BAKELITE® VINYL BUTYRAL RESINS

BAKELITE Vinyl Butyral Resins are partial butyrals of poly(vinyl alcohol) resins, supplied in both dry resin and solution forms and covering a range of molecular weights. They are widely useful in the coatings and adhesives areas and are the base for the well-known wash primers.

BAKELITE Vinyl Butyral Resins are characterized by excellent adhesion to non-porous surfaces such as glass, metal, and plastic (particularly to epoxy- and phenolic-based materials). Although these resins readily absorb up to eight per cent of their own weight in water, they retain good film integrity during cycles of sorption and desorption.

BAKELITE Vinyl Butyral Resins are tough, flexible, and shock-resistant and they retain these characteristics over a wide temperature range. They are thermoplastic, softening at about 135°F., but they may be crosslinked by reaction with many resins and reagents.

Although the light stability of vinyl butyral resins is excellent, they are seldom suitable (unmodified) for exterior exposure. They tend to fail by chalking from water absorption.

BAKELITE Vinyl Butyral Resins do not discolor on prolonged heating at temperatures up to 200°F. At higher temperatures, they become amber in color and, on prolonged heating, may lose their alcohol solubility and become more hydrocarbon soluble.

BAKELITE Vinyl Butyral Resins are typically dissolved by strong mineral acids and alcohols. They are swelled by weak acids, ketones, esters, and aromatic hydrocarbons. Strong alkalies have a slight effect. Aliphatic hydrocarbons, natural oils and mineral oils have little or no effect. The presence of plasticizers and other modifiers will influence this performance. BAKELITE Vinyl Butyral Resins retain their properties under unusually high pigment loading and with unusually large amounts of rosin, ester gum, and other low molecular weight resins. See Figure I for the impact resistance of different pigment loadings.

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Bonding

(insert section on bonding from Bakelite Vinyl Alcohol-Acetate & Resin Solutions, Product Data.

A description of bonding methods using ~~VA~~ vinyl acetate resin solutions is available along with more complete information on ~~product use, compounding~~ their properties, use, compounding, and compatibility in the Bakelite Vinyl Acetate Resins, Product Data sheet.

Storage and Handling

In the storage and handling of resin solutions, observe the same safety practices that ~~appy~~ apply for flammable solvents. Keep containers sealed when not in use. Maintain adequate ventilation when being used.

TABLE 1
TYPICAL PHYSICAL PROPERTIES

BAKELITE Vinyl Butyral Resin	Form	Resin Solids, %	Viscosity of Solutions	Chemical Composition, of Resin % by wt.		Viscosity at 10% Solids, cps.	Specific Gravity
				Vinyl Acetate	Vinyl Alcohol[5]		
XYHL	Dry Resin	–	0.90[4]	0.5	19.5	162[2]	1.12
XYSG	Dry Resin	–	1.23[4]	0.5	19.5	680[2]	1.12
XYLS-1	Solution[1]	20.0	12,000 to 18,000 cps.	0.5	19.5	320[6]	0.840
XYLS-2	Solution[2]	20.0	6,000 cps.	0.5	19.5	218[6]	0.887
XYLS-4	Solution[3]	25.0	2,300 cps.	0.5	19.5	100[6]	0.914

FOOTNOTES:
(1) XYHL in isopropanol
(2) XYHL in ethanol
(3) XYHL in ethanol 41.0
ethyl acetate 19.0
water 6.0
mixed solvents 9.0
Total ..... 75.0% by wt.
(4) Inherent viscosity, ASTM D-1243-58T Procedure A
(5) Hydroxyl content of dry resin calculated as vinyl alcohol
(6) Solution diluted to ten per cent total solids with ethanol

SOLUBILITY

Alcohols are the best solvents for BAKELITE Vinyl Butyral Resins. Ketones, esters, and aromatic hydrocarbons do not dissolve them. When used as diluents, however, they can reduce solution viscosity below that obtained with alcohol alone. This apparent anomaly is explained by the presence of both hydrophilic hydroxyl groups and organophilic butyral groups. Table 2 lists the solvents typically considered for use with BAKELITE Vinyl Butyral Resins. Figure II shows the influence of diluent on viscosity of a ten per cent solution of XYHL in ethanol.

BAKELITE Vinyl Butyral Resins are more soluble in alcohol solutions containing water than in anhydrous alcohols. Figure III shows this latent solvent effect in a water/isopropanol system for XYHL at 20 per cent solids content. Figure IV shows the three-way inter-relationships of isopropanol, water and resin. Compositions that fall within the encircled area are soluble. Systems bordering this area may be gelatinous or turbid.

TABLE 2
TYPICAL SOLVENTS FOR VINYL BUTYRAL RESINS

Acids
- Formic Acid
- Acetic Acid

Alcohols
- Methanol
- Ethanol
- Isopropanol
- Butanol

Esters
- Methyl Acetate
- Ethyl Acetate

Glycol Ethers
- Methyl CELLOSOLVE
- CELLOSOLVE Solvent

Ketones
- Diacetone Alcohol
- Cyclohexanone
- Isophorone

Special Solvents
- Propylene Oxide
- 1,4-Dioxane
- Cresol
- Morpholine
- Pyridine

COMPATIBILITY

Plasticizers may be added to increase flexibility for some applications and to reduce viscosity for hot melts. BAKELITE Vinyl Butyral Resins are compatible with FLEXOL Plasticizers DOP, 3GH, and TOF, with many other chemical-type plasticizers, and with certain natural oils. Raw castor oil is compatible but tends to soften the film without developing elasticity. It may be used advantageously, however, with chemical-type plasticizers.

BAKELITE Vinyl Butyral Resins are compatible with a variety of natural gums and resins. Compatibility with synthetic resins, however, is limited to types that can tolerate the alcohol needed to dissolve the vinyl butyral. Generally, the compatibility of vinyl butyral resins is the same regardless of molecular weight. One important exception is that XYLS-4 is compatible from 1-9 to 9-1 (by weight) with RS-type nitrocellulose and with SS-type nitrocellulose, while XYHL and XYSG and the other solutions are not compatible with RS-type nitrocellulose. Compatibility data for vinyl butyral resins appears in Table 3.

INSOLUBILIZATION OF VINYL BUTYRAL RESINS

The hydroxyl groups of BAKELITE Vinyl Butyral Resins are reactive and can be used as crosslinking sites to improve water and solvent resistance. BAKELITE Phenolic Resins BKS-2710 and BKS-2600, urea-formaldehyde, and melamine-formaldehyde are useful as crosslinking agents. Urethane prepolymers are useful, too, if urethane grade solvents are used. Alcohols, for example, react with isocyanates. Systems crosslinked with phenolic, urea, and melamine resins must be baked at 275°F. for 30 to 45 minutes (or at higher temperatures for shorter schedules). Phosphoric acid esters or *para*-toluene sulfonic, phosphoric or sulfuric acids (at 0.5 to 1.0 per cent on the crosslinker) can be used to speed the cure.

FIGURE I

IMPACT RESISTANCE AS FUNCTION OF PIGMENT LOADING

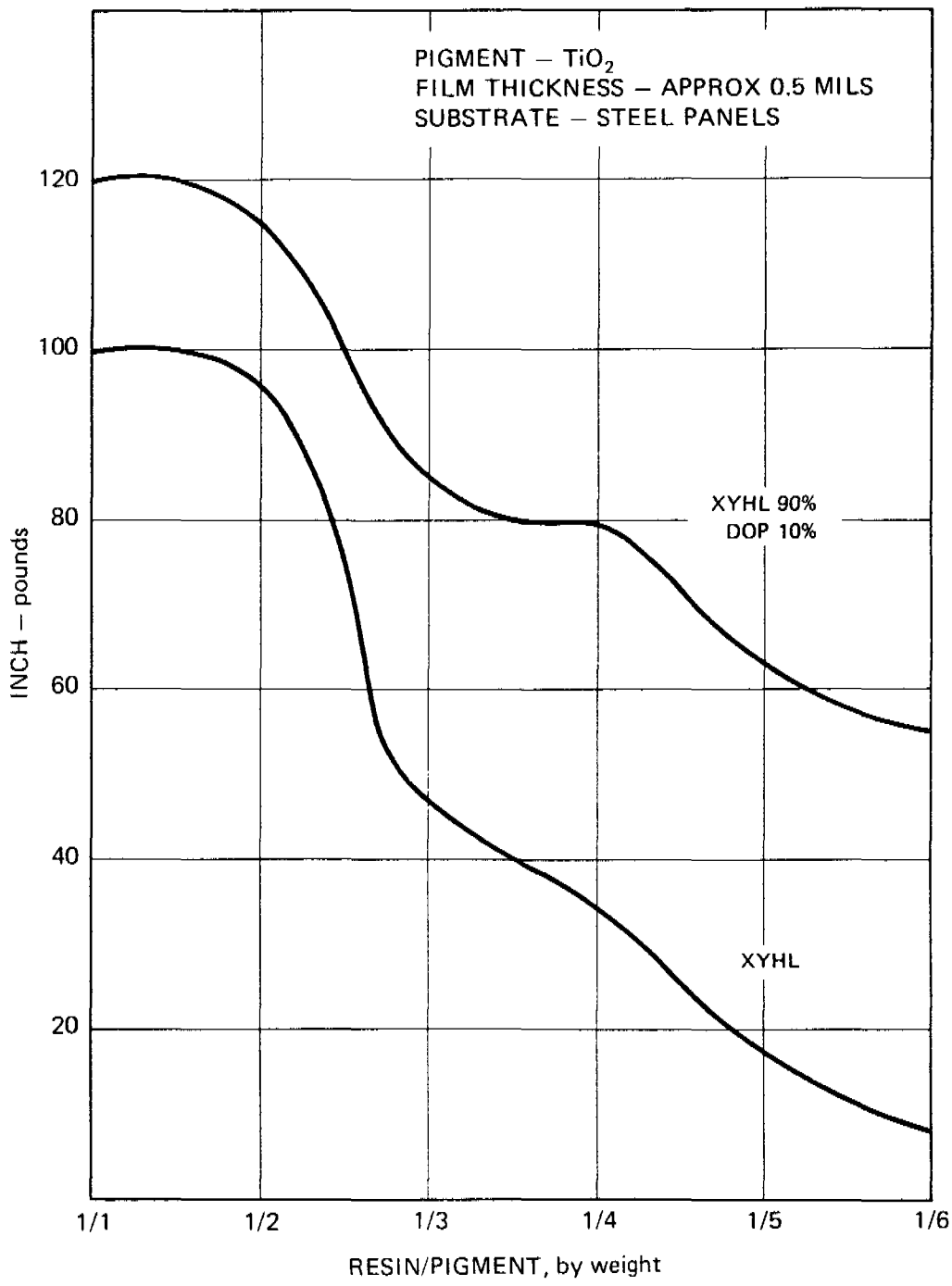

FIGURE II

VISCOSITY OF XYHL AT TEN PER CENT TOTAL SOLIDS IN ETHANOL/DILUENT MIXTURES

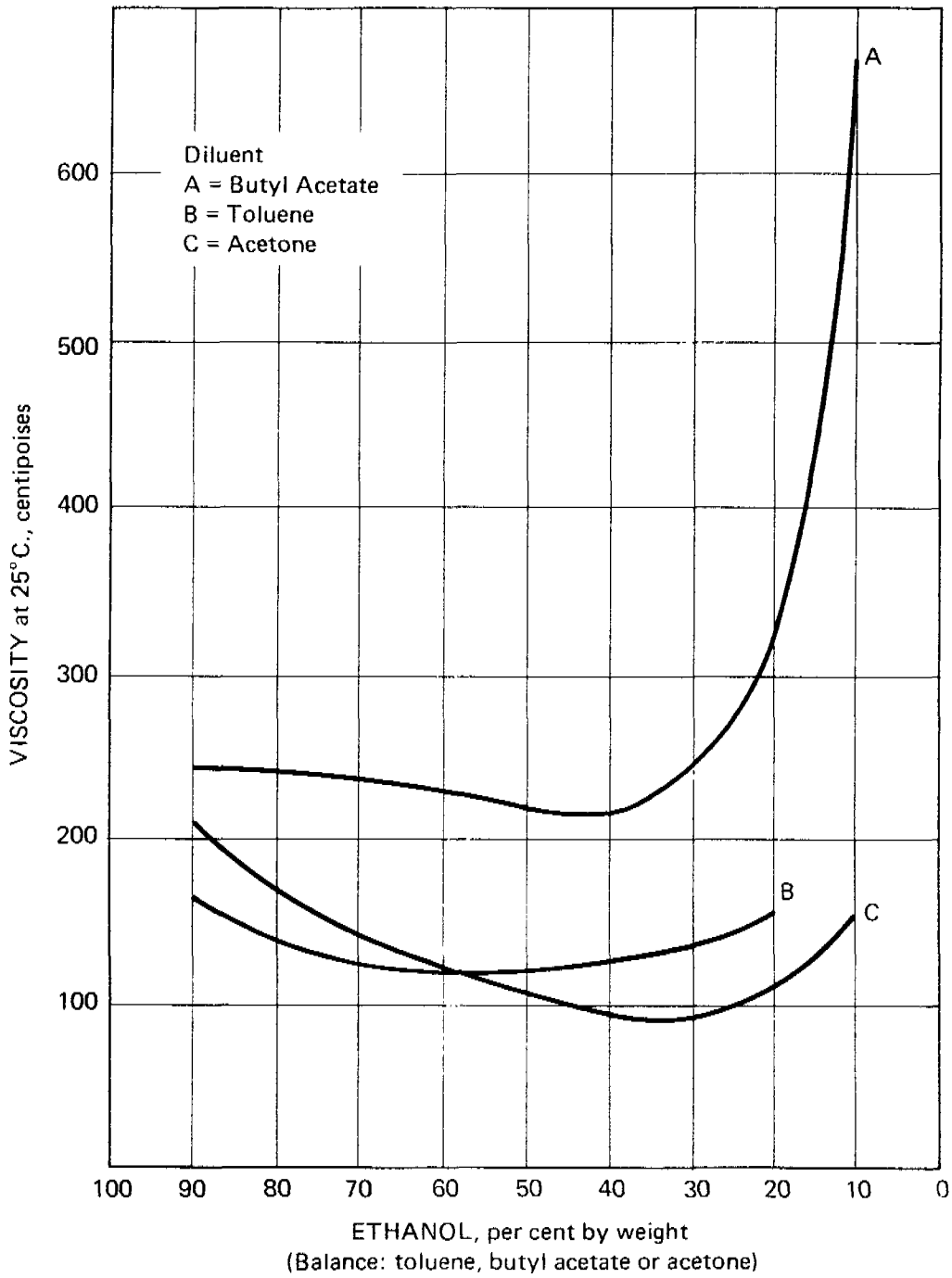

FIGURE III

VISCOSITY OF XYHL AT 20 PER CENT TOTAL SOLIDS

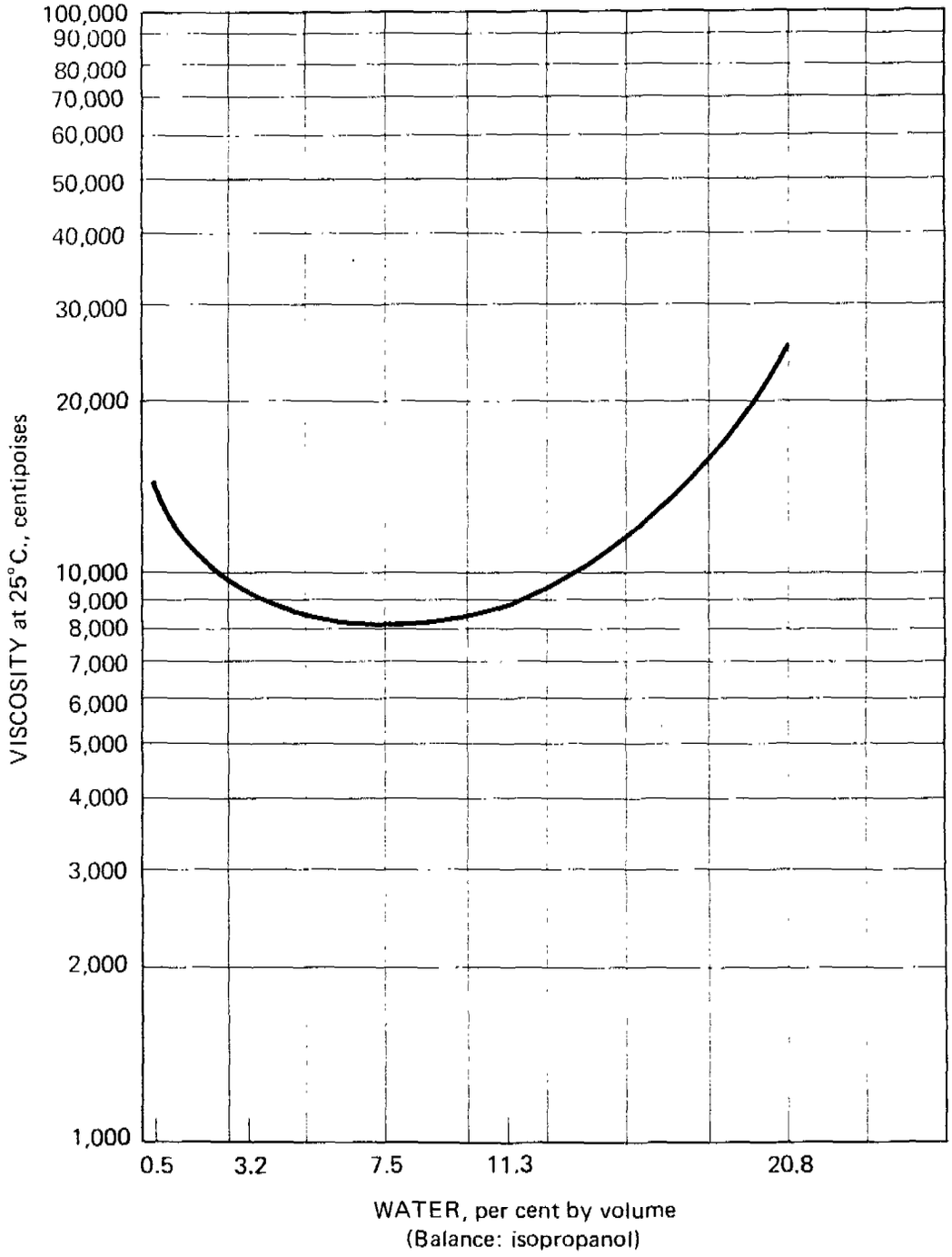

FIGURE IV

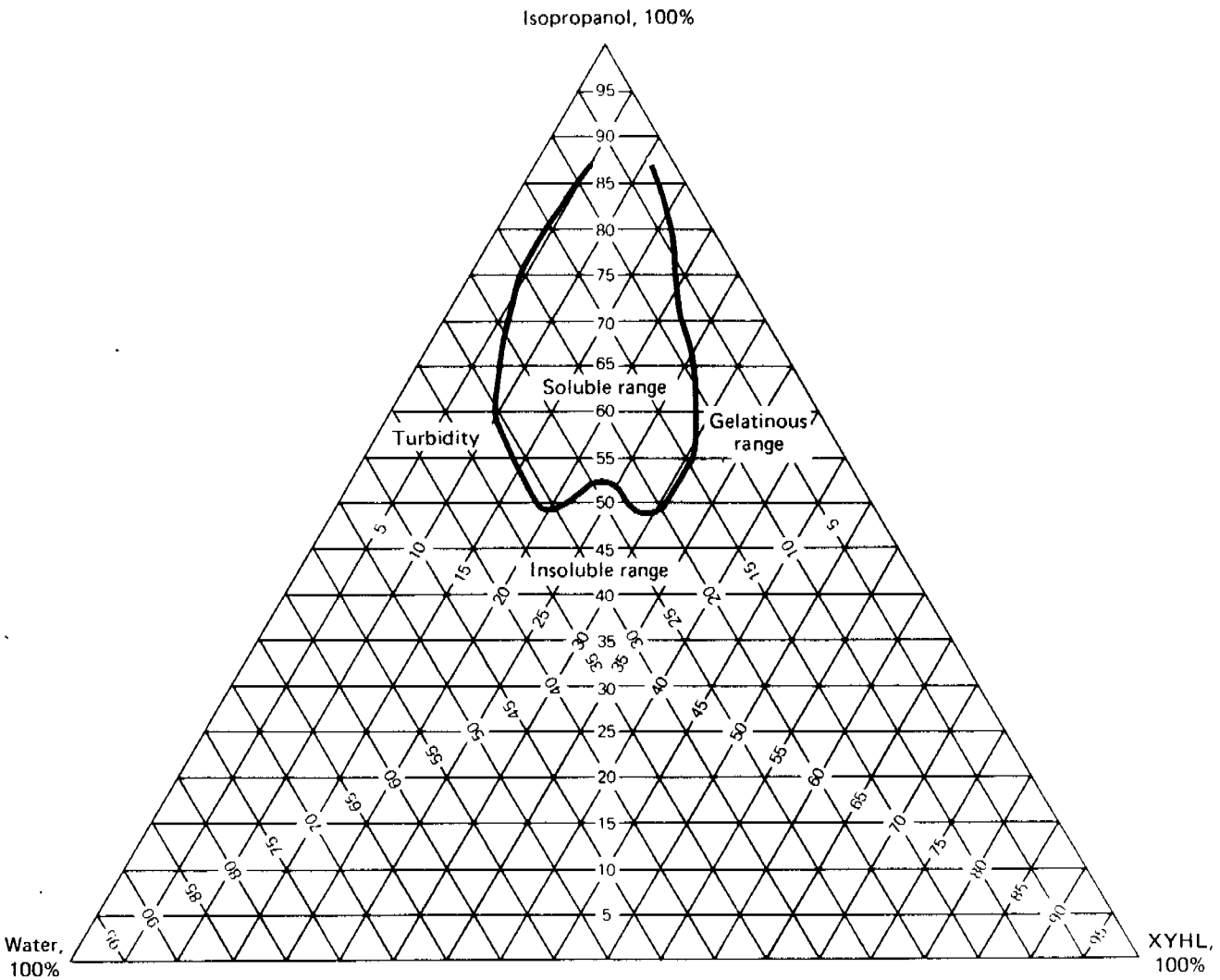

TABLE 3
COMPATIBILITY[1] OF BAKELITE VINYL BUTYRAL RESIN

	Resin or Oil/Vinyl Butyral Resin				
	9/1	4/1	1/1	1/4	1/9
"Acryloid"[2] B-66	C	C	C	C	C
"Acryloid"[2] B-82	C	C	C	C	C
"Acryloid"[2] A-101	C	C	C	C	C
"Amberol"[2] No. 226	C	C	C	C	C
BAKELITE Phenolic Resin CKR-2432	C	C	C	C	C
BAKELITE Phenolic Resin BKS-2710			C	C	C
BAKELITE Phenolic Resin BKS-2600	IC	IC	IC	IC	IC
"Beckacite"[3] 1110	SIC	SIC	SIC	C	C
"Beckacite"[3] 1111	IC	IC	SIC	C	C
"Beetle"[4] 212-8	IC	IC	IC		
"Beetle"[4] 216-8	IC	IC	IC		
"Beetle"[4] 227-8	IC	IC	IC		
Cellulose Acetate	IC	IC	IC	IC	IC
Cellulose Acetopropionate	IC	IC	IC	IC	SIC
Cellulose Acetobutyrate	IC	IC	IC	IC	IC
Chlorinated Rubber	IC	IC	IC	IC	IC
Cumar Resin P-25	IC	IC	IC	IC	IC
"Duraplex"[2] C-45LV	IC	IC	IC	IC	IC
"Durez"[5] No. 550	C	C	C	C	C
Copal Ester Gum, Synthetic	SII	IC	IC	IC	IC
R-103[6]	C	C	C	C	C
"Melmac"[4] 245-8	IC	IC	IC		
"Nevillac"[7] Resin Hard	C	C	C	C	C
"Neville"[7] Resin R-17	IC	IC	IC	IC	IC
"Nevidene"[7] R-1	IC	IC	IC	IC	IC
Nitrocellulose SS	C	C	C	C	C
Nitrocellulose RS (XYHL, XYSG, and solutions)	SIC	SIC	IC	IC	IC
"Uformite"[2] F-240	C	C	C	C	C
"Cymel"[4] 300	C	C	C	C	C
"Cymel"[4] 301	C	C	C	C	C
"Varcum"[3] #250	C	C	C	C	C
Castor Oil, Raw	C	C	C	C	C
Castor Oil, Blown	C	C	C	C	C
Linseed Oil, Bodied	IC	IC	IC	IC	IC
Tung Oil	IC	IC	IC	IC	IC
Mineral Oil	IC	IC	IC	IC	IC
Shellac	C	C	C	C	C
Damar, Dewaxed	C	C	C	C	C
Congo Hard	C	C	C	C	C
Manila Loba	C	C	C	C	C

[1] Code C = Compatible; IC = Incompatible; SIC = Slightly Incompatible; SII = Slightly Insoluble

[2] Rohm and Haas

[3] Reichhold Chemicals, Inc.

[4] American Cyanamid Co.

[5] Hooker Chemical Corp.

[6] General Electric Co.

[7] Neville Chemical Co.

STRUCTURAL ADHESIVES

Crosslinked with one-step and two-step phenolic resins, structural adhesives based on BAKELITE Vinyl Butyral Resins XYHL and XYSG are characterized by the following properties:

- Excellent film integrity and adhesion to nonporous surfaces even after prolonged and intermittent water immersion.
- Toughness and flexibility.
- Shock resistance.
- Light and heat stability.

Vinyl butyral/phenolic structural adhesives are used for aircraft construction, brake linings, printed circuits, and wall and honeycomb construction. Vinyl butyral/phenolic ratios depend on the end-use requirements. A 100/40 ratio will yield optimum room-temperature shear and peel strengths. Higher phenolic concentrations will allow more crosslinking and yield higher elevated-temperature shear strengths. Since most structural applications require good strength properties at reasonably high temperatures, most commercial vinyl butyral/phenolic adhesives are formulated at 100/50 to 150 ratios.

Phenolic resins act as tackifiers and crosslinking agents. Both one-step and two-step resins are used. Two-step resins are preferred for applications requiring short cure cycles (about 15 minutes) or lower temperature cures (about 300°F.). BAKELITE Phenolic Resins BKS-2710, BKPA-5904, and BKPA-5864 are specifically recommended. BKS-2710 is a one-step resin. BKPA-5904 and BKPA-5864 are two-step resins.

To prepare the adhesive, blend the solvents and the phenolic resin solution until a uniform solution is obtained. Add BAKELITE Vinyl Butyral Resin XYSG or XYHL slowly. Continue mixing until a homogeneous solution is prepared.

WOOD SEALERS AND FINISHES, TRANSFER COATINGS FOR RIGID URETHANES

An ethanol solution of BAKELITE Vinyl Butyral XYHL and BAKELITE Phenolic Resin BKS-2710 is widely used in the wood finishing area as a knot sealer. Applied over knots, it seals in the resinous materials and prevents them from bleeding through the paint film.

FORMULA SUGGESTION VP-2756 • KNOT SEALER MIL-S-12935 (CE)

Ingredients	Parts by Weight	Per Cent by Weight
BAKELITE Phenolic Resin BKS-2710 (60% N.V.)	5.0	33.3
BAKELITE Vinyl Butyral Resin XYHL	0.5	3.3
Ethanol, 95 per cent	9.5	63.4
Total	15.0	100.0

Combinations of BAKELITE Vinyl Butyral Resins and nitrocellulose are widely used as sealers for furniture finishes. They are characterized by toughness, adhesion, and sandability without modification with stearate sanding aids.

Combinations of BAKELITE Vinyl Butyral Resins and nitrocellulose are also useful as transfer coatings for the rigid urethane foam used in molded furniture components. In this process, the transfer coating is applied on silicone RTV or urethane elastomer molds and allowed to dry. The liquid foam chemicals are charged and allowed to blow. In forming the part, the urethane foam bonds to the transfer coating. When it is cured, the part is removed from the mold for further finishing.

BAKELITE Vinyl Butyral Resin XYLS-4 is recommended over other vinyl butyrals because it has better compatibility. It permits the use of the more economical RS-type nitrocellulose. Additionally, sealers based on XYLS-4/RS nitrocellulose can be sprayed at 30 to 50 per cent higher solids than comparable systems based on XYHL/SS nitrocellulose.

FORMULA SUGGESTION • WOOD SEALER AND URETHANE TRANSFER COATING

	Parts by Weight	
	Sealer	**Transfer Coating**
BAKELITE Vinyl Butyral Resin XYLS-4	40.0	40.0
Nitrocellulose, 1/2 sec. RS dry base	10.0	10.0
"Paraplex" Plasticizer 5B	10.0	10.0
Solvents		
Methyl Isobutyl Ketone (MIBK)	Equal parts by weight to spray viscosity	–
Toluene		–
Ethanol		–
Methyl Isobutyl Ketone (MIBK)	–	25
Butyl Acetate	–	25
Ethanol	–	50 to spray viscosity
Pigments		
Red Iron Oxide	–	4.2
Yellow Iron Oxide	–	8.3
Titanium Dioxide (TiO_2)	–	1.1
Lampblack	–	0.3 or as desired for basic color

STRIPPABLE COATINGS

Strippable coatings for metals and plastics, such as high-pressure melamine laminates or styrene, high-impact styrene or acrylic, are easily formulated from BAKELITE Vinyl Butyral Resins. The low-viscosity resin solution XYLS-4 is particularly well suited for this application because it is sprayable at higher weight per cent solids (than a similar formula made with XYLS-1).

FORMULA SUGGESTION • STRIPPABLE COATING

Ingredients	Parts by Weight
BAKELITE Vinyl Butyral Resin XYLS-4	100.0
Raw Castor Oil	5.0
Total	105.0

Procedure

Thin to spray viscosity with a suitable thinner, such as butanol/toluene (20/80 by weight) for metals or butanol/isopropanol or ethanol mixtures for plastic surfaces attached by aromatic hydrocarbons.

Emulsified vinyl butyral resin also functions well as a strippable coating. Formula Suggestion VC-3140, available from Union Carbide Sales Offices, can be used as a starting point for preparing vinyl butyral emulsions.

METAL FINISHES

One-half to two per cent of BAKELITE Vinyl Butyral Resins XYHL or XYSG are used to control the "eyeing" of phenolic resin baking solutions applied over imperfectly cleaned surfaces.

In larger proportions, XYHL can be used to improve the flexibility of phenolic resin-baking finishes, such as BKS-2600 and BKR-2620. XYHL will range from 10 to 100 per cent of the weight of the phenolic resin. Increasing the butyral resin content increases the haze and decreases the chemical resistance of the films. A coating based on one part of BAKELITE Vinyl Resin XYHL and two parts of BAKELITE Phenolic Resin-Baking Solution BKS-2600 will, however, withstand commercial can-forming operations at thicknesses up to 0.3 mil and has extremely good resistance to steam processing.

BAKELITE Vinyl Resin XYHL can be

used in clear finishes for exterior exposure when modified with a urea-formaldehyde resin. For example, a 3/1/1 ratio of XYHL, FLEXOL Plasticizer 3GH, and "Uformite" resin F-240 has given outstanding service as a clear coating on chromium plate. Ethanol/toluene or methyl ethyl ketone/xylene/butanol mixtures have proved satisfactory for thinning. Both air-dry coatings and those baked for ten minutes at 350°F. were satisfactory after 1300 hours in an accelerated weathering unit and after 103 days of roof exposure. At a slight sacrifice in performance, a higher solids coating can be obtained using equal proportions of the two resins.

METAL CONDITIONERS

Wash primers, metal conditioners or pretreatments are applied as thin coatings of between 0.1 and 0.5 mils and air-dried to establish a firm bond to metal surfaces. This inhibitive film serves to prevent corrosion and undercutting of the film by rust as well as providing a firm anchor for subsequent paint coats.

Wash primers provide a temporary protection against atmospheric rusting, and must be protected by topcoats before exposure to the weather. These topcoats can be applied within 15 minutes of the application of the wash primer, since the vinyl butyral resin solution dries entirely by solvent evaporation. If desired, this drying can be speeded by heat.

The fact that wash primers can be applied with conventional spray equipment eliminates the need for expensive tanks, ovens, and technical control required for conventional metal pretreatments. Moreover, the simplicity of operation permits one to prepare metal surfaces and apply a coating in the field that is at least equivalent to a shop-applied system.

Phenolic, oleoresinous, alkyd, epoxy, and alkyd-melamine paints adhere to the wash-primed metal. Coatings based on BAKELITE Vinyl Resin VAGH or VAGD develop excellent adhesion. Nitrocellulose, itself, has relatively little adhesion to the wash primer film but alkyd-modified nitrocellulose will adhere well. In general, coatings based on vinyl chloride copolymers (except VAGH or VAGD), vinylidene chloride, and acrylic and methacrylic resins do not adhere to the wash primers. Just as alkyd resins improve the adhesion of nitrocellulose lacquers to wash primers, suitable blends of VAGH or VAGD with other vinyl resins will develop the required adhesion.

USE OF METAL CONDITIONERS

The wash primer holds the paint system firmly to the steel and prevents the spread of underfilm corrosion despite occasional mechanical breaks in the film. These areas can be easily cleaned and touched up without damage to the surrounding finish.

Multiple coats of this all-vinyl system can be applied quickly, with resultant economies in dry-dock service. In addition, the protective life of the system leads to greater savings since less frequent painting is necessary.

The outstanding results in the marine field have been duplicated in other fields. Pipe lines, oil storage tanks, and offshore drilling rigs are protected with the wash primer-vinyl paint system. The speed of application and abrasion resistance of this system have led to many applications on bridges, dam gates and barges. Air conditioning equipment, particularly fans where the corrosion on the edge of blades is severe, is often protected by the wash primer system.

Wash primers are used widely to coat galvanized iron, a surface that is usually difficult to paint. Exterior signs and outdoor movie screens that are wash-primed retain their paint despite cold weather shock instead of having to be repainted each spring as has been customary.

APPLICATION OF METAL CONDITIONERS

To establish adhesion to a metal surface and to prevent rusting, grease, oils, rust, scale, and other contaminants should be removed from the surface before applying the wash primer. Grit or sandblasting are more effective than wire brushing or flame descaling. Acid washes should not be used, since salts left on the surface may be a source of osmotic blisters.

The performance of wash primers over rusty steel is always poorer than over clean steel. Moreover, on a rusty surface, the results are often erratic. When a wash primer is applied to a surface covered with mill scale, galvanic action between the steel and the mill scale can be accelerated and lead to more rapid failure. This latter effect is more often observed in underwater exposures. The economies possible by less frequent painting can only be realized by avoiding the erratic and inferior performance resulting from improperly prepared surfaces.

Wash primers may be applied by conventional methods, such as spraying, dipping, brushing, or roller coating. They should be applied as a wet coat to cover the surface and penetrate cavities and corrosion pits. They should be applied thin in an alcohol dilution, since a heavy coating of wash primer may detract from the performance. The dry film should not exceed about 0.5 mils. Precautions should be taken to avoid conventional paint thinners for this dilution, since even small amounts of high boiling aliphatic hydrocarbons may precipitate the butyral resin during drying.

Although not good practice, the wash primers may be applied over wet metal. In this case, the thinner should contain adequate butanol to prevent resin precipitation. Usually, 30 per cent butanol in the thinner will give good performance. On wet or rough surfaces, brush application will help the wash primer penetrate any pits in the surface.

PREPARATION AND STORAGE OF METAL CONDITIONERS

Pigmented wash primers are made in conventional paint equipment, precautions being taken to prevent contamination by incompatible ingredients. The vinyl butyral resin is dissolved in the solvents, care being taken to add the resin slowly to prevent the formation of large resin clumps. The pigment base should be prepared from the base solution by dispersing the pigment in a pebble mill, grinding to a Hegman gauge reading of 7. Steel mills and equipment should be avoided since the alcohol solvents used often lead to rapid rusting, and the iron contamination which is introduced into the wash primer detracts from the adhesion. *For the same reason, the containers used for storage should be lined with a phenolic resin-baking or vinyl resin coating or should be of a non-reactive metal such as terneplate.*

The acid diluent should be packaged in glass or polyethylene containers or in containers having a suitable baked phenolic or vinyl resin coating. The same precautions are required if the diluent and base are combined in a one-package wash primer.

Table 4 lists suggested pigment grinding bases and diluent compositions for several representative wash primers.

CHARACTERISTICS AND SELECTION OF METAL CONDITIONERS

The original wash primer, WP-1, was developed by Union Carbide to improve ship-bottom paints.

Several government specifications have been written around the original WP-1 wash primer formula. All formulations contain the same essential ingredients but differ in the choice of solvent or the color of the tinting pigment; some specifications do not allow the use of any tinting pigment. Formula suggestions for the two most widely used two-package wash primers, as well as formulations for other one-and two-package wash primers, are shown in Table 4. Of course, the formulator must carefully follow the composition of the wash primer listed in each particular specification. Two-package wash primers must be used within eight hours after the acid diluent has been mixed into the base grind. Beyond the eight-hour period, the wash primer loses its adhesion to metals, even though the appearance seems unchanged.

BASIC ZINC CHROMATE METAL CONDITIONERS, WP-1 PRIMERS

WP-1 primers (both MIL-C-15328B and MIL-C-15328C) give outstanding adhesion to a wide variety of surfaces, including the following:

steel	cadmium	galvanized iron
stainless steel	tin	magnesium
zinc	aluminum	glass

WP-1 formulations are the preferred primers for use where exposure to salt water or salt spray is involved. These metal conditioners give maximum protection where the topcoat is a relatively permeable type such as alkyd, oleoresinous, or emulsion paint.

For outstanding performance, the WP-1

type wash primers should be topcoated with a coating based on BAKELITE Vinyl Resin VAGH or VAGD. This approach is an especially effective system in sea water and corrosive atmospheres. On fresh-water immersion or under conditions of high humidity, however, this system may develop osmotic blisters when the temperature is above 100°F. The reason is the lack of ionic permeability with coatings based on vinyl and phenolic resins. Pigmentation of the topcoats with leafing aluminum pigments may minimize the osmotic blisters. In general, however, where higher temperatures and humidity are encountered, the wash primer should contain fewer soluble ions.

The rust inhibitive action of WP-1 primers is enhanced as the quality of the pigment dispersion is improved. This improved dispersion is best obtained by extended grinding rather than by the use of grinding aids, since most surface-active agents detract from the protection afforded by the wash primer.

In the mixing of WP-1 primers, add the diluent to the base slowly, with agitation. In that way, the thinner concentration is balanced and local gelation prevented. The mixing should be done in clean containers. Contamination by oils or high boiling naphthas, such as mineral spirits, is detrimental to performance.

The proportion of acid diluent is an important factor in the performance of wash primers. While a variation of 10 to 20 per cent in the volume of acid diluent does not bring about noticeable changes in the performance of the wash primer, larger variations should be avoided. *Do not reduce viscosity with extra acid diluent.* If further reduction in viscosity is required, use isopropanol or butanol. On certain surfaces, such as clean magnesium, the proportion of acid diluent may be reduced by 75 per cent, but the necessity to do so should be established by experiment.

PHENOLIC MODIFIED WASH PRIMER

The phenolic-modified wash primer VP-2849 was developed to improve the durability of the wash primer itself. It is suggested as a replacement for WP-1 where the wash primer system will not be topcoated within three months.

Exposure tests show that the phenolic wash primer itself will protect steel from corrosion in atmospheric conditions in excess of two years. Three year atmospheric exposures of the phenolic wash primer topcoated with a vinyl chloride-based system show comparable performance to that of the conventional WP-1 type wash primer previously discussed.

LEAD CHROMATE METAL CONDITIONER

The lead chromate wash primer VP-2894 was developed specifically for use on steel and may not develop as good adhesion as WP-1 on other metal surfaces. VP-2894 is suggested as a replacement for WP-1 primers where the coating system is subjected to fresh water immersion or condensing moisture, or where the acid diluent is mixed with the base and

TABLE 4
COMPOSITION OF WASH PRIMER

	VP-2980 WP-1 (MIL-P-15328B) Using XYHL Parts by Weight	VP-3446 WP-1 (MIL-P-15328B) Using XYLS-1 Parts by Weight	VP-3374 WP-1 (MIL-P-15328C) Using XYHL Parts by Weight	VP-3447 WP-1 (MIL-P-15328C) Using XYLS-1 Parts by Weight
Basegrind:				
BAKELITE Vinyl Butyral Resin XYHL	7.33	–	7.01	–
BAKELITE Vinyl Butyral Solution XYLS-1	–	36.75	–	35.05
BAKELITE Phenolic Resin BKS-2710	–	–	–	–
Basic zinc chromate pigment[1] (insoluble)	7.07	7.08	6.76	6.76
Lead chromate pigment (low in soluble salts)	–	–	–	–
Chromic phosphate pigment	–	–	–	–
Strontium chromate pigment	–	–	–	–
Precipitated red iron oxide	–	–	–	–
Magnesium silicate (talc)	1.05	1.04	–	–
Lampblack	0.08	0.08	–	–
Titanium dioxide, rutile	–	–	4.88	4.88
Phthalo blue pigment[2]	–	–	2.13	2.13
Isopropanol, anhydrous	46.24	16.85	42.68	14.64
Ethanol, 95 per cent	–	–	–	–
Xylene	–	–	–	–
Butanol	16.37	17.56	15.64	17.18
Water	1.96	0.82	1.88	0.34
Toluene	–	–	–	–
Methyl isobutyl ketone	–	–	–	–
Sub-Total	80.10	80.18	80.98	80.98
Acid diluent				
Phosphoric acid, 85 per cent	3.67	3.66	3.50	3.50
Water	3.27	3.28	3.13	3.13
Isopropanol, anhydrous	12.96	12.88	12.39	12.39
Ethanol, 95 per cent	–	–	–	–
Sub-Total	19.90	19.82	19.02	19.02
TOTAL	100.00	100.00	100.00	100.00

*Denotes one package wash primer. The acid diluent can be added to the grind without affecting the shelf life of the primer. The other wash primers mentioned in Table 4 are two package primers. The base grind and the acid diluent have to be stored separately. After mixing, they should be used within a short time, since there is a gradual decline in the adhesion of films applied after the mixed primer has aged several hours.

Suppliers:

(1) 2813 Zinc Chromate (Harshaw Chem.), X-2259 (Hercules Inc.) or equivalent.

(2) X-3367 (Imperial Color), BT425D (E. I. du Pont de Nemours & Co., Inc.) or equivalent.

VP-2849 Phenolic Modified Parts by Weight	VP-2894* Lead Chromate Modified Parts by Weight	VP-3448* (MIL-C-14504A) Parts by Weight	VP-2979* Chromic Phosphate Modified Parts by Weight
10.39	9.00	9.41	9.0
–	–	–	–
15.58	–	–	–
3.46	–	4.31	–
–	8.60	–	–
–	–	–	9.0
–	–	4.31	–
0.86	–	–	–
2.16	1.40	1.96	1.4
–	–	–	–
–	–	–	–
–	–	–	–
–	53.00	58.96	–
34.20	–	–	54.5
7.80	–	–	–
7.80	–	–	–
–	–	–	–
10.39	–	–	–
–	13.00	16.48	16.1
92.64	85.00	95.43	90.0
1.84	2.90	2.74	1.8
–	2.90	1.83	1.8
–	9.20	–	–
5.52	–	–	6.4
7.36	15.00	4.57	10.0
100.00	100.00	100.00	100.00

stored for a long period. Storage tests of eighteen months have not revealed any deterioration in the primer. This means that a one-package primer can be supplied and the material can be used in dip tanks. Since the composition is designed for storage, VP-2894 is prepared at a somewhat higher solids content and, as formulated, may be too viscous for spraying. Thinning 20 to 30 per cent with butanol will reduce the composition to spray viscosity.

The easier dispersibility of lead chromate usually results in a smoother primer than can be obtained with basic zinc chromate, an advantage where gloss coatings are applied over the primer. Where the thickness is determined visually, however, the coating may be applied too thick.

Coatings applied over the VP-2894 primer should not be pigmented with lead pigments. Topcoats based on red lead, chrome yellow, and chrome orange have shown poor adhesion, especially if the wash primer is aged some time before coating. Moreover, the VP-2894 primers have given some indication of poorer adhesion over wet surfaces than WP-1 primers, especially when heavy films are applied. Additional thinning with butanol before application, or warming during drying, usually eliminates these difficulties. Finally, the VP-2894 primers are somewhat slower in developing adhesion; although on steel the final adhesion is equal to that of WP-1 primers.

To sum up, VP-2894 is formulated for use on steel. VP-2894 is definitely poorer than WP-1 primers on aluminum and magnesium and the performance of this wash primer should be checked on other metal surfaces before use.

CHROMIC PHOSPHATE METAL CONDITIONER VP-2979 or XE-5298

Salt-free chromic phosphate serves as an excellent rust inhibitor in vinyl butyral solutions. Wash primers based on chromic phosphate may be combined with the acid diluent as a one-package system. These chromic phosphate wash primers show less tendency to develop osmotic blisters than the WP-1 primers, basic zinc chromate formulations. For this reason, they are to be preferred in locations involving high humidity or fresh water immersion.

Formula VP-2979 is shown in Table 4 and is suggested for use on steel. While this formula has not been tested as extensively as the WP-1 formulations, it gives excellent performance in all types of accelerated tests, and is offered as a starting point for the development of improved single-package primers.

Like the VP-2894 formula, this chromic phosphate wash primer is formulated with higher resin and lower phosphoric acid content. Thus the formulation as written is more viscous and may require additional thinning with alcohol for spray applications. Since chromic phosphate pigments are prone to settle in the container, the composition should not be stored at too low a viscosity.

SELECTED REFERENCES

Suggested Mechanisms of Changes with Time in WP-1 Wash Primer Metal Conditioning Composition, E. R. Allen. *Corrosion* v 17 n 6 June 1961 p 114-18. History of wash primers with emphasis on laboratory research; mechanism is postulated to explain loss of adhesion with time of reactive type WP-1; phase rule studies of zinc tetraoxychromate, intrinsic viscosities of recovered polymers, reactions involving formation of phosphorus-chromium-resin complex, deposition of tertiary zinc phosphate on metal, and modifications made in WP-1; several organic structural formulas are included.

Wash Primer Development and Characteristics, L. R. Whiting. *Corrosion* v 15 n 6 June 1959 p 45-7 (discussion) 47-8. Reacted wash primers discussed mainly; formulation of WP-1 reactive type and its advantages; wash primer reaction; reacted and non-reactive wash primers; application recommendations.

Mechanism of Wash Primer Action, J. Kruger. M. C. Bloom. *Indus. & Eng. Chem.* v 48 n 8 Aug 1956 p 1354-60. During World War II, L. R. Whiting and P. F. Wangner empirically developed compositions known as wash primers considered one of the most important steps in corrosion prevention in recent years; initial attempt to investigate structure of this wash primer film on iron surface, its mechanism of formation, and its mode of action in retarding corrosion and increasing paint adhesion.

Introduction to Wash Primers, E. S. Beck. *Metal Finishing* v 56 n 1, 2 Jan 1958 p 58-60, Feb p 61-4. Value of wash primer for corrosion resistance, adhesion, or durability; composition and properties of WP-1 wash primer; application within certain ranges of film thickness; primer was developed which used lead chromate as pigmentation in place of basic zinc chromate; other wash type primers.

Wash Primer Has Good Adhesion To Metal, M. Barlet. *Ind Finishing* 43:93-4 Feb 1967.

Wash Primers For Metal; Not For Fiberglass, *Ind Finishing* 37:106-7 Apr 1961.

STORAGE AND HANDLING OF RESINS AND RESIN SOLUTIONS

Store dry resins in a cool dry place, away from direct sunlight or other sources of heat. To avoid contamination, keep all containers sealed when not in use.

In the storage and handling of resin solutions, observe the same safety practices that apply for flammable solvents. Keep containers sealed when not in use. Maintain adequate ventilation when being used. Eliminate potential sources of ignition. The two main differences between resin solutions and solvents are (1) the possible reactivity of the resin and (2) the higher viscosity of the resin solution. Avoid unwanted exposure to reactants and catalysts. In the transfer of resin solutions, size the pipelines, pumps, and motors for the higher viscosity.

For details on the storage and handling of particular resins and resin solutions, phone or write the Union Carbide office nearest you. See the back page for phone numbers and addresses.

BAKELITE® VINYL BUTYRAL RESINS

SHIPPING DATA FOR RESIN SOLUTIONS

Subject to change without notice

	XYLS-1	XYLS-2	XYLS-4
Weight per Gallon, lb.			
at 20°C.	7.12	7.18	7.61
at 15.56°C.	7.15	7.21	7.65
Δ Pounds per Gallon, °C.	0.00718	0.00716	0.00810
Coefficient of Expansion			
at 20°C.	0.00101	0.00100	0.00106
at 55°C.	0.00105	0.00103	0.00110
Flash Point [a] °F.	70	62	60
Type Container and Net Contents			
55-Gallon	390[b]	394[b]	419[c]
DOT Warning Label Required	Red	Red	Red
Freight Description			
Rail	Plastics, Synthetic, Liquid, Noibn		
Truck	Plastic Materials, O/T Expanded, Liquid Noibn		
Dangerous Article Description on Container	Resin Solution (Flammable Liquid)		

FOOTNOTES:

[a] Tag open cup, ASTM method D 1310
[b] DOT 17H Steel Drum, UCC No. 2 baked phenolic lined.
[c] DOT 17E Steel Drum, UCC No. 2 baked phenolic lined.

PRECAUTIONARY LABELING

XYLS-1 and XYLS-2

WARNING: FLAMMABLE

Keep away from heat, sparks and fire. Do not leave container open. Use with adequate ventilation.

FOR INDUSTRY USE ONLY

XYLS-4

WARNING: FLAMMABLE

Breathing of vapors harmful.

May cause eye irritation. Do not breathe vapors. Avoid contact with eyes.

FOR INDUSTRY USE ONLY

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