MEK AND MIBK



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UNION CARBIDE PLASTICS COMPANY • *Division of Union Carbide Corporation* • 270 PARK AVE., NEW YORK

BAKELITE® VINYL SOLUTION RESIN VYNS

BAKELITE vinyl resin VYNS is one of a class of versatile vinyl chloride-vinyl acetate copolymers solution resins available from Union Carbide Plastics Company. As a class, BAKELITE vinyl chloride-acetate copolymers for surface coatings are permanently thermoplastic, neutral, non-oxidizing, and non-heat-reactive. They are characterized by absence of color, odor and taste. Films of these resins are not attacked at normal temperatures by alkalies, mineral acids, alcohols, greases, oils, or aliphatic hydrocarbons. Coatings based on BAKELITE vinyl chloride-acetate resins have low water vapor permeability, low water absorption, and excellent toughness and flexibility.

These copolymers are designed to dissolve in organic liquids such as ketones, certain esters, and chlorinated hydrocarbons and form a protective film by evaporation alone. Properly formulated coatings based on BAKELITE vinyl chloride-acetate resins can be applied by spraying, roller-coating, dipping, and knife-coating.

This data sheet presents only those properties and performance values specific to resin VYNS-based solution coatings. A more comprehensive description and discussion of vinyl solution coatings preparation, formulation, baking and fusing, and other end-use applications is presented in Union Carbide Plastics Company's special booklet, "BAKELITE" Vinyl Resins for Solution Coatings."

PROPERTIES

BAKELITE vinyl resin VYNS has a medium-high molecular weight and a chemical composition of approximately 90 per cent vinyl chloride and 10 per cent vinyl acetate. These properties have been found to give a high degree of chemical resistance, film strength, and thermoplasticity.

Vinyl resin VYNS, supplied as a dry white powder, is usually dissolved in relatively strong solvents such as methyl ethyl ketone and methyl isobutyl ketone to produce 12% to 18% solids resin solutions. Pigments, plasticizers, and heat and light stabilizers can be used in a formulation to obtain the required end-use properties. Coatings based on vinyl resin VYNS are rarely used over bare metal surfaces because of the high baking temperatures required to achieve good adhesion; over primed surfaces, the temperature need only be high enough to drive out residual solvents (about 250 F); over rough surfaces the mechanical adhesion developed may be sufficient without baking.

Overlacquers for vinyl film and sheeting, strippable and cobweb type coatings for protecting finished products during storage and shipment, high chemical and moisture resistant coatings, and architectural finishes over primed masonry, wood, and steel are among the principal applications for finishes based on BAKELITE vinyl resin VYNS.

FORMULATIONS

A complete discussion of formulation techniques for producing both clear and pigmented vinyl solution coatings are presented in the general booklet, "BAKELITE" Vinyl Resins for Solution Coatings."

Table 1 gives a convenient starting point for the formulation of a clear overlacquer based on vinyl resin VYNS. All suggested quantities are based on 15 parts by weight of vinyl resin VYNS. A partial list of suitable pigments, stabilizers, and plasticizers are presented in

Tables 2, 3, and 4. A more complete list of pigments and dyes suitable for use with vinyl solution resins is presented in the general booklet.

TABLE 1

Typical Formulation for a VYNS Overlacquer

	Parts by Weight
BAKELITE vinyl resin VYNS	15
Methyl methacrylate resin	3-5
Methyl isobutyl ketone	50
Methyl ethyl ketone	30

Specific formulations of vinyl solution coatings will depend on the actual application methods used and the end properties sought. A number of starting point formulations for many types of vinyl coatings are available through your Union Carbide Plastics Company technical representative.

PIGMENTS

The amounts of pigments suggested in Table 2 are based on the quantity of each pigment that is necessary to ensure good hiding and adequate ultra-violet light protection for the vinyl resin.

TABLE 2

Suitable Pigments for Use in VYNS Solutions Formulations

Pigment	Parts per 15 parts VYNS resin by weight
Aluminum powder	6-8
Titanium dioxide	10-18
Titanium dioxide/antimony oxide (9:1)	10-18
Titanium dioxide/zinc oxide/antimony oxide (3:2:1)	10-18
Phthalocyanine green	2-4
Phthalocyanine blue	2-4
Chromic oxide green	10-15
Carbon black	1
Blue lead sulphate	15-25
White lead sulphate	15-25
Red lead	20-25
Iron oxide yellow (synthetic)*	8-15
Iron oxide red (synthetic)*	8-15
Iron oxide brown (synthetic)*	8-15
Iron oxide black (synthetic)*	8-15
Lead chromate	15-25
Strontium chromate	15-20
Cadmium reds	15-20
Chrome orange	15-20
Cadmium yellow	15-20

*Natural iron oxides are seldom satisfactory

STABILIZERS

In general, stabilizers are not necessary with resin VYNS in pigmented coatings. Clear coatings, even with stabilizers are not generally suitable for exterior exposure. If stabilizers are desired, the amount and type are dependent on the plasticizer and pigments and the conditions of baking and exposure. Table 3 lists some of the commercially available stabilizers for use with vinyl resin VYNS, along with the supplier of each stabilizer. In all cases careful attention must be paid to the proper choice of stabilizers, and they should be tested under the actual conditions of use. Recommendations of stabilizer suppliers should generally be followed.

Zinc stabilizers should be avoided due to extreme color development in relatively short periods of time, especially in low plasticizer systems.

TABLE 3

Several Commercial Stabilizers for Use With VYNS

Stabilizer	Supplier
"Advance" 17 M	Advance Chemical and Solvent Co
"Mark" LL and KCB	Argus Chemical Company
"Ferro" 1720	Ferro Chemical Company
"Harshaw" 6-V-6	Harshaw Chemical Company
"Nuodex" V-134	Nuodex Chemical Company

PLASTICIZERS

It is usually desirable to include certain portions of plasticizers in coatings of BAKELITE vinyl resins in order to obtain increased flexibility. Because of the high molecular weight and vinyl chloride content, resin VYNS will tolerate up to 40 per cent plasticizer content without becoming tacky. As a guide to the selection of the proper plasticizer, Table 4 gives the compatibilities of resin VYNS with a number of commercially available plasticizers.

TABLE 4

Compatibility of BAKELITE Vinyl Resin VYNS with Commercial Plasticizers

Compound Designation	Compatibility Data* Weight Ratio of Resin VYNS to Plasticizer 9:1	4:1	2:1	1:1
Acetyl tributyl citrate	C	C	C	C
Acetyl triethyl citrate	C	C	C	C
"Aroclor" 1242 chlorinated diphenyl (1)	C	C	C	C
"Aroclor" 1254 chlorinated diphenyl (1)	C	C	C	C
Butyl acetate ricinoleate	C	IC	IC	IC
Butyl phthalate	C	C	C	C
Butyl sebacate	C	C	C	C
Butyl stearate	IC	IC	IC	IC
Butyl tartrate	C	C	C	C
Dicapryl phthalate	C	C	C	C
Diisoctyl phthalate	C	C	C	C
Di-n-octyl phthalate	C	C	C	C
Dioctyl sebacate	C	C	C	C
Ethylhexyl phthalate	C	C	C	C
Ethyl phthalate	C	C	C	C
FLEXOL plasticizer DOP (2)	C	C	C	C
FLEXOL plasticizer EPO (2)	C	C	C	C

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TABLE 4 (continued)

Compatibility of BAKELITE Vinyl Resin VYNS with Commercial Plasticizers

Compound Designation	Compatibility Data* Weight Ratio of Resin VYNS to Plasticizer 9:1	4:1	2:1	1:1
FLEXOL plasticizer JPO (2)	C	C	C	C
FLEXOL plasticizer TOF (2)	C	C	C	C
FLEXOL plasticizer PEP (2)	C	C	C	C
FLEXOL plasticizer EP-8 (2)	C	C	C	C
FLEXOL plasticizer 4GO (2)	C	C	C	C
FLEXOL plasticizer 426 (2)	C	C	C	C
FLEXOL plasticizer 810 (2)	C	C	C	C
FLEXOL plasticizer Z-88 (2)	C	C	C	C
"KP-23" butoxyglycol stearate (3)	SIC	IC	IC	IC
"KP-45" diglycol dipropionate (3)	C	C	C	C
"Kronisol" butoxyglycol phthalate (3)	C	C	C	C
Methyl phthalate	C	C	C	C
Phenyl phthalate	C	C	C	C
"Plastolein" 9720 (4)	C	C	C	C
"Santicizer" 8 (1)	C	C	C	C
"Santicizer" E-15 (1)	C	C	C	C
"Santicizer" B-16 (1)	C	C	C	C
"Santicizer" 141 (1)	C	C	C	C
"Santicizer" 160 (1)	C	C	C	C
Tributyl citrate	C	C	C	C
Tributyl acetylcitrate	C	C	C	C
Tributyl phosphate	C	C	C	C
Tricresyl phosphate	C	C	C	C
Tri-2-ethylhexyl phosphate	C	C	C	C
Triphenyl phosphate	C	C	C	C

List of Plasticizer Suppliers

(1) Monsanto Chemical Company

(2) Union Carbide Chemicals Company

(3) Food Machinery and Chemical Corp.

(4) *Emery Industries, Inc.*

NOTE Data given in this table are based on tests conducted over a period of years by Union Carbide Corporation in its laboratories at South Charleston, West Virginia on commercial compounds purchased in the open market or submitted by manufacturers. Every effort has been exerted to present only accurate, impartial information as a guide to surface coating formulators; but specific conditions and formula modifications may affect the characteristics of the various compounds in certain instances. Under no circumstances are the data in this table to be construed as a reflection on the grade, quality or purity of any of the compounds listed. In all cases formulators are urged to make their own tests, following their individual procedures, and to draw their own conclusions.

**Compatibility data are based on operator's inspection of films deposited on glass plates after evaporation of solvents. Results were interpreted as follows*

C—Complete compatibility, film clear

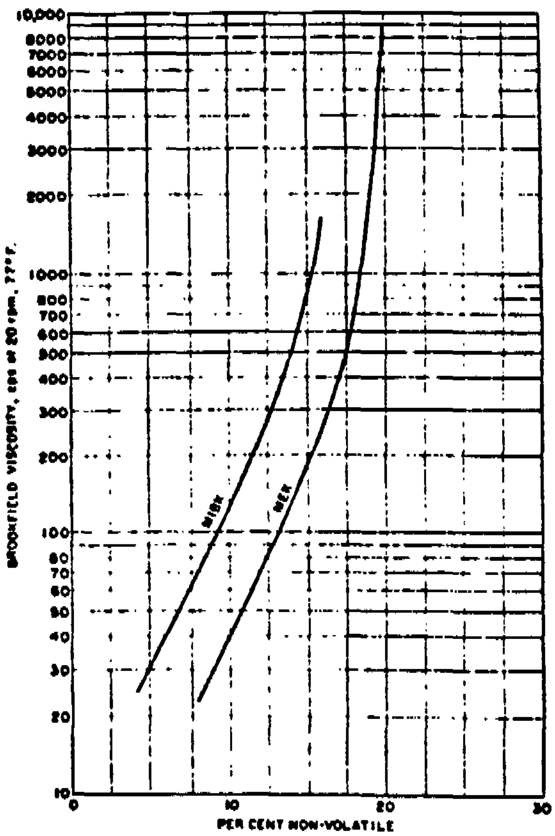
SIC—Slightly incompatible, faint haze or blush in film

IC—Incompatible, film badly blushed, inhomogeneous, or oily

SOLUBILITIES

BAKELITE vinyl solution resins such as VYNS can be dissolved at room temperature by such solvents as ketones, nitro compounds, and certain esters and chlorinated hydrocarbons. Keto-ethers, ether-esters, polyethers, aldehydes, and certain other types of solvents have varying degrees of solvent action on these resins. Aromatic or coal-tar hydrocarbons, such as toluene and xylene, tend to swell the resin. Water, alcohols, and aliphatic hydrocarbons (petroleum naphthas) are strong precipitants. The hydrogenated naphthas, containing large proportions of aromatics, are grouped between the last two classes. Generally, resin VYNS is used in ketone solution with little or no aromatic hydrocarbon diluent present, due to the lower order of tolerance for hydrocarbons as compared to resin VYHH.

Typical solubility curves for resin VYNS appear in Figure 1. A thorough discussion of solvents and solution characteristics of BAKELITE vinyl solution resins are given in the general booklet.



SOLUBILITY OF VINYL RESIN VYNS in MEK and MIBK

- FIGURE 1 -

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SALES OFFICES

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Cleveland 14, Ohio	1300 Lakeside Avenue, N. E.	Main 1-4202
Clifton, New Jersey	1051 Bloomfield Avenue	Prescott 8-2900 or Oxford 5-1645 (N. Y. ex. no.)
Dallas 6, Texas	6300 N. Central Expressway	Emerson 3-1691
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San Francisco 6, California	22 Battery Street	Yukon 2-1360

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ATTACHMENT V

CHEMICAL HYGIENE FELLOWSHIP

KEY TO TOXICITY TESTS

Number *Name*

1----------Peroral, single dose to standard rats
2----------Peroral, single dose to other animals
3----------Oral, subacute (usually 90 days or less)
4----------Oral, chronic (lifetime or 2 years)
5----------Parenteral (subcutaneous, intraperitoneal, intravenous, etc.)
6----------Skin Penetra[illegible]n, rabbits (24-hour contact under impervious sheeting)
7----------Skin Penetra[illegible], rats (4-hour contact under impervious sheeting)
8----------Skin Penetra[illegible], subacute (usually less than 90 days), 1 hour contact, 5 days per w[illegible]
9----------Skin Absorp[illegible] (quantitati[illegible] using tagged compounds)
10----------Inhalation, [illegible]gle--saturat[illegible] [illegible]apor at room temperature, 20 to 25°C
11----------Inhalation, [illegible]gle--mist (a[illegible]/0°C or selected temperature)
12----------Inhalation, single--fog (aerosol of 1 to 2 micron particle size)
13----------Inhalation, single--measured concentration (ppm or mg/liter)
14----------Inhalation, subacute (usually 90 days or less, 6 or 7 hours per day, 5 days per week
15----------Metabolism, animal *in vivo* and *in vitro* on either biopsy or surgical specimens
16----------DOT Corrosive, 4-hr
17----------Rabbit Belly, irritation (single application, uncovered)
18----------Rabbit Belly, irritation (4-hour, eight applications)
19----------Rabbit Belly, irritation *via* repeated application ≤3x daily for up to 3 days)
20----------Rabbit Eyelid, irritation, to classify bland materials
21----------Rabbit Cornea, volume and concentration to produce injury
22----------Rabbit Cornea, injury from vapor
23----------Mouse Skin Painting, for carcinogenicity
24----------Rabbit Ear, chloracne formation
25----------Guinea Pig, Landsteiner (sensitization *via* intradermal or topical application)
26----------Human Patch Test (sensitization)
27----------Organoleptic Tests
28----------Wear Test (FDA), miscellaneous irritation and wound healing
29----------Bacteriology, miscellaneous biochemical tests
30----------3-Generation Reproduction and Lactation
31----------Teratology
32----------Mutagenicity
33----------Demyelination
34----------Cholinesterase and/or other Enzyme Studies
35----------Joint Action, to detect potentiation or antidotal response
36----------Literature Reviews
37----------Endotracheal Injection
38----------Pyrolysis (identification and toxicity studies)

January, 1976

Chemical Hygiene Fellowship
Carnegie-Mellon Institute of Research
Carnegie-Mellon University
4400 Fifth Avenue
Pittsburgh, Pennsylvania 15213

Product	Test	Report	Series
VMCH	26. 23 subject powder, 0% trace sensitivity	1-31-43	23, 24
	33 on guaze from acetone, 3% trace sensitivity	2-29-44	25
VYHH	26. 33 from acetone, 6% definite papules	2-29-44	25
VYNS	26. 54 from acetone, 9% trace	2-29-44	6, 7, 25
	10 powder, 11 sheet, 0% trace	V11	5, 8

Sensitization of Human Skin, Patch Test

Resin	Sheeted from Solvent			Applied as Powder		
	Subjects	Sensitizations	Report	Subjects	Sensitizations	Report
VMCH	23	3% trace	[1]	23	0	[2]
VYHH	33	6% definite	[1]	--	-	---
VYNS	54	10% trace	[1]	10	0	[3]

[1] Monthly Report 2-29-44

[2] Monthly Report 12-31-43

[3] No Report 1940, 1941