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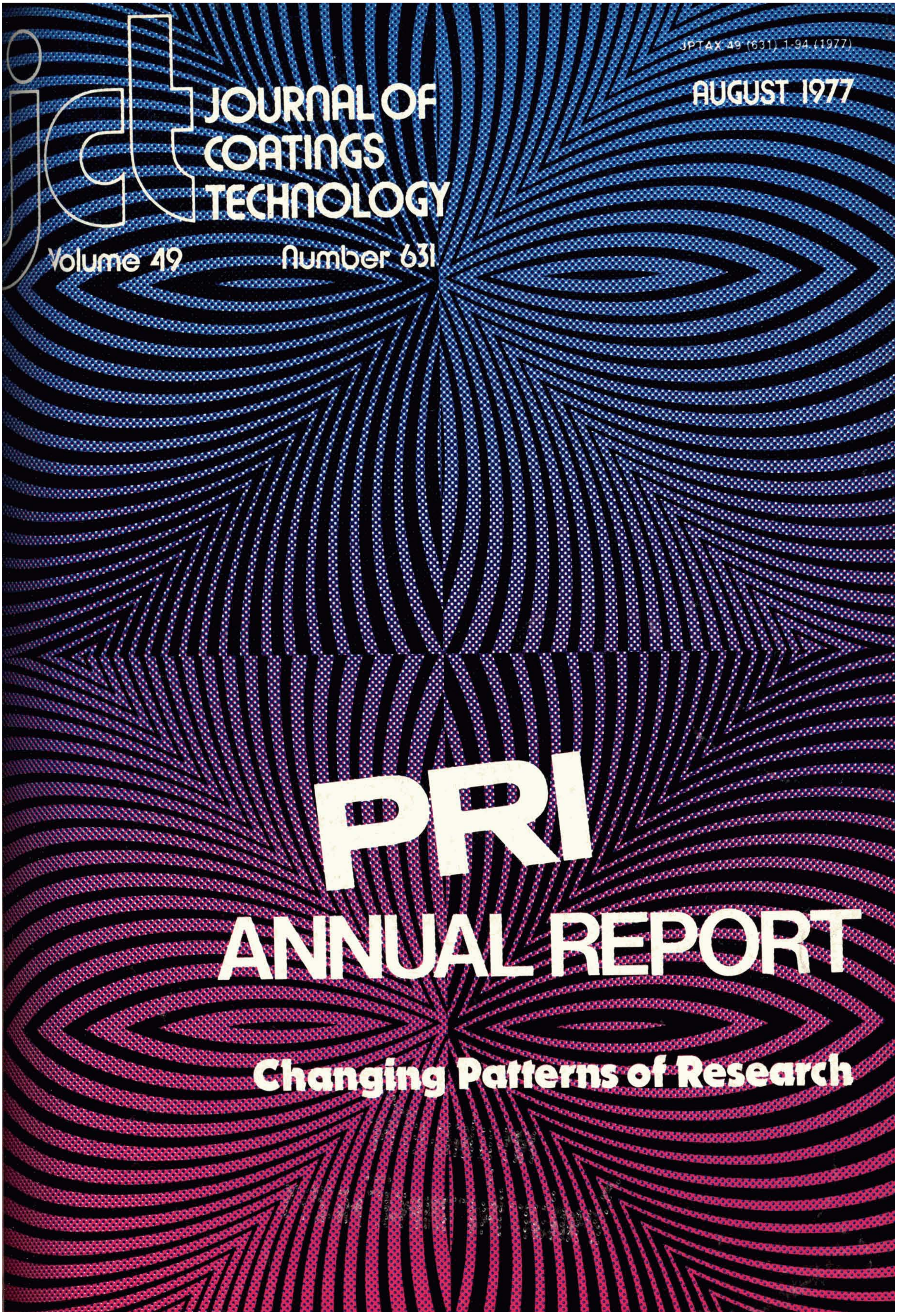
TECHNOLOGY

AUGUST 1977

Volume 49 Number 631



PRI

ANNUAL REPORT

Changing Patterns of Research

Announcing new VAN GEL. A uniform thixotrope designed especially for paint.

Drum after drum, VAN GEL® is always the same because R. T. Vanderbilt carefully produces it that way for water base paints. Result: you can count on uniform paint rheology batch after batch. Now, you can accurately predict the precise amount of thixotrophy you'll achieve by adding a given amount of VAN GEL. This uniformity ushers in a new era of accuracy and predictability in water-thinned paint manufacturing.

VAN GEL is so easy to hydrate that it can be added dry at the beginning of the mixing process. That saves one costly step right there.

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Because VAN GEL is inorganic and not affected by organisms or enzymes, it will not decompose in production, in the can or in the film.

VAN GEL lets you take it easy because you know your customers will find your paint easy to use. They'll find your paint mixes fast and has better suspension. Plus more anti-sag, drip-free properties, and better flow. That's what VAN GEL is all about – making things easier for you and your customers.

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R. T. Vanderbilt Company, Inc.

INDUSTRIAL MINERALS AND CHEMICALS

AROBRIEFS

NEWS FOR ALL
COATINGS FORMULATORS
ASHLAND CHEMICAL COMPANY
RESINS & PLASTICS DIVISION

Who says styrene, water and electricity won't mix?

You'll hear people say that waterborne systems can't be applied by *electrostatic spray.* But a bulk user, whose process was written up in "Industrial Finishing", has been electrostatically applying AROLON® 969-based finishes for over 5 years. They're happy with it on their automated line since they use one oven, set at 175°-200° F, for both pre-drying before spraying and baking the finished parts. These finished parts, right off the line, can be handled immediately. And their 30,000 parts-per-week run stacks for shipment without any sticking problems.

Energy Savings

Because AROLON 969-D-70 air-dries or cures rapidly at low temperatures, you save energy (see graphs below). You could even operate if the gas were turned off again this winter.

Ecological Benefits

AROLON 969-D-70 coatings will keep the EPA away from your door—and these coatings are fire-safe for good measure. You may pay lower insurance rates if you're using only water-borne coatings.

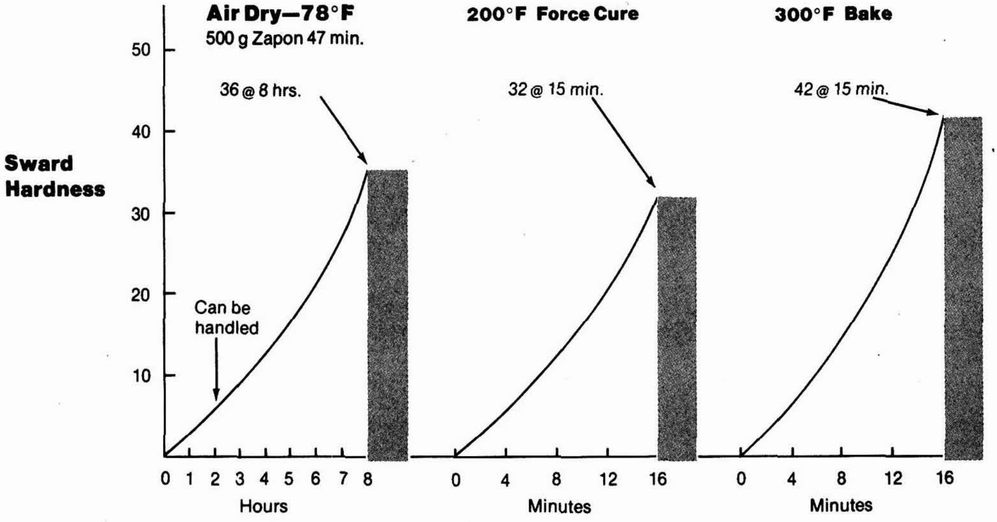
Why Styrenated?

Everybody knows styrenated alkyds dry fast. This added dimension comes when your styrenated alkyd is water-dispersible. Our AROLON 969-D-70 is so simple to use, you just add water and ammonia, and stir. You don't need storage space for water; just turn on the faucet. AROLON 969 is shipped at 70% solids in butoxy ethanol.

So water, styrene and electricity do mix when you use AROLON 969-D-70 coatings to provide economic, ecologic priming and finishing systems. Discuss them with your Ashland technical sales representative, or write to Resins & Plastics Division, P.O. Box 2219, Columbus, Ohio 43216.

Hardness Development

(Clear films—3 mils, wet)



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Ashland Chemical Company

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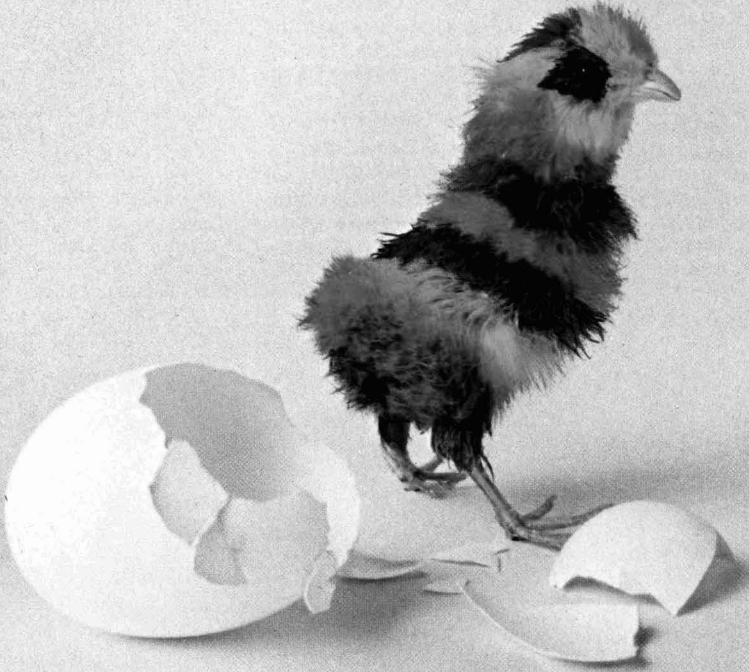

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Subtle, quiet colors…bright, vibrant ones…plus all the shades, tones and combinations in between. Tenneco has an industrial colorant line with exactly what it takes to produce the desired effect. And do it consistently. Each line features high color strength, machine dispensability and close color tolerance.

Take our 844 Non-Aqueous series for example. Based on a new acrylic-type ester film-forming binder, it's equally great at high or low tint levels in solvent systems. Binder content is low, virtually incapable of interfering with cured coating properties. And it's exceptionally compatible.

For water-borne industrials our 895 Aqueous line is ideal. Compatible in a wide range of systems including acrylic emulsion-melamine types, these polymer binder-based agents provide unequalled coloring performance. High pigment concentration and low binder content is featured.

Then there's Chroma-Cal® 850. This series' proprietary polyester resin system is 100% convertible …the perfect answer for coloring gel-coats (even by dispensing machine) and other high-solids or solventless coatings.

If we've started you thinking about Tenneco colorants, contact us. We have a wealth of detailed information, samples and comparative data you'll find particularly interesting and, we think, impressive.

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A Tenneco Company
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AUGUST 1977

jct JOURNAL OF COATINGS TECHNOLOGY

Volume 49 Number 631

Features

Federation Activities

Departments

THE JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology at Cresent & Mulberry Streets, Harrisburg, Pa. 17104. Editorial and executive offices are located at 1315 Walnut St., Philadelphia, Pa. 19107. Phone: (215) 545-1507.

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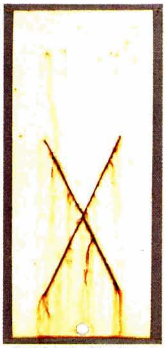
NALZIN™ SC-1...
The non-lead, non-chromat
that performs as well o

Tests prove it!

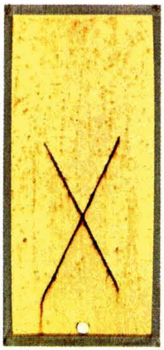
NALZIN™SC-1 vs. Zinc Chromate
(40 PVC Oil Alkyd 1:1 Primer)



NALZIN™ SC-1

340 HOURS SALT FOG
(ASTM Test B117-64)

Corrosion-Inhibitive Pigments:
Equal Cost Comparisons (64¢)
(Formulated to Constant PVC)
Substrate: Phosphated Steel
Application: Brush
Number of Coats: 1
Total Film Thickness: 1.5 mils (dry)

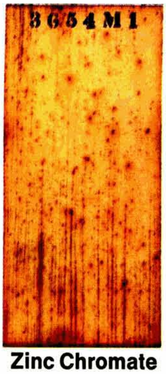


Zinc Chromate

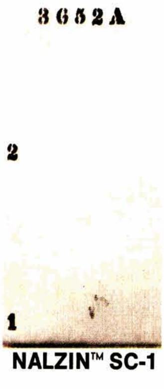
NALZIN™ SC-1

7 MONTHS MARINE EXPOSURE
(45° South, Ocean City, N.J.)

Corrosion-Inhibitive Pigments:
Equal Cost Comparisons (64¢)
(Formulated to Constant PVC)
Substrate: Hot Rolled Steel, Sandblasted
Application: Brush
Number of Coats: 1
Total Film Thickness: 2.0 mils (dry)



Zinc Chromate



NALZIN™ SC-1

18 MONTHS ATMOSPHERIC EXPOSURE
(45° South, Hightstown, N.J.)

Corrosion-Inhibitive Pigments:
Equal Cost Comparisons (64¢)
(Formulated to Constant PVC)
Substrate: Hot Rolled Steel, Sandblasted
Application: Brush
Number of Coats: 1 coat of primer over all
2nd coat over upper half
Total Film Thickness:
Upper Half—3.0 mils (dry)
Lower Half—1.5 mils (dry)

Zinc Chromate

anti-corrosive pigment better than Zinc Chromate.

There is an answer to the problem of having to reformulate away from lead and chromate pigments and still come up with an anti-corrosive metal-protective system that will provide the performance benefits that have always been identified with lead and/or chromate-based pigments.

The answer is NALZIN™ SC-1, the zinc phospho oxide pigment that is as versatile as it is effective. Lead-free and chromate-free, it works equally well in aqueous and solvent-based coating systems—oil/alkyds, acrylic latexes, styrene acrylic latexes.

The tests shown at left compare the performance of NALZIN SC-1 with that of Zinc Chromate. They demonstrate conclusively that:

- NALZIN SC-1 Pigment performs as well or better than Zinc Chromate at all levels tested.
- It consistently equals or tops Zinc Chromate both at equal weight and at equal cost levels.
- Low levels perform as well as high loadings, so it takes less to achieve good results.

NALZIN SC-1 has other highly beneficial cost and performance features:

- Stable in a wide variety of binder systems.
- White color and low tinting strength allow formulation of virtually any color coating.
- Minimizes tendency for flash rusting in aqueous coatings.
- Excellent throwing power and can stability in electrodeposition systems.

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NL Industrial Chemicals

JOURNAL OF COATINGS TECHNOLOGY

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Comment

PRI and the Winds of Change

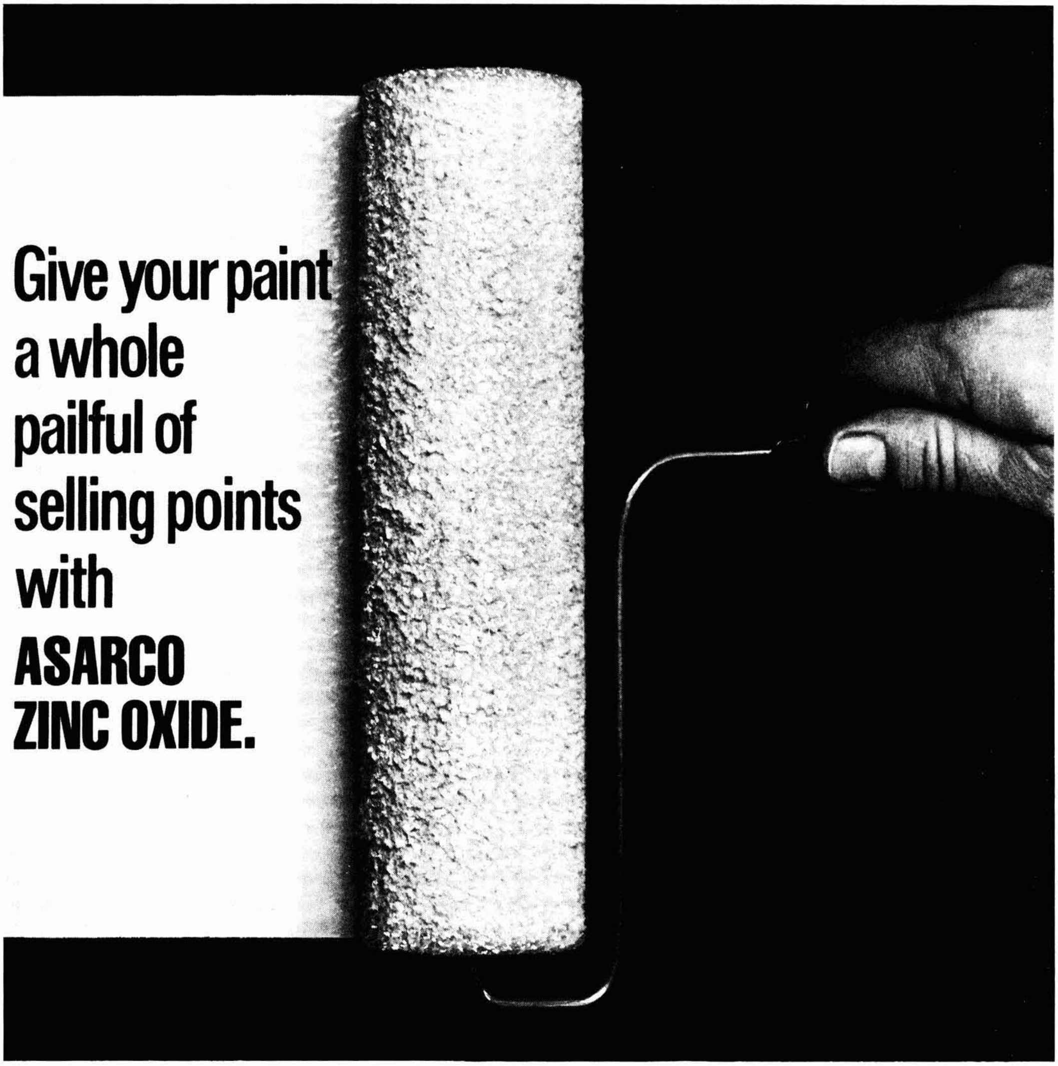
For 20 years the Paint Research Institute has been pursuing its major objective of advancing the knowledge and application of those sciences relating to the technology of protective coatings through supportive research efforts.

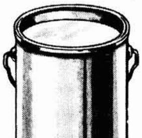
PRI programs are aimed at developing concepts (not products or processes), with the resultant basic information designed to serve as a catalyst for research and development in the paint manufacturer's own laboratory. This devotion to basic research is partly due to the tax-exempt status PRI enjoys as a charitable organization concerned exclusively with such research. Additionally, however, is the concern that such research not be commercially oriented because of the potential for becoming embroiled in proprietary conflicts.

As a consequence of its commitment to basic research, PRI has not been universally popular, especially with some of the more practically oriented Federation members who feel too much of the research has been "blue sky" and its relevance to current industry problems too nebulous. Further, they have commented that the results of PRI research are reported at such an abstract level as to be virtually incomprehensible to the average member.

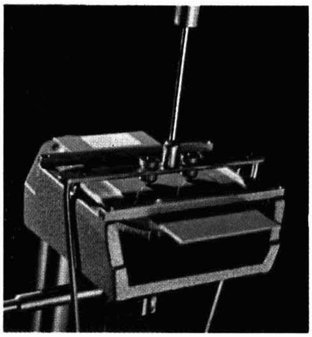
PRI is not a static organization. As the Federation research arm, it makes changes as necessary to maintain its role as a viable and meaningful service organization for the coatings industry. Currently, for example, the Research Director and the Trustees have become increasingly involved in formulating research proposals—they are spending more time identifying the needs of the industry and working on sharply focused proposals to meet those needs. Their goal is to select projects that, although still basic in nature, are only one level removed from practical application, such as the current PRI-sponsored research on mildew defacement of coatings. The aim is to ensure that future programs will have the same relevance and immediacy. In this regard, PRI invites suggestions for proposed projects from Constituent Societies, committees, companies, or individual members.

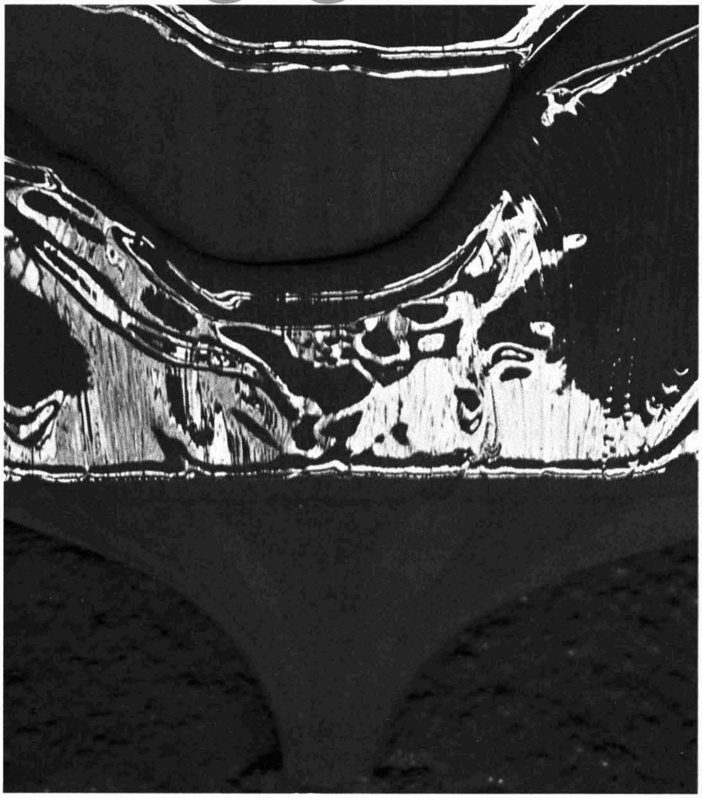
To make the reports of such research more comprehensible, meaningful reviews will be provided which will be couched in the language of the "practical" rather than the "academic." The Report of the Research Director (see pages 41-45) reflects the new approach in communicating PRI activities. Meanwhile, research people at the universities will be asked to make their presentations more comprehensible to the paint chemist. And to assure that the membership is kept abreast of the changing patterns of research, the Trustees are visiting Constituent Societies to present a "PRI Night." These visitations are made at no expense to the Societies, and can be scheduled for the asking. So if your Society would like to hear the PRI story, as well as to pass along any comments (pro or con) on the research efforts, contact Federation headquarters with your request. PRI is ready when you are! — TAK


Give your paint a whole pailful of selling points with
ASARCO ZINC OXIDE.



High grade coatings with excellent properties- VEBA epoxy curing agents





VEBA-CHEMIE supplies diamines and anhydrides for hot and cold curing.

VEBA diamines
IPD and TMD as well as the hardener V214 are colourless, low viscosity liquids. They are of aliphatic or cyclo aliphatic structure.

VEBA anhydrides
HHPA, THPA and PMDA are solid pure white products. MHHPA is a low viscosity liquid.

VEBA special hardeners
B31, B55, B68 and B73 enable the manufacture of highly reactive or normal curing powder coating systems from high gloss to matt or dead matt finishes.

Check how the VEBA epoxy curing agents can improve your products. Samples, technical information and advice are available on request.

HHPA = Hexahydrophthalic anhydride
THPA = Tetrahydrophthalic anhydride
PMDA = Pyromellitic dianhydride
MHHPA = Methyl hexahydrophthalic anhydride

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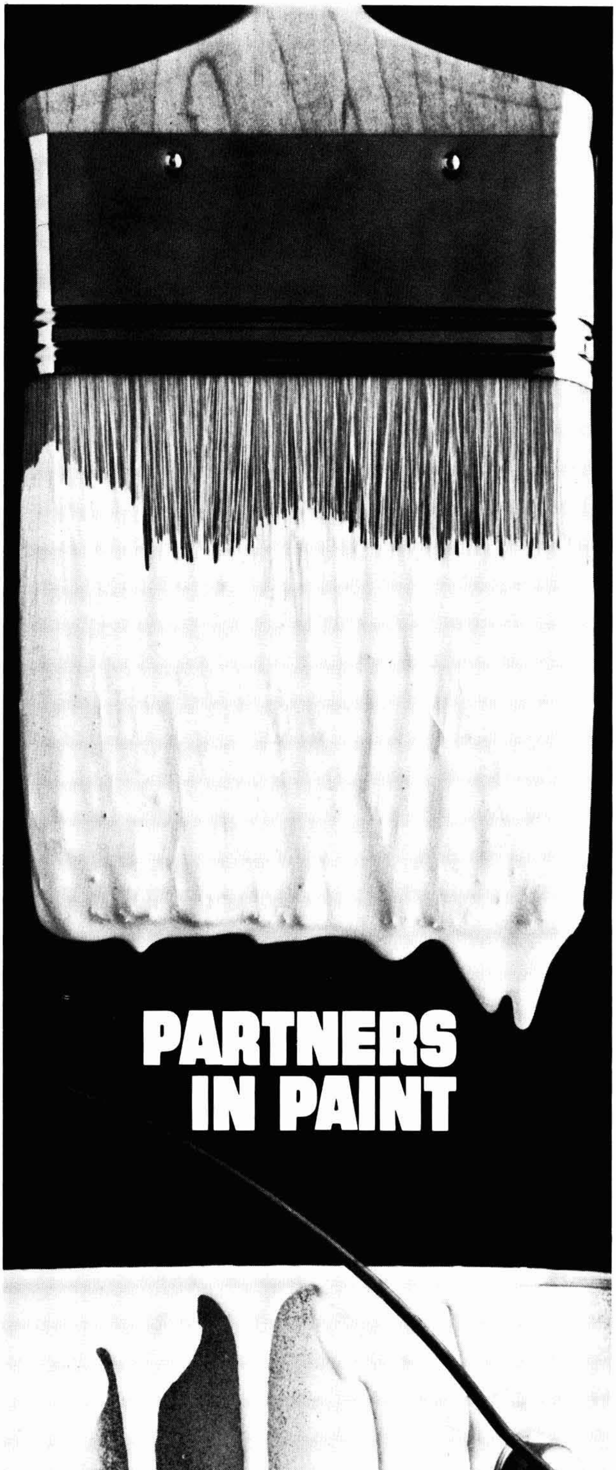
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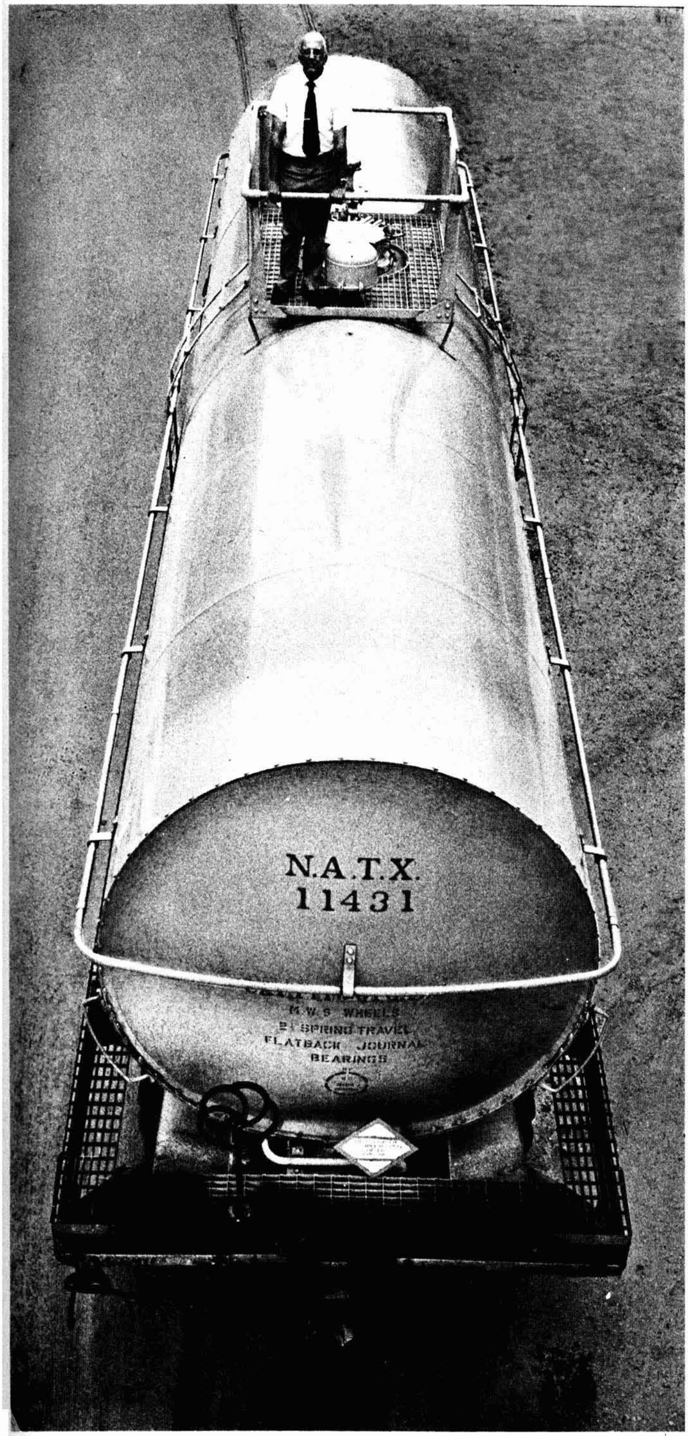
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BEARINGS

Abstracts of Papers in This Issue

A NEW APPROACH TO FORMULATION OF WATER-BORNE COATINGS—W.J. Blank

Journal of Coatings Technology, 49, No. 631, 46 (Aug. 1977)

New polyether polyol resins, based on a hydrophobic aromatic or cycloaliphatic moiety grafted with an alkylene oxide or preferably ethylene oxide, have been developed as low molecular weight resins or reactive diluents for water-borne or high solids industrial coatings. Crosslinked with an amino resin, these polyether polyol resins give, for most applications, acceptable performance. Variations in polyol composition and acrylic backbone resin as well as the performance of such coatings have been studied.

DEVELOPMENT OF WATER-BORNE VEHICLES FOR USE IN INDUSTRIAL WOOD COATINGS—J. Hortensius

Journal of Coatings Technology, 49, No. 631, 60 (Aug. 1977)

Water-borne vehicles for wood coatings consisting of an emulsion and a water soluble resin have been developed that exhibit properties equal to solvent-based coatings. Water-borne vehicles in clear coatings must possess very good surface wetting properties to show the natural grain of the wood as exhibited by solvent systems. The best effect is obtained when part of the water-borne vehicle is water soluble. The water soluble part is critical in developing the rheological properties in pigmented systems.

Water-borne coating systems based on these vehicles can be applied using existing coating equipment.

HIGH PERFORMANCE ISOCYANATE-OXAZOLIDINE COATINGS—W.D. Emmons, A. Mercurio, and S.N. Lewis

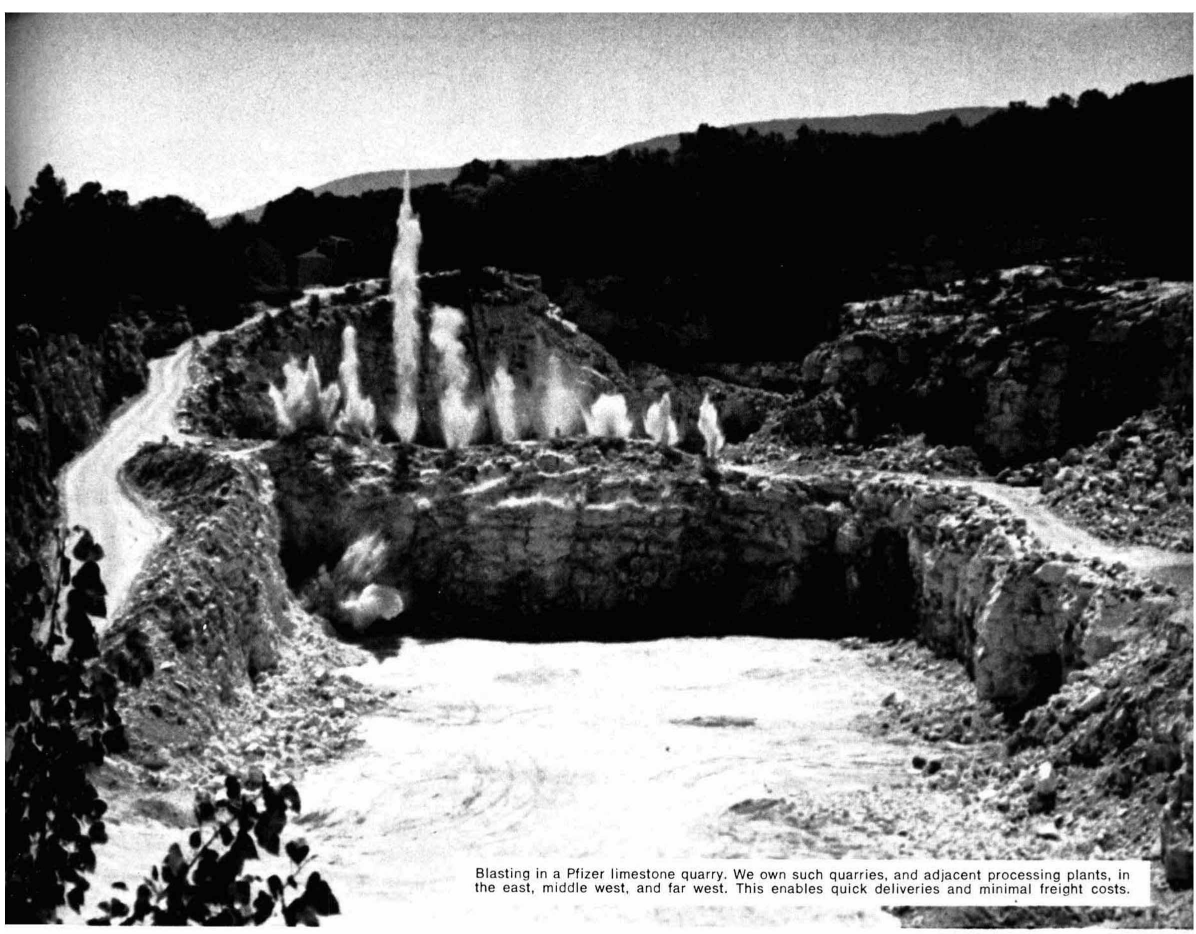
Journal of Coatings Technology, 49, No. 631, 65 (Aug. 1977)

The 2.2-dihydro and the 2-isopropyl oxazolidine moieties possess the features of low basicity, facile hydrolysis by ambient moisture and high reactivity with isocyanate of the unblocked ethanolamine functionality that permit design of coatings that display long pot-life as well as rapid cure under ambient conditions. Furthermore, the incorporation of these groups into carefully tailored acrylic polymers and oligomers as well as into monomeric esters provides high solids coatings with low solvent demand for application. The ambient or force dry cure of these compositions provides a low energy route to coatings with mechanical and resistance properties at least equal to those of high performance baking finishes. Florida exposure of test panels demonstrates that the exterior weatherability of the acrylic-isocyanate coatings is comparable to that of currently used automotive top-coats.

ECONOMIC AND TECHNICAL PARAMETERS OF PIGMENT DISPERSIONS—F.K. Daniel and R. Pineiro

Journal of Coatings Technology, 49, No. 631, 74 (Aug. 1977)

High-speed dispersers and sand mills are excellent tools for dispersing TiO_2 and most other bulk pigments, but they have definite limitations when it comes to dispersing hard-to-grind pigments. Alternate approaches to full tint strength development, especially for expensive organic pigments are discussed. Buying ready-made dispersions from subcontractors is one way to solve the problem. The higher visible cost of such out-of-house dispersions is often offset by indirect economic and technical advantages. Some of the technical benefits derived from intensive grinding are illustrated. The effects of pigment/vehicle interactions on tint performance are also demonstrated.



Blasting in a Pfizer limestone quarry. We own such quarries, and adjacent processing plants, in the east, middle west, and far west. This enables quick deliveries and minimal freight costs.

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A FILLER AND EXTENDER THAT'S NATURALLY BETTER

Approximately 7% of the earth's crust is composed of calcite, chiefly organic substances metamorphosed into limestone and marble. Yet despite such abundance of calcium carbonate, relatively *pure and uniform* deposits of it in the U.S. are scarce.

Pfizer owns and draws upon several such rare deposits for our very high quality, very finely ground Vicron. Produced in a choice of controlled particle sizes, Vicron has exceptional whiteness and brightness as well as purity and uniformity. It also has good wetting and dispersion characteristics, low absorption and specific gravity.

This outstanding mineral product can improve the properties and reduce the cost of paints, plastics, paper, rubber, and ceramics. And thanks to now-completed plant expansions, it's promptly deliverable in any desired amounts.

Direct nation-wide sales and technical services are provided for Vicron. For information or assistance regarding it, call your nearest Pfizer sales-service office (see your Yellow Pages) or phone our headquarters at 212-573-2816.

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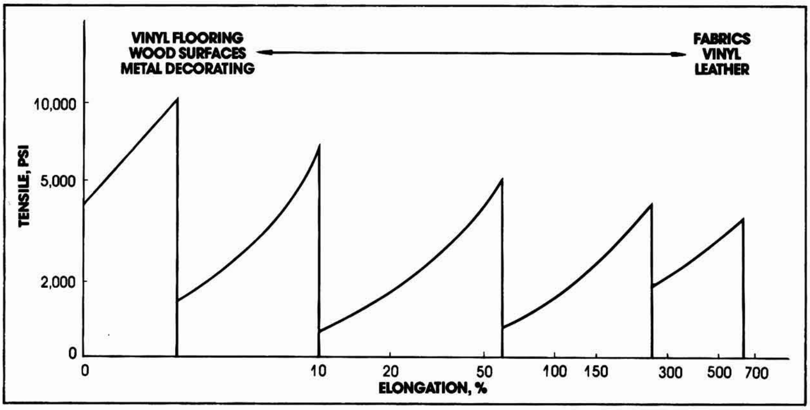

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METAL DECORATING
FABRICS
VINYL
LEATHER
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5,000
2,000
0
0
10
20
50
100
150
300
500
700
ELONGATION, %

Replace half your TiO_2 with economical Min-U-Sil.®

Now, you have an economical alternative to costly TiO_2 powder coating fillers. It's PGS Min-U-Sil.

Min-U-Sil is a high-purity silica, available in four uniform micron sizes and meshes. You can use it to replace 50% of the titanium dioxide in powder coating formulations with no loss in hiding power. Even higher replacement rates are possible with adjusted formulations.

Since TiO_2 costs about 47¢ a pound and Min-U-Sil costs only 5¢ a pound, changing to Min-U-Sil can save you tons of money. Savings that become profits at the sales end.

Min-U-Sil also offers important benefits to your customers. Like greater film thickness per coat, resulting in higher productivity than TiO_2 in fluid bed applications. And it's totally compatible with every known powder coating formulation. Epoxy, acrylics, polyesters. You name it.

Replace half the TiO_2 in your powder coatings with economical Min-U-Sil. Your customers will like the change. And so will you.

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1lb. TiO_2
(Approx.Cost)

1lb. Min-U-Sil
(Approx.Cost)

Some Chief Executives speak up about the Payroll Savings Plan.

We thought you'd be interested in why your peers feel the Payroll Savings Plan makes good business sense.

So, recently we asked the chief executive officers of 291 companies with 500 or more employees to express their thoughts about offering their employees the opportunity to buy U.S. Savings Bonds through the Payroll Savings Plan.

Here's a sample of what they had to say:

"For the employee, it's a way to save. An organization that offers the Plan helps the employee achieve at least part of his goal for security."

The Payroll Savings Plan is a convenient, guaranteed way for employees to save regularly, virtually without effort. An employee knows that the money he invests in U.S. Savings Bonds is his, that it's earning interest, and that it will be there when he needs it—for a special purchase, for an emergency, for his children's education, for his retirement.

"It's a fringe benefit for the employee and an indirect benefit for the company. The employee may feel more secure financially, so his mind is at ease and he can do a better job."

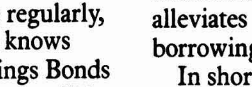
A secure employee is a more productive employee. A more productive employee benefits your company.

In addition, Bonds provide an attractive supplement to company retirement programs. And since Bonds act as a liquid reserve against emergencies, established company thrift plans are sheltered against continual withdrawals.

"... As far as our company's concerned, it's patriotic and worthwhile ... we feel we should support the government."

Savings Bonds contribute to our country's financial stability. The Payroll Savings Plan reduces the need for government borrowing from the banking system—businesses' own prime source of capital. The money invested by private individuals in the form of Savings Bonds alleviates the pressure generated by government borrowing in the money market.

In short, what these people are saying is what we've been telling you all along: The Payroll Savings Plan is a fringe benefit that benefits everyone. Your employees. Your company. Your country. Everyone. For a complete selection of materials telling you how you can install and promote the Plan among the employees in your company, simply clip and mail the coupon below.



Take stock in America.

Buy U. S. Savings Bonds

Director of Sales
U.S. Savings Bonds Division
Department of the Treasury
Washington, D.C. 20226

Please send me information on how to install and promote the Payroll Savings Plan.

Name________

Company________ Position________

Address________

City________ State________ Zip________

Number of Employees____over 500____under 500

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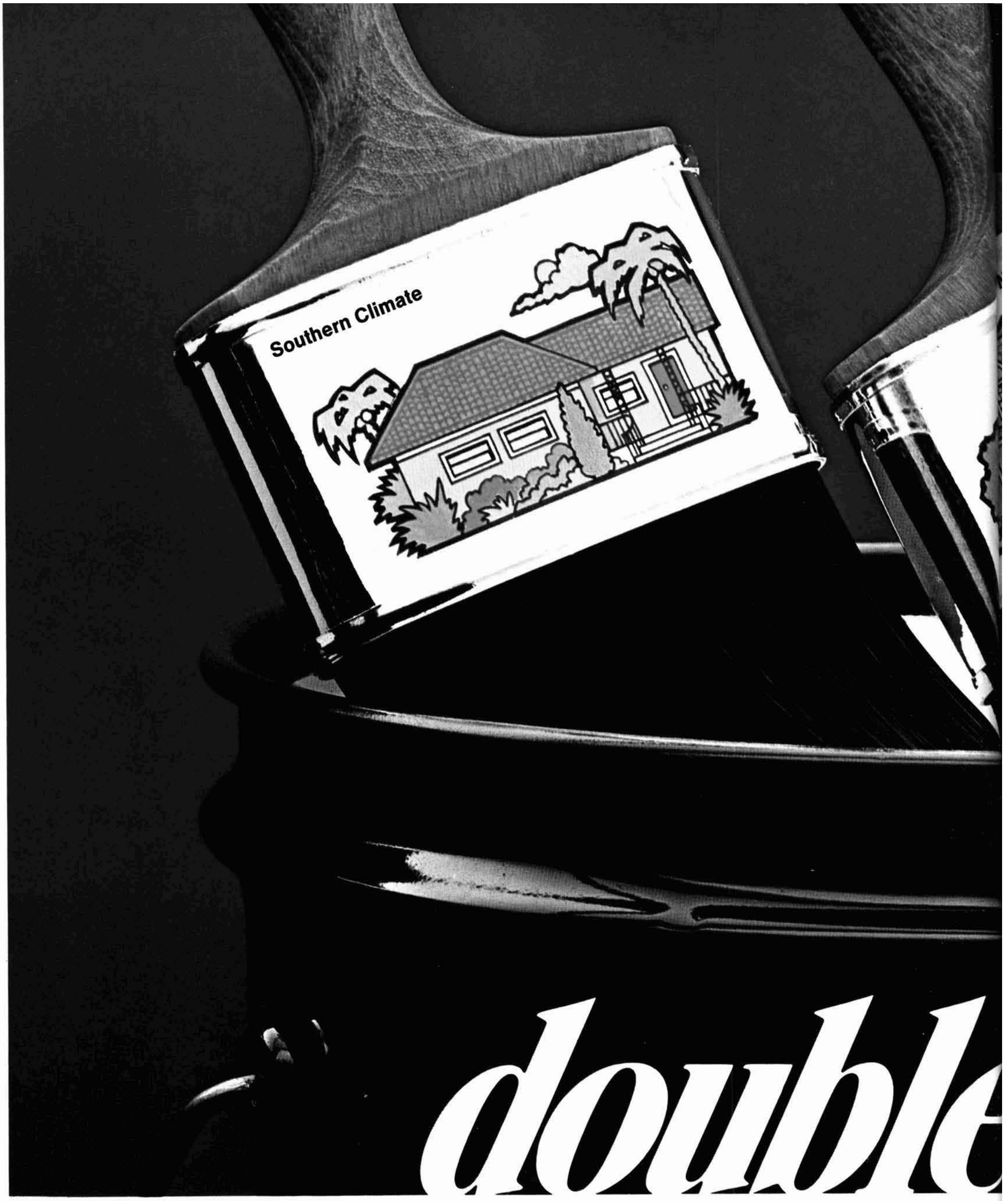
& The Advertising Council


...it's worth a second look!



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SKANE

PRELIMINARY PROGRAM

Annual Meeting and Paint Show

Astrohall Houston, Texas
October 26, 27, 28, 1977

Federation of Societies for Coatings Technology

Preliminary Program

WEDNESDAY, OCTOBER 26

OPENING SESSION
(10:30 — 11:00)

Fifty-fifth Annual Meeting of the Federation of Societies for Coatings Technology opened by President Neil S. Estrada.

Invocation and In Memoriam

Welcome: Gerry J. Goldberg, President of Houston Society for Coatings Technology

Elder C. Larson, Chairman of the Program Committee

Robert J. Klepser, Chairman of the Host Committee

David Cook, Chairman of the Paint Industries' Show Committee

Introduction of Federation Officers.

Introduction of Distinguished Guests.

E. W. FASIG KEYNOTE ADDRESS
(11:00 — 12:00)

THE COATINGS INDUSTRY: SOME FUTURE PERSPECTIVES — John C. Dean, of Stanford Research Institute, Menlo Park, Calif.

GENERAL INTEREST SESSION
(2:00 — 4:30)

MICROEMULSIONS, A MEANS TO REPLACE SOLVENTS IN PAINTS — Stig Friberg, of University of Missouri—Rolla, Rolla, Mo.

SURFACE PROFILE FOR BETTER COATING PERFORMANCE — John D. Keane and Joseph A. Bruno, of Steel Structures Painting Council, Pittsburgh, Pa.

ECONOMIC AND ENERGY SAVINGS THROUGH COATINGS SELECTION — Harold R. Powers, of The Sherwin-Williams Co., Chicago, Ill.

ENERGY SAVINGS OPPORTUNITIES IN COATINGS MANUFACTURE — S. T. Greer, of PPG Industries, Inc., Pittsburgh, Pa.

GENERAL INTEREST SESSION
(2:00 — 4:30)

POLYURETHANES AS ENERGY EFFICIENT COATINGS — J. C. Hixenbaugh, of Mobay Chemical Corp., Pittsburgh, Pa.

CONSERVATION THROUGH HIGHER SOLIDS, LOWER ENERGY CURE COATING RESIN SYSTEMS — George H. Wilhelm and Robert N. Price, of Ashland Chemical Co., Columbus, Ohio.

ENERGY CONSERVATION UTILIZING COUPLING AGENTS — Al Mersberg, of Briner Paint Manufacturing Co., Inc., Corpus Christi, Texas.

ASSESSMENT OF PIGMENT DISPERSION BY A COLORIMETRIC TECHNIQUE — Robert C. Zeller, of Pfizer, Inc., MPM Div., Easton, Pa.

THE ENERGY CRISIS AND ITS IMPACT ON TRENDS IN PLURAL COMPONENT FINISHING MATERIALS AND EQUIPMENT — David B. Huberfield, of Graco, Inc., Minneapolis, Minn.

Program at a Glance

Tuesday, Oct. 25	**Registration (9:00 am to 5:00 pm)**
Wednesday, Oct. 26	**Registration (8:00 am to 5:00 pm)** **Opening Session (10:30 am)** **Keynote Address (11:00 am)** **General Interest Sessions (2:00 pm)** **Paint Show (12:00 to 5:00 pm)**
Thursday, Oct. 27	**Registration (8:00 am to 5:00 pm)** **PRI Seminar (9:00 am)** **Environmental Affairs (9:00 am)** **Educational Program (11:00 am)** **Society Papers (2:00 pm)** **Roon Awards Papers (2:00 pm)** **Paint Show (9:00 am to 5:00 pm)**
Friday, Oct. 28	**Registration (8:00 am to 3:30 pm)** **Overseas Papers (9:00 am)** **Manufacturing Committee Seminar (9:00 am)** **General Interest Paper (10:20 am)** **Mattiello Lecture (11:00 am)** **General Interest Session (2:00 pm)** **Roon Awards Papers (1:30 pm)** **Annual Business Meeting (4:00 pm)** **Paint Show (9:00 am to 4:00 pm)**

Annual Meeting Dinner/Dance will be held Thursday, Oct. 27, at the Shamrock Hilton Hotel, beginning at 7:00 pm

Spouses' activities will begin with a wine and cheese social on Wednesday afternoon. Hospitality rooms will be maintained at both the Shamrock Hilton and the Astrovillage Hotels.

NOTE: Courtesy bus service will be provided between the Astrohall and participating hotels on a regular schedule basis on Tuesday, Wednesday, Thursday, and Friday. Special courtesy bus service will also be provided between the Shamrock Hilton and Astrovillage hotels on Wednesday and Thursday evenings. Schedules and route maps will be posted in the participating hotels and the Astrohall. Bus service provided courtesy of the Federation, Reichhold Chemicals, Inc., Shell Chemical Co., and Union Carbide Corp.

THURSDAY, OCTOBER 27

PAINT RESEARCH INSTITUTE SEMINAR
(9:00 — 12:00)

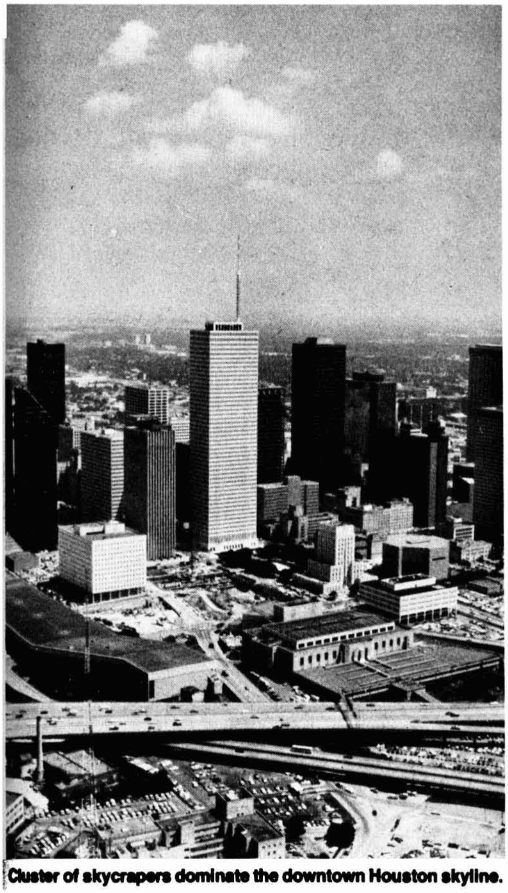
THE APPLICATION OF HYDRODYNAMIC VOLUME AND SWELLING THEORY TO THE CROSSLINKING OF LATEX PARTICLES—B. George Bufkin, of University of Southern Mississippi, Hattiesburg, Miss.

NEW DIMENSIONS IN THE STRUCTURE OF AUREOBASIDIUM PULLULANS — Richard E. Crang, of Bowling Green State University, Bowling Green, Ohio.

COATING POLYMERS WITH COVALENTLY-ATTACHED BIOCIDES — Charles U. Pittman, Jr., of University of Alabama, University, Ala.

ENVIRONMENTAL AFFAIRS
(9:00 — 11:00)

Panel of industry and government speakers will provide update on needs, limitations, and energy requirements as they apply to environmental considerations.



Cluster of skycrapers dominate the downtown Houston skyline.

FEDERATION EDUCATIONAL PROGRAM
(11:00 — 12:00)

WRITTEN TECHNICAL COMMUNICATION INVOLVES MORE THAN WRITING — Thomas J. Miranda, Clifford L. Tierney, and Robert E. Wilson, of Whirlpool Corp., Benton Harbor, Mich.

SOCIETY PAPERS
(2:00 — 4:30)

MILDEW DEFACEMENT OF COATINGS — C-D-I-C Society for Coatings Technology. Presented by John Schmitt, of The Ohio State University, Columbus, Ohio.

NMR STUDIES OF CARBOXYLIC-AMINE SALT DECOMPOSITION IN WATER DISPERSIBLE SYSTEMS — Detroit Society for Coatings Technology.

FACTORS IN THE LATEX COMPOSITION AFFECTING PAINT PERFORMANCE — Houston Society for Coatings Technology. Presented by William A. Wentworth, of Napko Corp., Houston, Texas.

INORGANIC PIGMENTS AND THEIR EFFECTS ON WATER-REDUCIBLE COATINGS SYSTEMS—Northwestern Society for Coatings Technology. Presented by Richard Johnson, of Cargill, Inc., Minneapolis, Minn.

IDENTIFICATION OF COLORED PIGMENTS IN COATINGS — Toronto Society for Coatings Technology. Presented by Peter Marr, of Reed-Pigments Div., Toronto, Ontario, Canada.

ROON PAPERS
(2:00 — 4:30)

IMPRESSED CURRENT CATHODIC PROTECTION AND ITS EFFECT ON MARINE PAINT SYSTEMS — M. H. Bingham and P. W. Munn, of Croda Paints Ltd., Berkshire, England.

REACTIONS OF DIETHYL MALONATE BLOCKED CYCLOHEXYL ISOCYANATE — Zeno W. Wicks, Jr. and Barry W. Kostyk, of North Dakota State University, Fargo, N. D.

AMINE SOLUBILIZERS FOR WATER-SOLUBLE ACRYLIC COATINGS — Zeno W. Wicks, Jr. and Gang-Fung Chen, of North Dakota State University, Fargo, N. D.

FLAT PAINT FORMULATION: STUDIES ON EXTENDERS — Julie P. Rudolph, of Sherwin-Williams Co., Chicago, Ill.

THE APPLICATION OF CRITICAL RELATIVE HUMIDITY, AN EVAPORATION ANALOG OF AZEOTROPY, TO THE DRYING OF WATER-BORNE COATINGS — Paul W. Dillon, of Union Carbide Corp., Tarrytown, N.Y.

ANNUAL MEETING DINNER/DANCE

7:00 pm — Shamrock Hilton Ballroom

FRIDAY, OCTOBER 28

OVERSEAS PAPERS

(9:00 — 10:20)

OIL ABSORPTION OF ORGANIC PIGMENTS — Walter Fibiger, of Canadian Hoechst, Ltd., Willowdale, Ontario, Canada. (Presented on behalf of Oil and Colour Chemists' Association.)

SOLVENT PLASTICIZED RESINS INTERACTION BY GAS-LIQUID CHROMATOGRAPHY — Giovanni Torriano, Trieste, Italy (Presented on behalf of FATIPEC: Federation of Associations of Technicians in the Paint, Varnish, Lacquer, and Printing Ink Industries of Continental Europe.)

MANUFACTURING COMMITTEE SEMINAR

(9:00 — 11:00)

HOW TO MAKE AN ENERGY SURVEY AT YOUR PLANT — Arthur J. Geib, of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

GENERAL INTEREST PAPERS

(10:20 — 11:00)

MICROVOID COATINGS: MATERIAL AND ENERGY SAVERS — Jerome A. Seiner, of PPG Industries, Inc., Allison Park, Pa.

GENERAL INTEREST SESSION

(2:00 — 3:30)

NONDESTRUCTIVE DETERMINATION OF ZINC PHOSPHATE COATING WEIGHTS USING SPECULAR REFLECTANCE INFRARED ABSORBANCE (SRIRA) — G. Dale Cheever, of General Motors Corp., Polymers Dept., Warren, Mich.

B-HYDROXYALKYLAMIDES — LOW POLLUTING CROSSLINKERS FOR CARBOXYL-CONTAINING POLYMERS — James Lomax and Graham Swift, of Rohm and Haas Co., Spring House, Pa.

UV CURABLE COATINGS — A FACTOR FOR ENERGY CONSERVATION — Joseph A. Vona, Charles B. Rybny, and David Armbruster, of Celanese Chemical Co., Summit, N.J.

MATTIELLO LECTURE

(11:00 — 12:00)

DISPERSION AND AGGLOMERATION: EFFECTS ON COATING PERFORMANCE — Dr. Walter K. Asbeck, Coatings Consultant, Westlake, Ohio.

ROON PAPERS

(1:30 — 4:00)

THE INTERNAL STRESS IN A SOLVENT-CAST THERMOPLASTIC COATING — S. G. Croll, of National Research Council of Canada, Div. of Building Research, Ottawa, Ontario, Canada.

ALKYL AND POLYOL SILICATE ZINC-RICH PRIMERS — Dean M. Berger, of Gilbert Associates, Inc., Reading, Pa.

RADICAL ANION QUENCHING BY EMULSION POLYMER COMPONENTS — Vincent D. McGinniss and Ann F. Kah, of Glidden Coatings and Resins Div. of SCM Corp., Cleveland, Ohio.

PIGMENT VOLUME CONCENTRATION EFFECTS IN COLOR PREDICTION AND PRACTICE — Robert Marcus and Jackie Walker, of PPG Industries, Inc., Pittsburgh, Pa.

A COMPARISON OF TENSILE AND MORPHOLOGICAL PROPERTIES WITH ABRASION RESISTANCE OF URETHANE FILMS — Robert M. Evans, of Mameco International, Cleveland, Ohio, and Joseph Fogel, of Tremco, Inc., Cleveland, Ohio.

ANNUAL BUSINESS MEETING

(4:00 — 5:00)

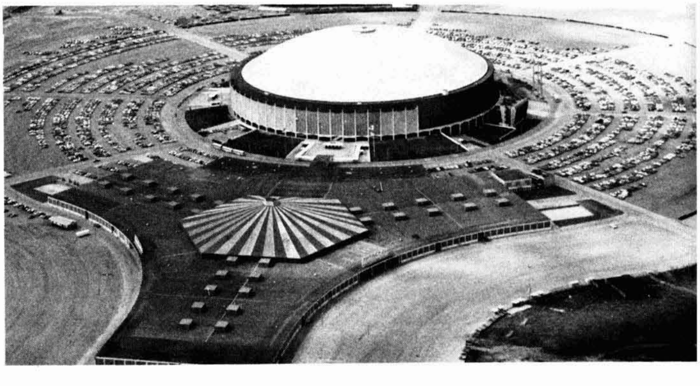
Annual Business Meeting of the Federation.

Presentation of these awards: American Paint Journal/A. F. Voss . . . . C. Homer Flynn . . . . Materials Marketing Associates . . . . Program Committee . . . . Roon Foundation . . . . Ernest T. Trigg.

Presentations to Federation Committee Chairmen, 1976-77.

Installation of Officers, 1977-78.

The Houston Astrohall, site of the 1977 Federation Annual Meeting and Paint Industries' Show, occupies 16 acres adjoining the famed Astrodome. The Y-shaped structure boasts the world's largest convention center on one level. Paint Show will be in area beneath striped roof section.



OTHER CONVENTION INFORMATION

Paint Industries' Show

The 42nd Annual Paint Industries' Show will run concurrently with the Annual Meeting in the Astrohall. The only national exposition of materials and equipment used in the formulation, testing, and manufacture of coatings, the Show will be open from Noon to 5:00 pm on Wednesday, October 26; 9:00 am to 5:00 pm on Thursday, October 27; and 9:00 am to 4:00 pm on Friday, October 28.

Participating supplier companies will have their top technical representatives on hand to discuss the latest developments with registrants at this year's event, the largest in Paint Show history.

Registration

Registration fees for the Annual Meeting and Paint Show are on a member and non-member basis:

	Member	Non-Member
Advance*	$35	$50
In Houston	$40	$55
One-Day	$20	$30

*Special for retired members only: Advance registration will be $15.

Registration form is included in this issue (see pages 29 and 30) and has also been mailed to all members.

Note: Purchase of dinner/dance tickets is optional for both advance and on-site registrations.

Annual Meeting Dinner/Dance

The annual Federation Dinner/Dance will be held on Thursday evening, October 27 at the Shamrock Hilton.

Tickets are $25 each, and include a steak dinner, music for listening and dancing by the Buddy Brock Orchestra, and a minimum of business formalities.

Housing

The Shamrock Hilton Hotel will serve as Federation headquarters during the Annual Meeting, with the Astrovillage hotels serving as co-headquarters. Blocks of rooms have been set aside at both and at other cooperating hotels.

Room Reservations

All requests for room reservations and suites must be made on the official housing form provided by the Federation.

Spouses Activities

A schedule of activities has been planned each day for spouses attending the Annual Meeting, and Hospitality Rooms will be maintained at both the Shamrock Hilton and Astrovillage Hotels, beginning Wednesday, October 26.

A get-acquainted Wine and Cheese Party is scheduled for Wednesday afternoon at the Shamrock Hilton.

On Thursday morning, continental breakfasts will be available at both hotels, preceding an all-day tour which will include a visit to the National Aeronautics and Space Administration facility and lunch at the Houston Yacht Club.

Continental breakfasts will be served again at both hotels on Friday, followed by a luncheon at the Shamrock Hilton.

Registration fees are $20 in advance and $25 on-site.

Post-Convention Tour

The Federation has completed arrangements with American Express Co. for a Post-Convention trip to Mexico City.

Literature covering the trip is available from Federation headquarters office or from American Express Co., 1710 J. F. Kennedy Blvd., Philadelphia, Pa. 19103.

NPCA Meets Same Week

The National Paint and Coatings Association will hold its Annual Meeting from October 24-26 at the Hyatt Regency Hotel in downtown Houston.

NPCA badges will be honored for admission to the Federation Annual Meeting and Paint Show on Wednesday, October 26.

Shuttle Bus Service

Free bus transportation will be provided between the Astrohall and various cooperating hotels for the Annual Meeting and Paint Show, beginning on Tuesday, October 25.

Airport/Hotel Transportation

Limousine and taxi service from the Houston Intercontinental Airport to the Astrodomain and Shamrock Hilton Hotel is readily available.

Air Coach Express Airport Transportation provides limousine service to and from the Airport on a 24-hr basis, every 30 to 45 minutes, depending on the time of day. One-way fare is $4.50; round trip is $8.50.

Taxi service is available from Yellow Cab Co. at a flat rate of $15 each way. Their "Share-A-Cab" program enables up to five persons to ride together at the $15 rate.

Council Meeting

The Fall Council Meeting of the Federation will be held Tuesday, October 25, at the Shamrock Hilton Hotel.

Speakers' Breakfasts

A breakfast and briefing for each day's program participants will be held in the Astrohall on Wednesday, Thursday, and Friday.

Publication of Papers

The Journal of Coatings Technology has prior rights to the publication of all papers presented at the Annual Meeting.

Program Steering Committee

Chairman—Elder C. Larson, of Shell Development Co., Houston, Texas.

Vice-Chairman—Fred G. Schwab, of Coatings Research Group, Inc., Cleveland, Ohio.

Morris Coffino, of D. H. Litter Co., New York. N.Y.

William F. Holmes, of DeSoto, Inc., Garland, Texas.

William A. Wentworth, of Napko Corp., Houston, Texas.

Meetings Committee

Members of the Houston Society for Coatings Technology are serving on the Meetings Committee under General Chairman Robert J. Klepser, of PPG Industries, Inc.

Chairing the various Subcommittees are:

Program Operations—Ken Confer, of Cook Paint and Varnish Co., Houston, Texas.

Information Services—Charles Lundquist of Ribelin Distributors, Inc., Houston, Texas.

Entertainment—Gordon Schreiner, of Gulf States Paint Co., Houston, Texas.

Publicity—Glenn W. Holladay, of Pfizer, Inc., Houston, Texas.

Ladies' Program—Mrs. S. G. (Betty) Hays and Mrs. Paul (Fran) Crozier.

1977 Paint Industries' Show Exhibitors

Houston Astrohall • October 26-28

Abbott Labs., Chem. Div.
Air Products & Chemicals, Inc.
Alcan Metal Powders
Alpine American Corp.
C.M. Ambrose Co.
AMF Cuno Div.
American Nepheline Corp.
Amoco Chemicals Corp.
AMSCO Div., Union Oil Co. of Calif.
Applied Color Systems, Inc.
ASARCO Incorporated
Ashland Chemical Co.
Atlas Electric Devices Co.

B.A.G. Corp.
BASF Wyandotte Corp.
Bennett's Colorant Div.
B.I.E. Instruments, Inc.
Big H Equipment Corp.
Brookfield Engineering Labs, Inc.
Buckman Laboratories, Inc.
Byk-Mallinckrodt Chem. Prod. GmbH

Cabot Corp., Cab-O-Sil Div.
Cargill, Inc., Chem. Products Div.
CDI Dispersions
Celanese Chemical Co.
Celanese Polymer Specialties Co.
Chicago Boiler Co.
Cities Service Co., Columbian Div.
Color Corp. of America
Cosan Chemical Corp.

Daniel Products Co.
Degussa, Inc.
Diamond Shamrock, Process Chems. Div.
Diano Corp.
D/L Laboratories
Dresser Minerals

Eastman Chemical Products, Inc.
Ebonex Corp.
Ecar Products, Inc.
Engelhard Minerals & Chemicals Corp.
Epworth Mfg. Co., Inc.

Filter Specialists, Inc.

GAF Corp.
Gardner Laboratory, Inc.
Paul N. Gardner Co.
General Mills Chemicals, Inc.
W.R. Grace & Co., Davison Chem. Div.

Halox Pigments
Harshaw Chemical Co.
Henkel, Inc.
Hercules Incorporated
Hooker Chemicals & Plastics Corp.
J.M. Huber Corp.
Hunter Associates Laboratory, Inc.

IBM - Instrument Systems
IMC Chemical Group, Inc.
IMC Industry Group, Inc.
Impandex, Inc.
Interstab Chemicals, Inc.

Johns-Manville

Kelco, Div. of Merck & Co., Inc.
Kenrich Petrochemicals, Inc.
Kerr-McGee Chemical Corp.

Labelette Co.
Leneta Co.

MacBeth Div., Kollmorgen Corp.
Malvern Minerals Co.
Manchem Limited
Mateer-Burt Co.
Meadowbrook Corp.
Merck Chemical Div.
Mini Fibers, Inc.
M&M Machine, Inc., Vorti-Siv Div.
Modern Paint & Coatings
Montedison USA, Inc.
Morehouse Industries, Inc.
Myers Engineering

Nalco Chemical Co.
Neville Chemical Co.
N L Industries, Inc.
New Way Packaging Machinery, Inc.
Netzsch Brothers, Inc.

Penn Color, Inc.
Pennsylvania Glass Sand Corp.
Pfaudler Co., Div. Sybron Corp.
Pfizer MPM Div.
Polyvinyl Chemical Industries
PPG Industries, Inc.
Premier Mill Corp.
Premier Paint Roller Mfg. Co.
Productos de Zinc y Plomo, S.A.

Q-Panel Co.

Reichard Coulston, Inc.
Reichhold Chemicals, Inc.
Rohm and Haas Co.
Russell Finex, Inc.

Sales y Oxidos, S.A.
Sanyo-Kokusaku Pulp Co., Ltd.
Shell Chemical Co.
Sherwin-Williams Co.
Silberline Mfg. Co., Inc.
Spartan Color & Chemical
Spencer Kellogg Div., Textron, Inc.
Sun Chemical Corp., Pigments Div.
Synres Chemical Corp.

TAMMSCO, Inc.
Tenneco Chemicals, Inc.
Tokheim Corp.
Torco Engineered Prods. Div.
Troy Chemical Corp.

Union Camp Corp.
Union Carbide Corp.
Universal Color Dispersions

R.T. Vanderbilt Co., Inc.
Viking Pump Div., Houdaille Ind., Inc.

Warren Rupp Co.
Wilden Pump & Engineering Co.

COOPERATING HOTELS AND MOTELS
FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
WEEK OF OCTOBER 24, 1977

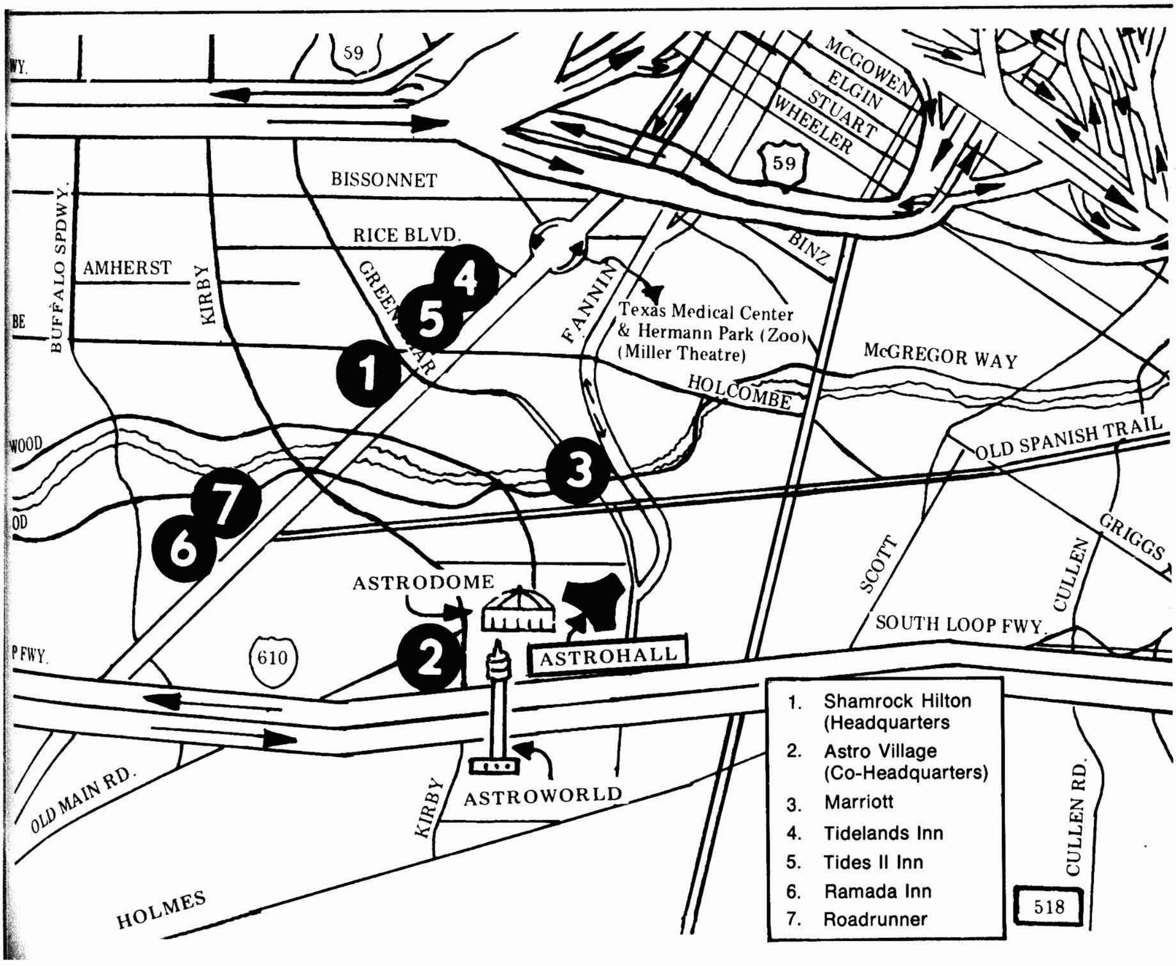
ROOM AND SUITE RATES

(6% City Tax additional)

Hotel	Code	# on Map	Single	Double	Twin	Parlor & 1 BR	Parlor & 2 BR
Shamrock Hilton (Headquarters)	SH	1	$34-46	$46-58	$46-58	$120-190	$200-500
Astro Village (Co-Headquarters)	ASVI	2	27-35	30-39	33-39	90-100	125-135
Marriott (Will require a deposit after your reservation has been confirmed)	MMH	3	32-42	42-52	42-52	75-100	125-250
Tidelands Inn	TLM	4	20-25	24-28	25-29	55-65	
Tides II Inn	TLII	5	20-25	24-28	25-29	55-65	
Ramada Inn	RID	6	18	23	25		
Roadrunner	RRMM	7	12-17	12-17			
Hyatt Regency (NPCA Hdqrs)	HR	Not Shown	42-48	52-54	50	100	190-250

The Hyatt Regency is located in center city Houston, about five miles from Astrohall. No Federation housing will be available at this hotel until Wednesday, October 26, 1977

SPECIAL CONVENTION BUS SERVICE WILL BE PROVIDED BETWEEN THE ASTROHALL AND THE COOPERATING HOTELS (EXCLUDING THE HYATT REGENCY)



FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
1977 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW

FOR HOUSING BUREAU USE ONLY

MAIL TO:

FEDERATION
HOUSING BUREAU
1006 MAIN – SUITE 1101
HOUSTON, TEXAS 77002

ASTROHALL, HOUSTON, TEXAS
OCTOBER 26, 27, 28, 1977

OFFICIAL HOUSING REQUEST FORM

• *PLEASE READ CAREFULLY* •

– PLEASE PRINT OR TYPE ALL ITEMS TO ASSURE ACCURACY.
– COMPLETE EACH PART BELOW IN DETAIL FOR CORRECT AND RAPID COMPUTER PROCESSING.
– SHOULD MORE THAN THREE (3) ROOMS BE NEEDED, SUPPLEMENTAL ROOM LIST MUST BE ATTACHED USING SAME FORMAT AS IN PART III. (See other side.)
– ALL CONFIRMATIONS WILL BE SENT TO INDIVIDUAL INDICATED IN PART I.

PART I

INSTRUCTIONS: Complete requested data using abbreviations as necessary.

(NAME OF PERSON REQUESTING ROOM/S)

(FIRST NAME) (LAST)

(NAME OF COMPANY OR FIRM)

(STREET ADDRESS OR P. O. BOX NUMBER)

(CITY) (STATE) (ZIP – U.S.A.)

(COUNTRY) (Area Code) (PHONE NUMBER)

PART II

INSTRUCTIONS: Select THREE Hotel/Motels of your choice. No request will be processed without THREE choices.

FIRST CHOICE ☐ ☐ ☐ ☐ (HOTEL CODE)
SECOND CHOICE ☐ ☐ ☐ ☐ (HOTEL CODE)
THIRD CHOICE ☐ ☐ ☐ ☐ (HOTEL CODE)

PART III

INSTRUCTIONS:
1. PRINT OR TYPE NAMES OF ALL PERSONS OCCUPYING EACH ROOM.
2. SELECT TYPE ROOM DESIRED WITH ARRIVAL AND DEPARTURE DATES.
3. SUPPLEMENTAL LIST FOR ADDITIONAL ROOM MUST USE SAME FORMAT. (See other side.)
4. PRINT OR TYPE LAST NAME FIRST.

	GUEST NAME/S (PRINT LAST NAME FIRST)	P+1 – Parlor & one bedroom	P+2 – Parlor & two bedrooms
ROOM NO. 1	1.	CHECK ONE	ARR. DATE ______ DEP. DATE ______
	2.	☐ SINGLE ☐ P+1	ARRIVAL TIME ______ ☐ AM ☐ PM (Check One)
	3.	☐ DOUBLE	**NOTE:** ROOM WILL NOT BE HELD AFTER 6 P.M. UNLESS PAYMENT IS GUARANTEED FOR FIRST NIGHT. HOTEL MAY REQUIRE DEPOSIT.
	4.	☐ TWIN ☐ P+2	
ROOM NO. 2	1.	CHECK ONE	ARR. DATE ______ DEP. DATE ______
	2.	☐ SINGLE ☐ P+1	ARRIVAL TIME ______ ☐ AM ☐ PM (Check One)
	3.	☐ DOUBLE	**NOTE:** ROOM WILL NOT BE HELD AFTER 6 P.M. UNLESS PAYMENT IS GUARANTEED FOR FIRST NIGHT. HOTEL MAY REQUIRE DEPOSIT.
	4.	☐ TWIN ☐ P+2	
ROOM NO. 3	1.	CHECK ONE	ARR. DATE ______ DEP. DATE ______
	2.	☐ SINGLE ☐ P+1	ARRIVAL TIME ______ ☐ AM ☐ PM (Check One)
	3.	☐ DOUBLE	**NOTE:** ROOM WILL NOT BE HELD AFTER 6 P.M. UNLESS PAYMENT IS GUARANTEED FOR FIRST NIGHT. HOTEL MAY REQUIRE DEPOSIT.
	4.	☐ TWIN ☐ P+2	

IMPORTANT NOTICE

ANYONE REQUESTING ACCOMMODATIONS AT THE SHAMROCK HILTON HOTEL (HEADQUARTERS) WILL BE LIMITED TO A MAXIMUM OF FIVE UNITS (FIVE ROOMS-OR-ONE PARLOR AND FOUR BEDROOMS). ADDITIONAL ROOM REQUESTS WILL BE ASSIGNED TO OTHER COOPERATING HOTELS. PAINT SHOW EXHIBITORS WILL RECEIVE PREFERENCE IN ALLOCATION OF SUITES.

SAVE TIME AND $$$, TOO!!

REGISTER NOW

Annual Meeting and Paint Show

October 26-28

Houston, Texas

USE ADVANCE REGISTRATION FORM ON REVERSE SIDE OF THIS PAGE

You can pre-register for the 1977 Annual Meeting and Paint Show by completing this advance registration form and mail with your check to FSCT headquarters. Your registration badge can be picked up at the Advance Registration desk in the Astrohall.

REGISTRATION FEES

	Member	Non-Member	Ladies' Activities
Advance*	$35	$50	$20
On-Site (Full-Time)	$40	$55	$25
On-Site (One-Day)	$20	$30	—

Note: You save $5.00 by registering in advance.

***Special registration for Retired Federation Members $15.00 in advance only.**

To register in advance for the 1977 Annual Meeting and Paint Show, please fill in the adjacent form and return with your remittance, to:

Federation of Societies for Coatings Technology
Suite 832
1315 Walnut Street
Philadelphia, Pa. 19107

Forms must be received by October 14.

Federation Dinner Dance

Thursday, October 27

Shamrock Hilton Hotel

Purchase of Dinner Dance tickets is optional this year, and is not part of advance registration. Please check square and send additional $25 if you wish to attend.

Dinner Dance ($25) (Per Person) ☐

Note: Emphasis will be on socializing.
Business formalities will be kept to minimum.
Ticket includes a steak dinner, entertainment and dancing.

PLEASE PRINT EXACTLY as you wish registration badge prepared

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CARB Adopts Standard on Solvent Coatings

A proposed model rule for architectural coatings which contain organic solvents was adopted by the California Air Resources Board at its July 7 meeting in Los Angeles. Initial provisions of the rule would take effect one year after adoption by the individual pollution control districts.

The standard adopted by CARB is somewhat less restrictive than the revised regulation issued in early June, which in turn was significantly different from the regulation first proposed in March of this year (see April and May issues of JCT).

Paint industry representatives, including members from the Los Angeles and Golden Gate Societies, NPCA, and local Coatings Associations, had worked over many months to present their views on the controversial CARB proposals, and the modifications reflected in the adopted version are due in large measure to their efforts.

Nevertheless, the proposed model rule as adopted provides stringent limitations on the sale and application of solvent-containing architectural coatings in California. By CARB definition, an architectural coating is any coating "applied to stationary structures and their appurtenances, to mobile homes, to pavements, or to curbs."

The revised standard lists 12 categories of coatings which are exempt from its provisions until 5 years after adoption. These are: (1) varnishes, lacquers, or shellacs; (2) semi-transparent stains; (3) opaque stains on bare redwood, cedar, mahogany, and douglas fir; (4) primers, sealers, or undercoaters; (5) wood preservatives; (6) fire retardant coatings; (7) tile-like glaze coatings; (8) waterproofing coatings, except bituminous pavement sealers; (9) industrial maintenance finishes; (10) metallic pigmented coatings; (11) swimming pool coatings; and (12) graphic arts coatings.

With the exception of these 12 exempt categories, no architectural coating manufactured after one year from date of adoption may be offered for sale or application which: (a) contains more than 250 grams of volatile organic material per liter of coating as applied, excluding water, except as provided in subsection b; (b) contains more than 350 grams of volatile organic material per liter of coating as applied, excluding water, and is recommended solely for use on interior surfaces. Interior coatings manufactured after three years from date of adoption may not contain more than 250 grams of volatile organic material per liter of coating as applied, excluding water; (c) is recommended for use as a bituminous pavement sealer, unless it is an emulsion type coating.

Small paint manufacturers have an extra year to comply with the provisions of the standard. A small manufacturer, as defined by CARB, is any business which in 1976 sold less than 200,000 gallons of paints and coatings.

Provisions of the adopted rule would not apply to architectural coatings supplied in containers having capacities of one liter or less, or to traffic coatings applied to public streets and highways.

Containers for products subject to solvent limitations are required to display either date of manufacture of the contents or a code indicating the dates of manufacture.

The standard adopted by CARB must be approved by the individual air pollution control districts in California, and there are indications that some districts may seek more stringent regulations. William Simmons, Air Pollution Control officer from San Diego, for example, says he believes the paint industry possesses the technology to immediately lower the allowable limits of volatile organic materials to 250 grams per liter for interior and exterior semi-gloss products and to 100 grams per liter for interior and exterior flat products, and he may recommend that his district adopt a much more stringent standard.

NPCA Establishes Committee For Small Paint Manufacturers

The Small Paint Manufacturers Steering Committee has been formed by the National Paint and Coatings Association to meet the needs of smaller member companies.

The term "small paint manufacturer" means an annual sales volume of three million dollars and under. Approximately 400 class A members of NPCA are in this category.

Preliminary Committee goals and objectives are:

(1) To isolate and communicate new and existing information to aid small paint manufacturers;

(2) To promote the exchange of ideas among small paint manufacturers;

(3) To deal with problems specific to small paint manufacturers;

(4) To provide guidance and counsel to other NPCA committees, the Board of Directors and staff.

The committee pledge is to provide meaningful, useful, updated information to all small paint manufacturers. In a survey taken last year of NPCA's 400 small paint manufacturers, the following were noted by respondents as areas where help is needed: (1) operating costs; (2) interpretation of government regulations; (3) efficient production methods; (4) marketing strategies; (5) management strategies; (6) manufacturing plant goals.

Other areas listed as needing attention were: energy, productivity, solvent reduction, solid waste, corrosion and its prevention.

NPCA Coatings Conference to Focus on End-User

The 1978 Chemical Coatings Conference of the National Paint and Coatings Association, to be held May 10-11 at the Convention Center, Cincinnati, Ohio, will direct its program towards customer-oriented subjects and provide expert information on product finishes and finishing.

Serving as Conference General Chairman will be Dr. C. Robert Hiles, of Lilly Industrial Coatings, Inc., while John L. Armitage, of John L. Armitage & Company will be Vice-Chairman of the Program Committee.

The first day's agenda will include a half-day general session covering ecology, energy, and economics.

Concurrent sessions for the remainder of the conference will feature the following subjects:

"Water-Borne Coatings"—Chairman Richard J. Anderson, of DeSoto, Inc.

"High Solids Coatings"—Chairman Jack S. Harrison, of E.I. du Pont de Nemours & Co., Inc.

"Electrocoatings"—Chairman Arne C. Lindholm, of Glidden-Durkee Div., of SCM Corp.

"Powder Coatings"—Chairman Francis P. McKiernan, of M & T Chemicals, Inc.

"Radiation Cured Coatings"—Chairman Ralph S. Michael, Jr., of PPG Industries, Inc.

Details on registration, speakers, and presentations will be available at a later date.

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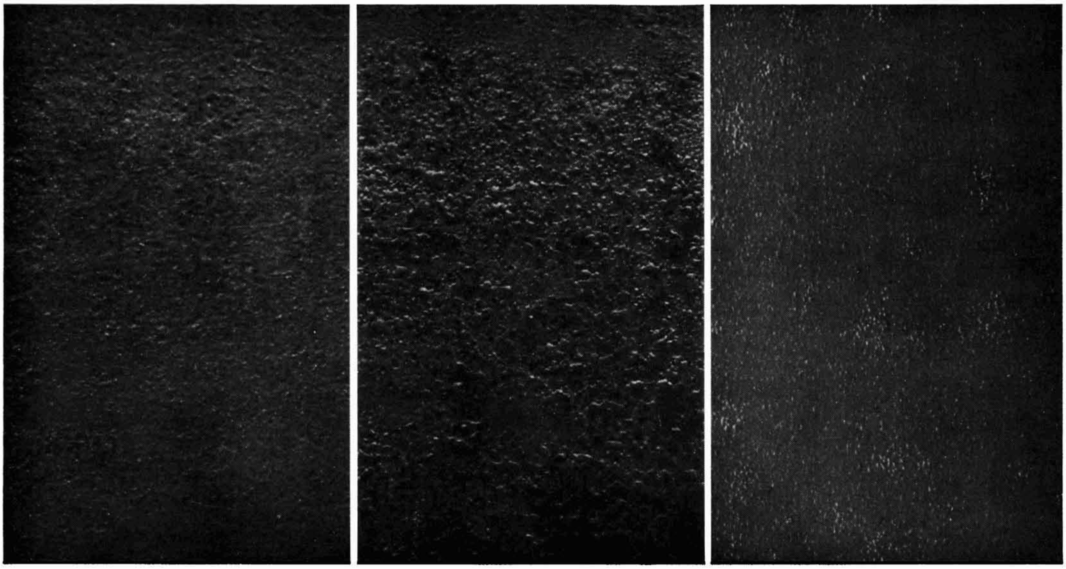


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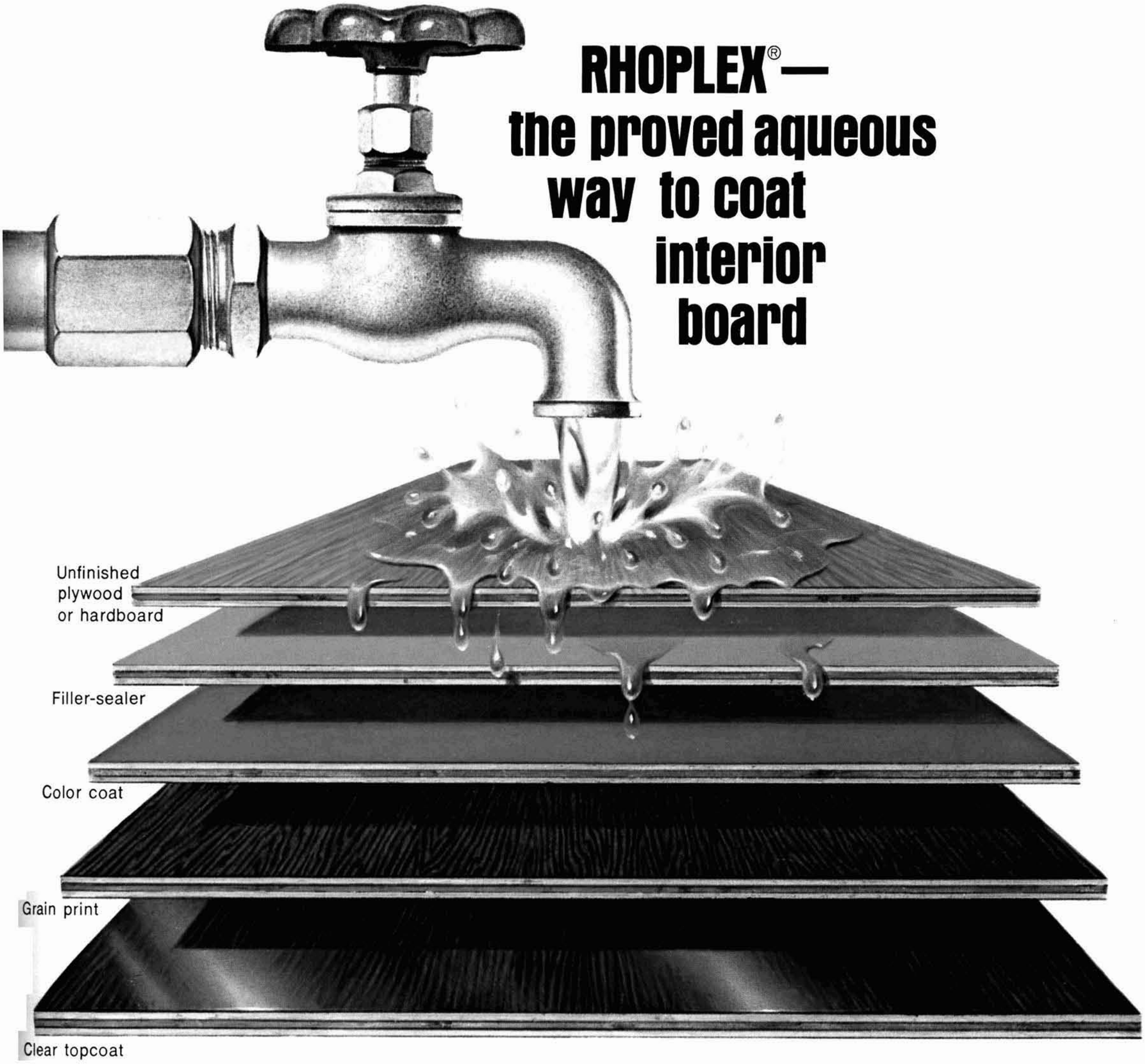

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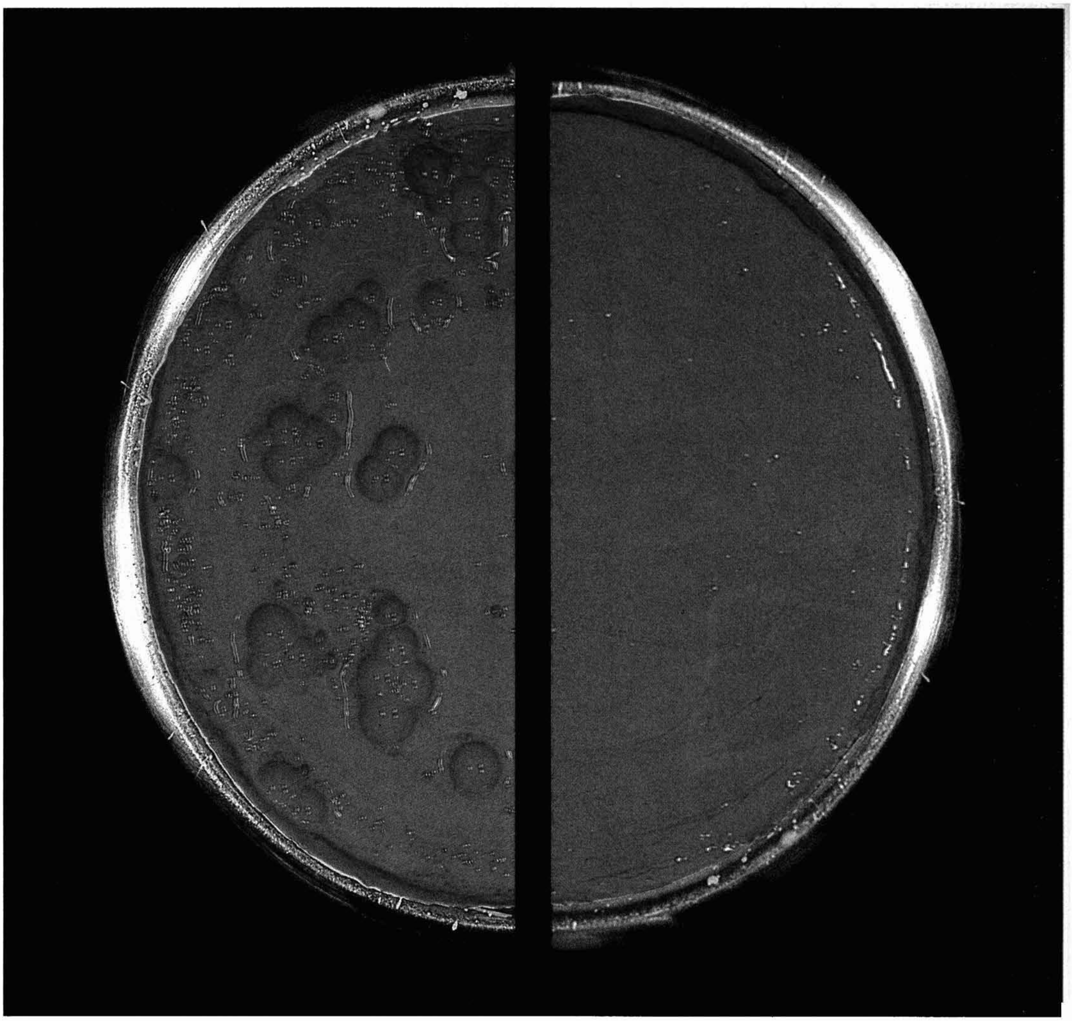

PRI Paint Research Institute
of the Federation of Societies for Coatings Technology

PROCEEDINGS/NUMBER 126

Report of the Research Director

Raymond R. Myers
Research Director, Paint Research Institute

INTRODUCTION

The following is an abstract of my 1976 report to the Federation on the year's PRI-sponsored research activities. The essence of the report is given here in terms which we hope will make for fast reading by busy paint chemists and executives who want to keep abreast of what is going on. Since this is the first time the report has been presented in this way, background information has been interwoven where needed to make the story of each program as self-sufficient as possible.

The full report is still available to interested readers. Requests for copies should be sent to the writer at Kent State University, Kent, Ohio 44242.

Four categories of Trustee-directed research activities were in progress during 1976. These were: (1) Mildew Defacement; (2) Water-Borne Systems and Principles; (3) Corrosion; and (4) Hiding. Of these categories mildew studies took 32% of our research dollar; water-borne systems and principles, 31%; corrosion, 26%; and the hiding grant, which has now been terminated, 11%.

REPORT ON GRANT PROGRESS

MILDEW DEFACEMENT

The driving force behind this program was the urgent need of the paint industry to find ways of controlling mildew growth without resorting to the use of conventional mercury compounds. These are too toxic for unrestricted use and lose some of their potency as the paint film ages. It was reasoned that if the life processes of the mildew microorganisms were thoroughly understood, there would be a good chance of finding ways to interrupt growth at an early stage.

Mildew defacement is not the work of a single species of fungus. It is apparently the result of a succession of organisms. While the "black yeast" fungus, *Aureobasidium pullulans,* accounts for 80-95% of the ultimate mildew composition on painted surfaces, it is not an early invader of the film. *Aspergillus* sp. and *Alternaria* sp. are the primary early colonizers and there is evidence that their presence is helpful to the establishment of *A. pullulans* as the dominant fungus. The spores of this organism are found in most soils and are easily dispersed by air currents and human activity. Regardless of whether *A. pullulans* is the root cause of the problem, it is implicated so firmly that any knowledge of its growth habits is bound to be helpful.

Low molecular weight nutrient appears essential for fungal growth. If it is not present in the form of organic-rich dirt or material exuded from the substrate, it must be manufactured either by ultraviolet degradation of the paint film on exposure or by the degradative action of enzymes produced by the invading organisms. Since the standard acrylic paint used in these studies contained the usual hydroxyethyl cellulose thickener, and since most species of mildew microorganisms produce cellulase enzymes, the thickener is suspected of being the focus of fungal attack.

In this program the successional patterns, growth habits, nutrient requirements, enzymology and ultrafine structure of the organisms are being probed for weak spots that can be exploited to inhibit mildew growth.

No. 50Mi—Successional Ecology of *A. Pullulans* and Other Organisms

SITE: Ohio State University
PRINCIPALS: John A. Schmitt and David Padgett
MONITORS: H.L. Fenburr, M. Goll, L.P. Larson, and H.D. Snyder.

Dr. Schmitt and PRI Fellow David Padgett uncovered evidence that the dominant organism in mildew, *A. pullulans,* requires the presence of pre-invading organisms (fungi and bacteria) in order to propagate itself. When a panel of acrylic paint (containing a cellulosic thickener) was inoculated with *A. pullulans,* the fungus would not grow in the absence of added nutrient. *A. pullulans,* for some reason not yet fully understood, even though it is capable of producing cellulase and other enzymes, cannot manufacture the nutrients it needs and must depend on other coexisting microorganisms to do the job for it.

This important observation suggests that the attack on mildew need not necessarily be aimed directly at *A. pullulans.* The vulnerability of the supporting organisms may be equally important, since without them the chief offender is suppressed. This emphasizes the need to understand the conditions and mechanism of growth of all the involved species.

We are still in the data-gathering stage of mildew research and cannot specify all the conditions of growth for any species. However, it is possible to state that there are natural successions of organisms on a typical painted surface. In order to exploit this knowledge we must be able to recognize, classify, and explain the various patterns. Dr. Schmitt's renewal grant is designed to continue the classifying process.

Concurrently, other programs, sparked by questions raised in this project, are going on under PRI grants at other universities.

No. 56Mi—Biological Factors Which Influence Mildew-Induced Defacement of Organic Coatings

SITE: Fairleigh Dickinson University
PRINCIPALS: Harvey Winters, P. Neal, R. Bogossian, and I. Isquith
MONITORS: F.W. Arbir, F.G. Schwab, W. Singer, R.A. Smith, and J.P. Teas.

Dr. Winters is conducting enzymology research which, coupled with the studies at Ohio State University, should furnish some answers as to why certain organisms flourish initially and then give way to succeeding organisms that finally are dominated by *A. pullulans*.

Dr. Winters found that the early invaders and *A. pullulans* alike produce cellulase enzymes. This fact suggests that they should all be capable of hydrolyzing and degrading cellulosic materials (such as the thickener in acrylic paints) to nutrient-size molecules. It seems significant that while the enzymes isolated from *A. pullulans* were not inhibited by culture filtrates of the early invaders, definite inhibition was observed when the test was reversed. This difference in resistance to inhibition of the two sources of enzyme may provide a partial explanation of the dominance of *A. pullulans* on a paint film. Another part of the answer may be contained in the observation that the enzymes from *A. pullulans* can hydrolyze the cell walls of competing organisms and thus inhibit their growth.

Since cellulases are produced by all of the involved fungi, the cellulose thickener in the paint is implicated as a source of nutrient through enzymatic break-down to simpler carbohydrates. Both polysaccharides and hexose sugars were found as products of some of the early invaders. The hexoses are perhaps small enough in molecular size to be metabolized directly by *A. pullulans*. Perhaps, however, the function of the preinvading fungi is not entirely biological. The polysaccharides may act as a "glue" for attachment of nutrient and fungus spores to the paint surface.

This project runs until October 1977. A decision as to what the next step should be awaits publication and review of the data gathered thus far. It is clear, however, that one good lead to a successful attack on mildew may be to interfere with cellulase formation.

No. 57Mi—The Preparation of Mildew Metabolites, and Their Degradation of Paints. Preparation of a Paint Polymer Which "Fights Back."

SITE: University of Alabama
PRINCIPALS: Charles U. Pittman and G. Allan Stahl
MONITORS: M. Goll, R. Lalk, H. Lowrey, W. Machemer, D. Russell, S. Sanfilippo, and J. Williams

At the original encounter session on mildew defacement (see MIDOC Journal of Coatings Technology *43*, No. 558, 1971), Dr. Jack Richards, suggested the development of a polymer molecule that fights back at an invading organism. The principle involved is to bind mildewcidal groups chemically to the polymer molecule. As the enzymes released by the fungi break down the polymer to nutrient-size molecules the toxic moieties are set free. Thus the organism's diet is its undoing.

The advantages of such a system are its presumed low toxicity to humans and its retained effectiveness in the film. Chemical bonding of the fungicidal groups should eliminate the problems of leaching and evaporation.

This project ultimately was undertaken at PRI request by Dr. Pittman and his Postdoctoral Fellow, G. Allan Stahl. Impetus was lent to the program by the fact that the U.S. Navy had just created a class of organotin-grafted polymers that were useful against barnacles in anti-fouling paints on ship bottoms.

Since the enzymes released by mildew-type fungi are likely to be hydrolytic in nature, Dr. Pittman reasoned that the fungicidal group should be attached to the polymer via a hydrolyzable linkage (e.g., that of an ester). The acrylate of the biocidal compound, 8-hydroxyquinoline, was copolymerized with ethyl acrylate and vinyl acetate to produce a series of fungicidal polymers. These are currently under test for biocidal activity as Ohio State University. Other conventional fungicides such as Dowicide 7 (pentachlorophenol) have been incorporated in polymers in a similar manner. It is recognized, of course, that these test polymers are not finalized compositions for use in practical paints.

Dr. Stahl gave a preliminary report on this research at the 1976 Federation Annual Meeting. This report was updated by Dr. Pittman at the 1977 PRI spring symposium on mildew. The work is continuing, and while it is too early to draw any firm conclusions, the outlook is most promising.

No. 60Mi—Ultrastructural Analyses of *Aureobasidium Pullulans* and Localization of Inhibitory Agents

SITE: Bowling Green State University
PRINCIPALS: Richard E. Crang and David G. Pechak
MONITORS: H. Beeferman, H.L. Fenburr, S. Lauren, S.T. Bowell, and H. Poth

A major objective of this project was to determine the effect of a typical mildewcide, phenyl mercury acetate, on the growth of *A. pullulans,* and locate the sites in the fungus structure where the mercury accumulates and performs its lethal function. Such information should be useful in pinpointing the vulnerable spots in the life process of the organism and aid in designing more effective ways of controlling mildew growth.

Using electron-microscopic techniques which make readily visible the ultrafine structure of both the surface and the interior of mildew organisms, and combining these with an X-ray method for detecting the presence of metals, Crang and Pechak undertook to follow the course of the mercury into the organism and determine its effect on the growth pattern.

A. pullulans, grown on the surface of a standard acrylic latex paint in the presence of phenyl mercury acetate showed definite structural abnormalities, but no accumulation of mercury could be found localized in any particular part of the cells. However, the target sites for the mercury are apparently the cell membranes. The cells look "sick." In comparison with healthy cells their surface outline is less distinct, there is a thickening of the walls, and filament growth is suspended. The respiratory systems (mitochondria) are also swollen and there is evidence of less nutrient transport, less lipid production, and less enzyme activity. A slime formation was also noted.

This work is continuing. Results to date were reported in a paper presented at the 1977 PRI spring symposium on mildew.

No. 61Mi—Role of *Aureobasidium Pullulans* in the Deterioration and Disfigurement of Paint Films

SITE: State University of New York, Syracuse
PRINCIPALS: Robert A. Zabel and Fred Terracina
MONITORS: E.F. Gola, M. Goll, R.T. Ross, and J.P. Teas

Dr. Zabel is interested in elucidating the role of the wood substrate at various moisture levels in the propagation of *A. pullulans* on painted surfaces. Whereas other investigators have found that *A. pullulans* will not grow by itself on virgin acrylic paint films over glass, Dr. Zabel found it will grow well on painted wood surfaces provided the moisture content of the wood exceeds 90% of the original dry weight. At a wood-moisture content of 210% *A. pullulans* growth was rapid and severe and a measurable film deterioration (4% weight loss) was observed over a six-week period.

A. pullulans grows in the hyphal form (the form in which it puts out tubular, hair-like extensions) on both wood and paint. On paint the extensions (hyphae) are shown under the electron microscope to invade microcavities in the film. On wood the hyphae concentrate in the rays, around resin canals and in pits. Their presence is accompanied by secretion of slime.

Currently Dr. Zabel is engaged in studying the toxic threshold of various cellulase enzyme inhibitors. If enzyme production could be stopped, the organism would be deprived of the mechanism by which it prepares nutrient from polymeric materials.

This program is being extended for an additional 12 months to June 1978. Dr. Zabel presented a paper on his research at the 1977 PRI spring symposium on mildew.

WATER-BORNE SYSTEMS AND PRINCIPLES

No. 13Ba—Film Formation and Curing

SITE: Kent State University
PRINCIPALS: Raymond R. Myers, Milton Manes, Thomas H. Richert, and Carl Knauss
MONITORS: W.K. Asbeck, D.M. Gans, C.A. Kumins, O.C.C. Lin, and J.S. Dodge

Last year, work initiated earlier on the measurement of diffusion rates of solvent vapors through polymeric films was continued. In this connection a unique type of microbalance has been developed. This device operates on the principle that a change in mass on the surface of a quartz crystal causes a corresponding change in the natural oscillating frequency of the crystal. This device is much more sensitive and convenient to operate than any microbalance based on gravity.

To measure solvent vapor diffusion, the crystal is coated with an extremely thin film of coating material and placed in a controlled-temperature enclosure equipped with means for introducing or removing solvent. Solvent uptake or loss is measured by changes in the vibrational frequency of the crystal. This technique permits a much more rapid determination of diffusion constants than conventional methods. It has obvious application to the study of solvent retention in films and the permeability of films to water vapor and corrosive gases.

This grant has been extended to June 1978. In the coming months, attention will be given to the application of instrumental techniques to the solution of practical problems. The first of these will be to study film formation and drying of alkali-neutralized acid-bearing film-formers. The Torsional Braid Analyzer, the Ultrasonic Impedometer, the Quartz Microbalance and kinetic rheometry, all developed under PRI grants, will be used in this study wherever applicable and appropriate.

No. 36Ba—Rheological Properties of Uniform Latexes

SITE: Case Western Reserve University
PRINCIPALS: Irvin M. Krieger and Li-Jen Liu
MONITORS: D.M. Gans, J.L. Gardon, R.W. Kreider, G.K. Korpi, M.J. McDowell, A. Schejtman

The rheology, including electroviscous effect, of a latex determines to a large extent how it will perform. Uniform particle size is a requirement in a fundamental study of rheology. Controlled surface charge density of the particles is essential to a study of electroviscous effect. Particles which are uniform in size and carry chemically bound surface charges result in stable latexes by virtue of mutual repulsion of charges.

Li-Jen Liu, the Research Fellow working under Dr. Krieger on this project has succeeded in making latexes with chemically bound surface charges by carrying out the polymerizations in the presence of small amounts of sulfonated comonomer. Variations in surface charge density are achieved by using sulfonate-bearing free radicals as initiators. In order to maintain better control over the charges, surfactant-free polymerization recipes were employed. The incorporation of ionic comonomers makes it possible to achieve stability with such recipes. A range of particle sizes and surface charge densities, both positive and negative, has been achieved with polystyrene. The studies should now be extended to acrylic monomers.

One possible advantage to the paint formulator in using surfactant-free latexes containing ionic groups is that they permit a lower total surfactant content in the final paint. This fact suggests the possibility of better water resistance, but whether any improvement can be realized in practice remains to be seen. Also, surface-charged latexes should be amenable to electrodeposition. In this connection the cationic latexes should be of interest.

This project terminated June 1977, but Dr. Krieger has been asked to submit a new proposal emphasizing those aspects of more immediate interest to the paint industry.

No. 46Ba—The Investigation of Block Copolymers From Macroradicals

SITE: University of Houston
PRINCIPALS: Raymond B. Seymour and David P. Garner
MONITORS: B.P. Goodman, J.H. Sample, R.W. Tess, and W.A. Wentworth

Block and graft copolymers generally have a better balance of such film properties as hardness, flexibility, tensile strength and impact resistance than random copolymers of the same average composition. As a way of preparing block copolymers Seymour and Garner first prepared polymers with "living" chain ends, which, although stable under the conditions of preparation, are capable of continued reaction with other monomers under a different set of conditions. Since these polymers are actually very large free radicals, they are known as macroradicals.

The procedure for preparing stable macroradicals is to carry out the polymerization in a solvent whose solvency is carefully adjusted so that as the polymer grows it eventually reaches a point where it becomes insoluble. As the polymer precipitates the chains curl up and the living ends become tucked away in the folds of the polymer so that they are no longer accessible to the monomer for further reaction.

To produce block copolymers from these macroradicals it is necessary simply to readjust the solvency sufficiently to uncurl or dissolve the protected chains in the presence of a second monomer. The reaction can then be carried to completion.

This project has been completed. Random and alternating copolymers of styrene and maleic anhydride have been reported in the JOURNAL OF COATINGS TECHNOLOGY, and an account of a similar study with alpha-methyl styrene appears in *Polymer*.

No. 62Ba—Novel Thermosetting Emulsions Which Crosslink at Room Temperature or With Low Energy Cure

SITE: University of Southern Mississippi
PRINCIPALS: B. George Bufkin, Gary C. Wildman and George M. Crews
MONITORS: D. Bassett, D.J. Berenschot, J.H. Sample, and S. Sanfilippo

The goal of this project is a one-package epoxy emulsion paint. To be successful, a way must be found to prevent the curing agent from crosslinking the reactive polymer in the dispersed particles prior to coalescence in the applied film. Dr. Bufkin hopes to find a stable composition of this sort.

As a first step a test was developed to determine the extent of crosslinking within the particles. This test was based on the fact that when the emulsion is diluted with an active solvent the crosslinked particles swell less than the uncrosslinked ones. Hence, as crosslinking proceeds a progressively lower viscosity should be observed when the sample is diluted with active solvent.

As might be expected, a copolymer of glycidyl methacrylate and methyl acrylate in bead form suspended in an aqueous solution of a curing agent (tetramethylene pentamine) showed a marked reduction in viscosity when diluted with acetone after standing two days. Crosslinking within the particles obviously occurred at a fairly rapid rate.

This was a one year exploratory project designed to determine the validity and promotability of the idea. The work will be published and reviewed by the industry. At that time, the PRI will re-evaluate the project and decide whether to support it further.

CORROSION

No. 53Co—Chemical and Spectroscopic Studies of Metal—Metal Bonding

SITE: Northwestern University
PRINCIPALS: Tobin J. Marks, Gregory W. Grynkewich and Djordje R. Stojakovic
MONITORS: G.P. Bierwagen, W.R. Boberski, R.R. Eley, G.K. Korpi, P.V. Robinson, and P. Rosenberg

One of the best ways to protect a metal surface is to avoid a discontinuity between coating and metal of the type that allows disintegration of the bond in the presence of water and corrodents. Conceptually, it would be ideal to proceed from the substrate metal directly to an organic coating using a metal atom to bind the two layers together.

In his efforts to reduce this concept to practice, Dr. Marks first studied compounds that had a string of metal atoms for a backbone. The work then branched out into a preparation of two new classes or organometal compounds. The first of these was a group of relatively simple compounds containing partially oxidized metal atoms that served as a conductive species. The second was a new class of pigments called superphthalocyanines. These are analogous to copper phthalocyanine except for a modification in structure which permits the substitution of rare- earth metals for copper. The partial oxidation of these phthalocyanine analogs yielded adducts that were conductive.

The potential corrosion protection resulting from a conductive interfacial layer stems from the fact that this arrangement would short-circuit local electrolytic cells responsible for corrosion. A possible bonus resulting from a conductive primer coat would be its ability to function as an electrode for electrodeposition of a topcoat.

Although official PRI support of this project terminated June 1977, Dr. Marks plans to continue to work on his own. In the meantime, the industry will digest the information developed so far and a consensus will be reached as to whether further support by PRI is justified.

No. 59Co—Laser Interferometric Study of Corrosion

SITE: University of Victoria
PRINCIPALS: Robert N. O'Brien and Henryk Kolny
MONITORS: W.H. Biddle, C. Buzzard, D. Cook, F.G. Grimmett, R.G. Nickells, D.R. Pawsey, and O.C. Keplinger, Jr.

Metal corrosion is occasioned by the formation of local electrolytic cells on the surface of the metal. In the vicinity of the anodes of these cells there is an increase in the concentration of metal ions as metal dissolves while at the cathodes there is a corresponding decrease. The result is a concentration gradient of dissolved material near the electrodes. The change in concentration and the shape of the concentration gradient are a function of the amount of charge passed and the charge passed per unit of time is a measure of the corrosion rate. Concentration changes near the electrodes are accompanied by refractive index changes in the medium; consequently, refractive index measurements can be used to quantify corrosion rates.

O'Brien and Kolny have developed a sensitive method for following these refractive index changes based on laser interferometry. For calibration purposes a natural corrosion cell was simulated using two zinc electrodes in a Zn SO_4 electrolyte solution and applying a voltage of about the same magnitude as that encountered in a natural corrosion process. The interferometer is designed to enclose the electrodes in a parallel position between two optically flat glass plates. The space between the electrodes is made into a wedge of such slight taper that a series of interference fringes is achieved along its length. The electrolyte is inserted in the intervening space.

As ion concentration changes occur near the electrodes the corresponding refractive index change is registered by a bending of the fringes; the degree of bending can be correlated with corrosion rate as determined by ammeter measurement of current flow in the same cell. A high degree of fringe bending of course means a high corrosion rate and vice versa.

Various coatings can be applied to the electrodes to compare them for relative corrosion protection. A strong decrease in fringe bending was observed where an epoxy coating was employed, except where artificial "holidays" were introduced. Thus, the method lends itself not only to the study of the corrosion protection of a continuous coating but also permits examination of coating imperfections. If the results can be correlated with field performance we should have a very rapid method for predicting the corrosion protection characteristics of coatings.

PRI support of this work has been discontinued. A paper was given at the 1975 Federation Annual Meeting and is now being updated for publication. Further PRI action will be predicated on the industry's reaction to the published results.

No. 63Co—Improvement of Coatings by Varying Acid-Base Interaction Between Filler and Matrix System

SITE: Lehigh University
PRINCIPALS: Frederick M. Fowkes, John A. Manson, and Jerry W. Williams
MONITORS: D.M. Berger, C.A. Kumins, G. Mansell, R.E. Pike, A. Ramig, and R.W. White

In addition to hiding, pigments can often harden films and, if properly chosen, can enhance the corrosion-resisting properties of a vehicle. Dr. Fowkes and his coworkers hope to reduce the penetratability of corrodents by exploring acid-base interactions between pigments and vehicles. This concept was first studied under a PRI grant by Dr. Russell Drago at the University of Illinois about five years ago.

If an acidic pigment is dispersed in a basic binder, the interface should be cemented so tightly that the diffusion of water and ions through the film would be drastically reduced. Preliminary studies showed that a polymer is adsorbed onto a pigment of opposite polarity only when the solvent medium itself is close to neutral. If the solvent is acidic it competes with acidic polymer for sites on a basic pigment; if basic, it competes with basic polymer for sites on an acidic pigment.

There has been a practical observation with regard to solvent retention in films. It was observed that solvent retention is favored by combining acidic polymer with basic solvent. Presumably the opposite combination would produce a similar effect, and if one wishes to accelerate solvent release, the polarities of the polymer and solvent should be similar.

This project terminated in July 1977.

HIDING

No. 54Hi—Scattering of Microvoids in Paint

SITE:	Clarkson College of Technology
PRINCIPALS:	Milton Kerker and Derry D. Cooke
MONITORS:	S.L. Davidson, J. Oberle, W.D. Ross, and J.A. Seiner

It is a well-recognized fact that any finely dispersed material that differs in refractive index from the vehicle or binder in which it is dispersed will produce a more-or-less opaque film depending on the degree of difference between the two refractive indices. It does not matter whether the dispersed phase is of higher or lower refractive index than the continuous phase, just so long as it is different. Thus, dispersed air, with its very low refractive index, and titanium dioxide, with its very high refractive index relative to a given vehicle, will both impart opacity to the paint film. It was not known, however, whether the individual hiding effects would be additive when the two were used together in the same paint. If they were, a very inexpensive way obviously exists for enhancing the hiding power of conventional pigments.

Kerker and Cooke undertook to develop an answer to this question. Since an experimental program based on the testing of actual paints involved some almost insurmountable problems of particle shape and size control, a computer program was set up simulating the actual situation but using the simplified assumption of spherical pigment particles encapsulated in bubbles of air. Calculations made involving changes in the relative sizes of the pigment particle and the encapsulating air bubble, gave the surprising theoretical result that anomalies in hiding power lie in the direction of increased transparency rather than increased hiding.

While this result is disappointing in terms of the objective of the project, it is possible that paint chemists may find specialty uses for this phenomenon if the theoretical results can be actualized. It may have application, for example, where the reinforcing effect of a pigment without attendant hiding is a requirement.

This project has been closed out, but it is hoped that it will stimulate some thinking as to how advantage might be taken of this unexpected turn of affairs. A final paper covering this work was published in JOURNAL OF COATINGS TECHNOLOGY, October 1976.

PROCEEDINGS

The following PRI Proceedings were published in the JOURNAL OF COATINGS TECHNOLOGY during 1976.

No. 118—Effect of Temperature on Composition of Copolymers of Maleic Anhydride and Styrene, R. B. Seymour and D. P. Garner, Jan., p. 41.

No. 119—Hydrosilylation of Methyl Eleostearate, S. F. Thames, B. G. Bufkin, S. J. Jen, J. M. Evans, and J. S. Long, Jan., p. 46.

No. 120—Laboratory and Successional Studies with *Auerobasidium Pullulans*, J.A. Schmitt, D. E. Padgett, and J. B. Achmoody, Apr., p. 35.

No. 121—Report of the Research Director, May, p. 23.

No. 122—Predicting Reflectance and Color of Paint Films by Kubelka-Munk Analysis. IV. Kubelka-Munk Scattering Coefficient, D. G. Phillips and F. W. Billmeyer, Jr., May, p. 30.

No. 123—Chemical Anchoring of Mildewcides in Paint — Analysis of the Literature, C. U. Pittman, Jr., Jun., p. 31.

No. 124—New Results and Directions in Phthalocyanine Chemistry, T. J. Marks, Sept., p. 53.

No. 125—Pigmented Microvoid Coatings II. Luminance and Color of the Concentric Sphere Model, M. Kerker and D. D. Cooke, Oct., p. 35.

A New Approach To Formulation Of Water-Borne Coatings

Werner J. Blank
American Cyanamid Company*

New polyether polyol resins, based on a hydrophobic aromatic or cycloaliphatic moiety grafted with an alkylene oxide or preferably ethylene oxide, have been developed as low molecular weight resins or reactive diluents for water-borne or high solids industrial coatings. Crosslinked with an amino resin, these polyether polyol resins give, for most applications, acceptable performance. Variations in polyol composition and acrylic backbone resin as well as the performance of such coatings have been studied.

INTRODUCTION

Most industrial water-borne coatings presently in use utilize carboxyl groups containing resins which are solubilized in the presence of an amine.

Although emulsions offer the potential of better mechanical performance, they do have severe limitations in their application characteristics and have, therefore, found use only in special industrial applications. Both water-borne solutions and emulsion systems either have some limitations in their performance or application characteristics, or they are from an ecological standpoint only an improvement over existing solvent-borne paints.

Most existing water-soluble or dispersed paints still contain large amounts of amines and co-solvents which, under present regulations, are exempt. A large number of these compounds might not be exempt under new regulations. It is, therefore, highly desirable to eliminate or further reduce amine and co-solvents in aqueous paint systems.

This report deals with a new class of low molecular weight polymers which do not require an amine or co-solvent to achieve water-solubility. These new low molecular weight polymers are compatible with existing water-borne resins as well as with most solvent-borne resins, and they can be used as reactive diluents to replace co-solvents and some amine in the system. The performance achievable with these polymers is similar to that of alkyd resins.

EXISTING TECHNOLOGY

Carboxyl Group Containing Water-Dispersible Polymers

Virtually all commercial water-reducible alkyd, polyester, acrylic, epoxyester, and maleinized oil resin systems on the market are based on amine or base neutralized carboxyl functional polymers with an acid number of between 30 and 150. These polymers are normally prepared by condensation or polymerization reaction, either in bulk or in an organic solvent. The selection of the starting material and method of preparation give polymers with a high acid number. The so prepared polymers are cut at higher temperatures in an alcohol or glycol ether solvent and either sold or handled in the acid form at a solids of 70-80%, or they are neutralized after manufacture with an amine and diluted or emulsified with water. In the latter case, smaller amounts of solvents can be utilized.

The processing techniques used with most so called water-soluble polymers limit the molecular weight attainable. Polymers prepared in such manner also suffer from the disadvantage of limited shelf life. This is especially a problem if the ester groups are in the polymer backbone, such as in polyester and alkyd resins.

The presence of large amounts of amine also reduces the cure response of water-borne coatings, so most water-borne industrial coatings require higher cure temperatures and longer time to overcome this cure inhibition of the amines.

Emulsion Polymers

Emulsion polymers do overcome some of the limitations of water-soluble polymers, but they introduce problems of their own. Emulsions can be prepared with a low acid number and no co-solvent content. They can also be prepared at a high molecular weight and low viscosity. The amount of amine and co-solvent required to formulate an emulsion to achieve stability and good film formation can normally be kept at a minimum, and in some instances they can be omitted. However, the functional groups and the surfactants used in an indus-

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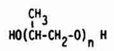
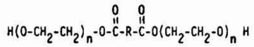
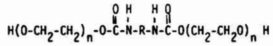
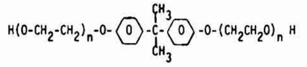
*Industrial Chemicals Div., 1937 W. Main St., Stamford, Conn. 06904.

Table 1—Possible Polyol Structures

Symbol	Structure
PPG	 $HO(\overset{CH_3}{CH}-CH_2-O)_n\ H$
PTMG	$HO(CH_2-CH_2-CH_2-CH_2O)_n\ H$
Polyether-ester	 $H(O-CH_2-CH_2)_n-O-\overset{O}{\overset{\|}{C}}-R-\overset{O}{\overset{\|}{C}}-O(CH_2-CH_2-O)_n\ H$
Polyether-urethane	 $H(O-CH_2-CH_2)_n-O-\overset{O}{\overset{\|}{C}}-\overset{H}{N}-R-\overset{H}{N}-\overset{O}{\overset{\|}{C}}-O(CH_2-CH_2O)_n\ H$
Polyether polyol	

trial emulsion have a tendency to concentrate at the water-polymer interface and reduce the water and corrosion resistance or adhesion to various substrates. The amount of functional groups required to achieve crosslinking in an industrial emulsion can also often lead to instability because of swelling of the emulsion particles on neutralization. Emulsions also have a rheology which makes them acceptable for brush applications, but not acceptable to most industrial application methods. The list of potential problems with an emulsion can be further extended. Although some of the problems with emulsions appear insurmountable, sufficient progress has been achieved to make emulsions acceptable in some application areas.

A New Approach to Water-Soluble Polymers

It is known that besides ionic groups, such as anionic or cationic functionality, nonionic groups can also contribute to the water-solubility or dispersibility of a polymer. In the family of nonionic surfactants, sufficient examples of polyhydroxyl or polyether compounds are known to show the overall guiding principles in designing water-soluble nonionic compounds. The same principles, it was felt, could be extended to design nonionic surface coating resins. Although such an approach does permit the elimination of solubilizing amines, it presents one major drawback; the solubilizing ether groups utilized to achieve water-solubility will remain in the film and can, therefore, reduce the water-resistance of the cured film.

The initial work conducted with polypropylene glycol or with the more hydrophobic homologs such as polytetramethylene glycol did confirm this suspicion. Not only was the water-resistance of the films poor, but adhesion of these aliphatic polyols to the steel substrate was also unsatisfactory. Increasing levels of melamine resin were able to overcome the softness of the film and also to some extent the water-resistance, but only at a sacrifice in flexibility. The uniform distribution of hydrophilic ether groups was felt to be mainly responsible for high diffusion rates of water into the film and poor resistance to water.

It was hoped that an alternating structure of hydrophobic and hydrophilic groups in the polyol could be used to achieve a segregation or clustering of hydrophobic and hydrophilic groups which in turn would reduce the diffusion rate of water and reduce the water-sensitivity of the film. We also hoped that this design of the polyol, to reduce the evaporation of the low molecular weight resin factions, would be a narrow molecular weight distribution. Although numerous possibilities exist in designing polyols with a certain distribution of hydrophobic and hydrophilic groups, only a few are commercially viable.

molecular weight resin factions, would be a narrow molecular weight distribution. Although numerous possibilities exist in designing polyols with a certain distribution of hydrophobic and hydrophilic groups, only a few are commercially viable.

Table 1 shows possible polyol structures. It includes polypropylene glycol, polytetramethylene glycol, and polyols with a hydrophobic-hydrophilic structure. Both polyester-ester[1] and polyether-urethane[2] resins fulfill the requirements for a certain hydrophobic-hydrophilic

Table 2—Comparative Performance of Different Polyether Resins Crosslinked with Hexa(methoxymethyl)Melamine

Test/Polyether	PPG-400	PTMG-600	Polyether-Ester[a]	Polyether-Urethane[b]	Polyether-Polyol[c]
Water-solubility	5	1	4	5	4
Stability	5	5	1	1	5
Pigment wetting	1	1	4	3	2
Weight loss on heating	2	2	1	1	5
Adhesion to metal	1	1	3	4	4
Hardness	1	1	5	5	4
Flexibility	3	3-4	4	4	4
Water-resistance	1	2	2	1	3
Salt-spray resistance	1	2	2	1	4
Stain resistance	1	2	4	2	4
Abrasion resistance	2	3	3	3	4
Exterior durability	2	3	3	1	2

Rating = 5 best, 1 worst.

(a) Polyether-ester, diethylene glycol o-phthalic acid.

(b) Polyether-urethane, diethylene glycol toluene diisocyanate.

(c) Polyether-polyol, bisphenol A - 6 EO.

balance, but they do not give a product with a narrow molecular weight distribution and also contain large levels of low molecular weight resin fractions which can evaporate on curing. The hydrolytic stability of these polyether-ester and polyether-urethane resins is also very unsatisfactory. This poor hydrolytic resistance manifests itself in poor stability of the paint and also in poor corrosion resistance of the film.

The polyether-polyol based on bisphenol A and ethylene oxide[3] comes closest to the desired polyol structure. The polyol has a narrow molecular weight distribution, does not contain any low molecular weight polymer fractions, and is also hydrolytically stable. The level of ethylene oxide required in such a polymer is about 50 wt% of the total molecule. The introduction of the hydrophobic aromatic and cycloaliphatic structure in the polyol also has a significant effect on the adhesion of films to metal surfaces.

Table 2 compares the performance of different resins utilizing ether groups to achieve water-solubility. Aliphatic polyols such as polypropylene glycol (PPG-400) and polytetramethylene glycol (PTMG-600) give the poorest performance overall. Although both polyols are hydrolytically very stable, their main deficiencies are poor adhesion, water-resistance, salt-spray resistance, and hardness. Therefore, aliphatic polyols of this type are not very suitable as the sole binder in a water-reducible resin, but only as a minor modifying component in aqueous paints.

Polyether-ester and polyether-urethane resins reduce some of the problems with aliphatic polyether resins, such as hardness of the film and adhesion to metal; however, they create new problems such as high weight loss on baking and poor hydrolytic stability of the paint. Polyether-polyols derived from bisphenol A and ethylene oxide overcome most of the aforementioned problems. The only serious problems are exterior durability and pigment wetting. Exterior durability could be achieved by selecting a cycloaliphatic moiety as the hydrophobic group of the molecule.

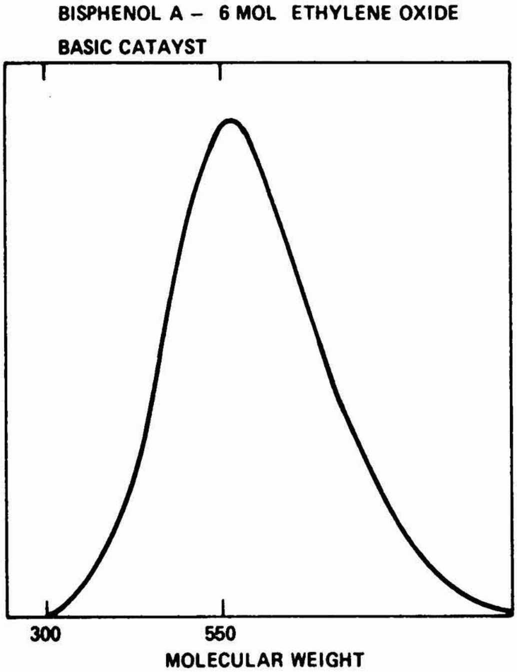


Figure 1—Molecular weight distribution of polyether polyol

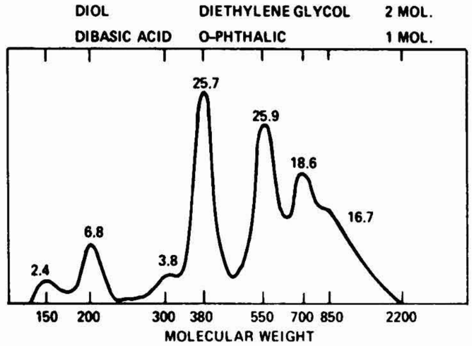


Figure 2—Molecular weight distribution of polyether-ester

The synthesis method for polyether-polyol resins derived from bisphenol A and ethylene oxide gives a very uniform molecular weight distribution as shown in *Figure* 1. The molecular weight distribution was measured by gell phase analysis using THF as a solvent.

As a comparison, the molecular weight distribution of a polyether-ester resin is shown in *Figure* 2. The resin prepared by polycondensation reaction shows, as expected, a broad molecular weight distribution. A large weight fraction of the polymer has a molecular weight below 250. These low molecular weight fractions can evaporate completely on baking and contribute to weight loss. In the exhaust stack of the baking oven, this low molecular weight resin can condense and cause smoking of the oven exhaust.

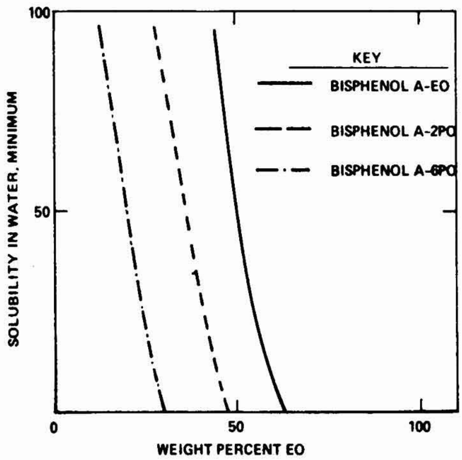


Figure 3—Water solubility of bisphenol A-based polyols

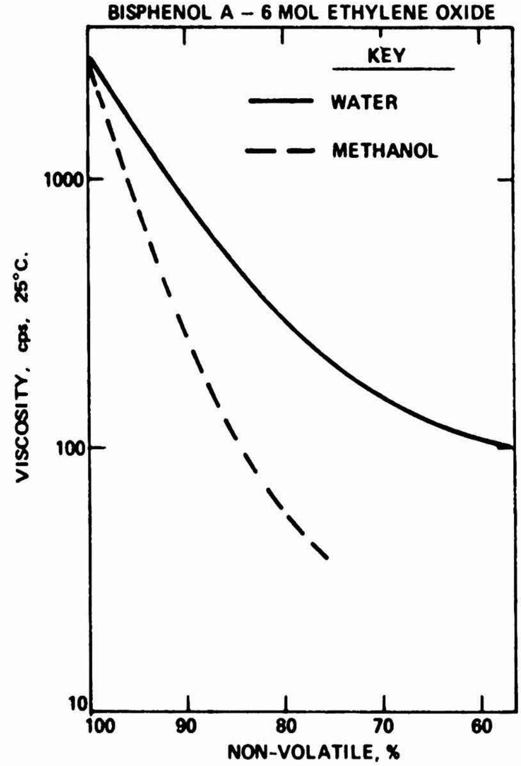


Figure 4—Viscosity of bisphenol A-based polyols

Structure/Solubility Relationship Of Bisphenol A-Based Polyols

The solubility of bisphenol A-based polyols grafted with different levels of ethylene oxide (EO) can be adjusted over a wide range. Polyols prepared from bisphenol A and less than 6 moles of ethylene oxide are only partially water-soluble. Surprisingly, these polyols are water-soluble at high solids and become water-insoluble at lower solids.

Figure 3 shows the water-solubility of bisphenol A-based polymers grafted with different levels of ethylene oxide and propylene oxide. Grafting of bisphenol A with only propylene oxide results in only a partially water-compatible system and never in a completely water-soluble resin. With ethylene oxide, about 8-8.5 moles of ethylene oxide are required to achieve complete water-solubility. This corresponds to about 62 wt% of ethylene oxide in the polyol. The optimum combination of performance, water-solubility, and water-resistance is obtained at about 50% ethylene oxide in the polyol. Although replacing the ethylene oxide with propylene oxide on a molar basis leads to a less water-soluble product, some propylene oxide can be used in the polyol. Two samples of bisphenol A were grafted with 2 moles of propylene oxide and 6 moles of propylene oxide, respectively, and were later grafted with different levels of ethylene oxide. As seen in *Figure* 3, replacing some of the bisphenol A with propylene oxide produces, at equal ethylene oxide content, a more water-soluble polyol. *Figure* 4 gives the viscosity/solids relationship of bisphenol A - 6 EO polyol using water or methanol as a diluent. Methanol, a more hydrophobic solvent than water, is capable to some extent at least of solvating the hydrophobic bisphenol A portion of the molecule and, therefore, gives less of a deviation from a true solution behavior than water as the diluent. The nonlinear dilution behavior of water indicates some clustering of water and hydrophilic groups and also of the hydrophobic groups.

Hydrophobic Groups in Polyol

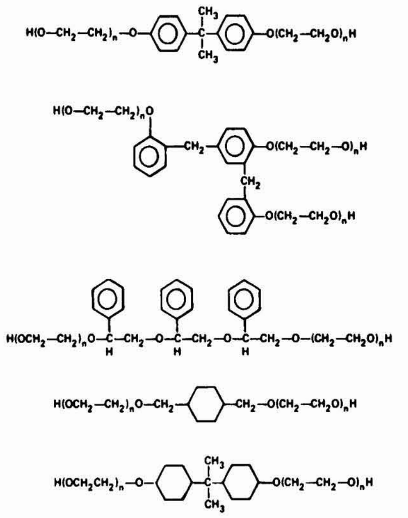
Although bisphenol A is a very convenient source of hydrophobic groups for these types of polyols, other groups such as derived from phenol-formaldehyde novolak resins, hydrogenated bisphenol A, styrene oxide co-polymers, cyclohexane dimethanol, etc., can be used to achieve similar performing polyols. Polyols based on cycloaliphatic compounds give exterior durable coatings.

Examples of typical polyols derived from different hydrophobic compounds are shown in structures (1)

Table 3—Solubility of Bisphenol A - 6 EO Adduct

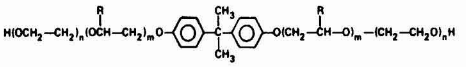
	Solubility
Alcohols	
Methanol	+
Ethanol	+
n-Propanol	+
n-Butanol	+
Esters	
Ethyl acetate	+
n-Butyl acetate	+
2-Ethoxy ethyl acetate	+
Glycol and Glycolethers	
Ethylene glycol	+
Propylene glycol	+
2-Ethoxy ethanol	+
2-Butoxy ethanol	+
Hydrocarbon	
Toluene	+
Xylene	±
Solvesso® 150	–
VM & P Naphtha	–
Hexane	–
Ketone	
Methylethyl ketone	+
Methylisobutyl ketone	+
Isophorone	+
Other Solvents and Mixtures	
Water	> 50%
Water/2B alcohol = 80/20	+
Xylene/n-butanol = 80/20	+
Hexane/n-butanol = 50/50	+

+ Completely soluble; soluble 0-100%.
± Partially soluble; soluble 50-100%.
– Insoluble; soluble 90-100%.



(1)

and (2). For most applications, polyols derived from aromatic compounds such as bisphenol A or phenol-formaldehyde novolak resins give better adhesion and water-resistance than the hydrogenated analogs of these compounds. Structure (2) shows a modified hydrophobic compound used as a starting material for the preparation of the polyol.



(2)

The use of polyols prepared by only ethylene oxide grafting on aromatic compounds somewhat limits the degree of flexibility and hardness which can be achieved with a polyol at a given water-resistance. By first grafting a higher homolog of ethylene oxide such as α-olefine oxides onto the aromatic or cycloaliphatic compounds and then grafting ethylene oxide onto the polyol, a more flexible coating system can be achieved without sacrifice in water-resistance.

Solubility Of Bisphenol A/Ethylene Oxide Polyols In Organic Solvents

The solubility of bisphenol A-ethylene oxide adducts can be regulated over a wide range by adjusting the level of ethylene oxide or replacing some of the ethylene oxide with propylene oxide or a higher α-olefine oxide. The solubility of the water-soluble bisphenol A - 6 EO adduct is quite broad in most polar solvents, but it has limited or no solubility in nonpolar diluents. (See *Table* 3).

Compatibility of Bisphenol A - 6 EO Adduct With Other Polymers and Crosslinking Agents

The bisphenol A - 6 EO adduct is compatible with all methylated amino resins, with most butylated amino resins, and with a large variety of acrylic, epoxy polyester, and alkyd backbone resins. The compatibility with backbone resins is not restricted to water-borne coatings, but also applies to solvent-borne systems. The results of the compatibility study are shown in *Table* 4.

Optimum Length of Polyether Chain In Bisphenol A Adducts

Increasing the polyether chain length grafted onto the bisphenol A produces not only a more water-soluble polyol which gives less water-resistant films, but also changes the hardness and the flexibility of the crosslinked film. To study the effect of the aliphatic polyether chain length in the polyol on hardness and flexibility of a coating film, blends of these polyols with an acrylic resin and crosslinked with HMMM were prepared. The flexibility of the coating improves up to 30 carbon and oxygen atoms in the aliphatic chain. A further increased aliphatic chain gives considerable

Table 4—Compatibility of Bisphenol A - 6 EO Adduct with Other Polymers and Crosslinked Agents

Methylated Urea-Formaldehyde Resins	**Compatibility**
Beetle® 55 resin	+
Beetle 60 resin	+
Beetle 65 resin	+
Butylated Urea-Formaldehyde Resins	
Beetle 80 resin	+
Beetle XB-1050 resin	+
Methylated Melamine-Formaldehyde Resins	
Cymel® 303 resin	+
Cymel 370 resin (series)	+
Cymel 385 resin	+
Butylated Melamine-Formaldehyde Resins	
Cymel 243-3 resin	–
Cymel 247-10 resin	–
Cymel 1156 resin	±
Alkylated Benzoguanamine-Formaldehyde Resins	
Cymel 1123 resin	+
Cymel 1125 resin	+
Backbone Resins Solvent Soluble	
Acryloid® AT-56 acrylic resin	±
Acryloid OL-42 acrylic resin	+
Rezyl® 94-5 alkyd resin	+
Rezyl 387 alkyd resin	+
D.E.R. 661 epoxy resin	+
Epon 1001 epoxy resin	+
Cyplex® 1546 polyester resin	+
Backbone Resins Water-Reducible	
Acryloid WS-24 acrylic resin	+
Carboset® 514H acrylic resin	+
Cyplex 1600 polyester resin	+
Rhoplex AC-604 acrylic emulsion	+
Ucar 4510 X acrylic emulsion	+
XC-4011 acrylic resin	+
XC-4012 acrylic resin	+

The bisphenol A - 6 EO adduct is also compatible with most polymers with an acid number of > 20.

+ Compatible; 5-95% polyol in blend.
± Partially compatible; 5-50% polyol in blend.
– Not compatible; 5-10% polyol in blend.

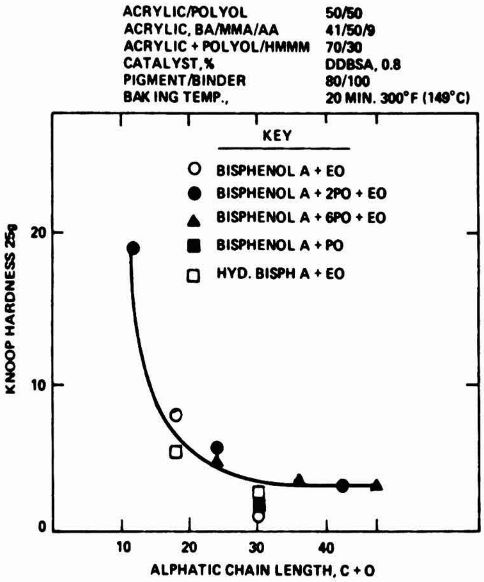


Figure 5—Polyol/acrylic—Knoop hardness

scatter in the impact results, presumably, as a result of decreased adhesion to metal. Often the coating does not fail the impact area by cracking, but fails the adhesive tape test.

As shown in *Figure* 5, the decrease in hardness of an acrylic/polyol system is mainly determined by the aliphatic chain length, independently if either propylene oxide, ethylene oxide, or a combination of both is used. Acceptable film properties are obtained if between 4 to 8 moles of alkylene oxide are grafted onto the bisphenol A. The lower levels of alkylene oxide give, of course, a harder and less flexible coating than the higher modification.

As shown in *Figure* 6, the impact resistance increases with increased aliphatic chain length; but at the higher chain length, a large scatter in impact resistance is observed indicating poorer adhesion.

Cure Response of Polyol/HMMM Coatings

The primary hydroxyl groups of the bisphenol A - ethylene oxide adduct give excellent cure response with fully alkylated melamine resins from type hexa (methoxymethyl)melamine (HMMM)[4]. Such coatings are suitable for low temperature cure in highly acid catalyzed coating systems. These water-reducible polyol coating systems do not suffer from the same amine inhibition problems as normally experienced with water-borne amine neutralized coatings.

As shown in *Figure* 7, a coating system catalyzed with 0.2% p-toluene sulfonic acid (pTSA) gives excellent cure at 250°F (121°C). This presupposes that KHN=cure. An increase in acid catalyst level from 0.2 to 0.4 and 0.6% pTSA improves the cure response significantly (*Figure* 8).

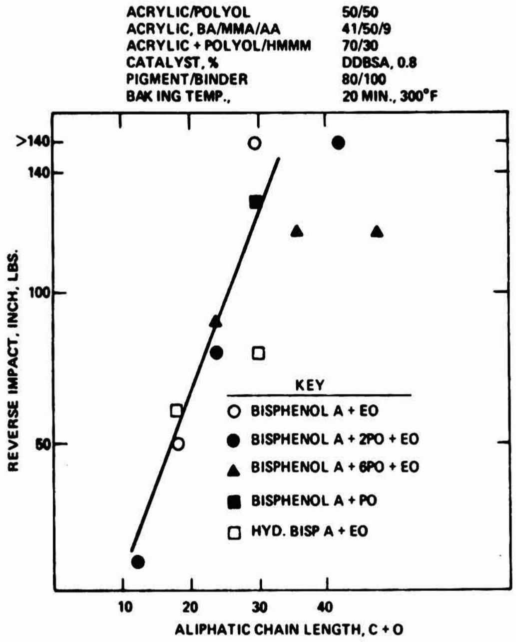


Figure 6—Polyol/acrylic—Impact resistance

Influence of Amine on Cure Response

Although clear polyether-polyol and amino resin combinations do not require any amine to achieve stability and water-solubility, pigmented systems do require additives such as carboxyl group containing re-

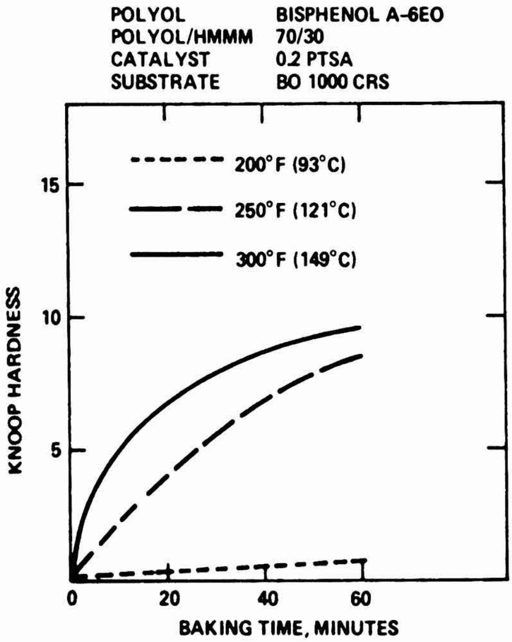


Figure 7—Polyol/HMMM cure response with 0.2% pTSA

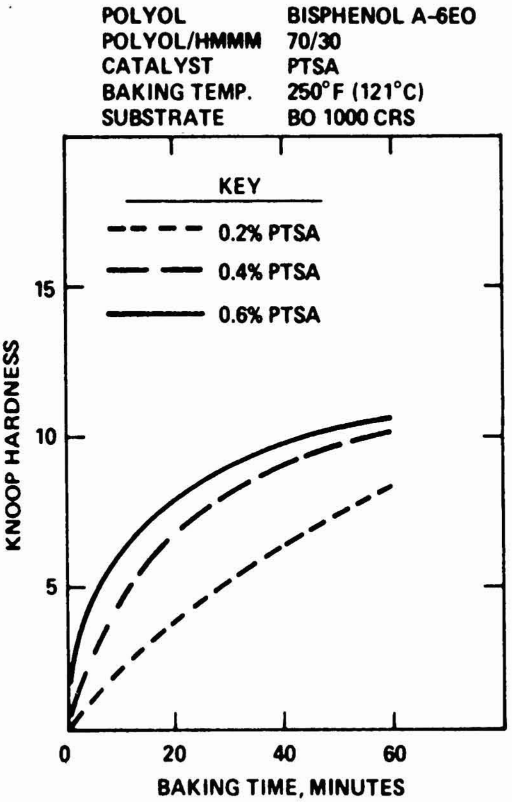


Figure 8—Polyol/HMMM cure response with 0.2, 0.4, and 0.6% pTSA

sins or wetting agents. These additives usually require basic pH conditions to be water-dispersible. The selection of the neutralizing amine has a great influence on the stability of amino resin crosslinked paints and also on their appearance and gloss. In a resin system, such as a polyol/HMMM system, the choice of amine determines the cure response of the coating.

As shown in *Table* 5, a pTSA catalyzed polyol/HMMM coating gives a good cure response at 250°F (121°C). The addition of different amines has a significant effect on the rate of cure. There is no relationship between boiling point of the amine and rate of cure. Primary, secondary amines and ammonium hydroxide have, in general, a lesser effect on the rate of cure than t-amines, the exception appears to be the weak basic triisopropanol amine. It appears that primary, secondary amines and ammonium hydroxide lose their basicity by reaction with formaldehyde. The resulting methylol compounds, being only very weak bases, do not inhibit the cure reaction. Because of the low pK value, a weak t-amine such as triisopropanol amine probably only has a minor influence on the rate of cure.

The increase in amine content in a carboxyl/hydroxyl containing resin system vs. the resin containing only hydroxyl functionality further reduces the cure response. It is interesting to note that the paint system neutralized with the strong basic t-amine shows the least reduction in cure response compared with all other amines tested. Apparently, the evaporation of the t-amines is not delayed as much as other mechanisms which are responsible for the deactivation of primary, secondary amines or ammonium hydroxide.

In blending conventional backbone resins with polyols, generally, functional groups with different reactivity are combined. The primary hydroxyl groups of the polyether polyol are faster reacting than the carboxyl groups on the backbone resin. The cure gradient set up by the evaporation of the volatile amines from the surface of the film can cause premature surface cure. In a polyether polyol-carboxyl group containing resin system, this can lead to reduced gloss, nonuniform gloss, or wrinkles. This polymer blend is more sensitive to this type of surface imperfection than single polymer systems. This problem can be eliminated by using suitable amines for the formulation. Methyl diethanol amine, diisopropanol amine or triisopropanol amine give reduced wrinkling or higher gloss in these polyol modified systems compared to lower boiling amines. Combinations of these higher boiling amines with dimethyl ethanol amine can also be used to give improved gloss.

Table 5—Rate of Cure of HMMM in Presence of Different Amines

Rate of cure: Minutes to achieve Knoop hardness 6
Substrate: Bonderite® 1000 CRS
Catalyst: 0.4% pTSA
Baking temperature: 250°F (121°C)

Amine[a]	pKa	Boiling Point, °C	Cure Response, min	
			OH-Functional[b]	OH/COOH Functional[c]
No amine	—	—	18	14
Ammonium hydroxide	9.24	-33	30	65
Monoisopropanol amine	9.6	160	18	45
Diisopropanol amine	8.7	248.7	40	67
Dimethyl ethanol amine	9.31	134.6	68	75
Triisopropanol amine	7.86	> 305	34	83

(a) pH was adjusted to 8.0 with amine.
(b) Bisphenol A - 6 EO/HMMM = 70/30
(c) Bisphenol A - 6 EO/XC-4011 acrylic/HMMM = 52.5/16.5/30.

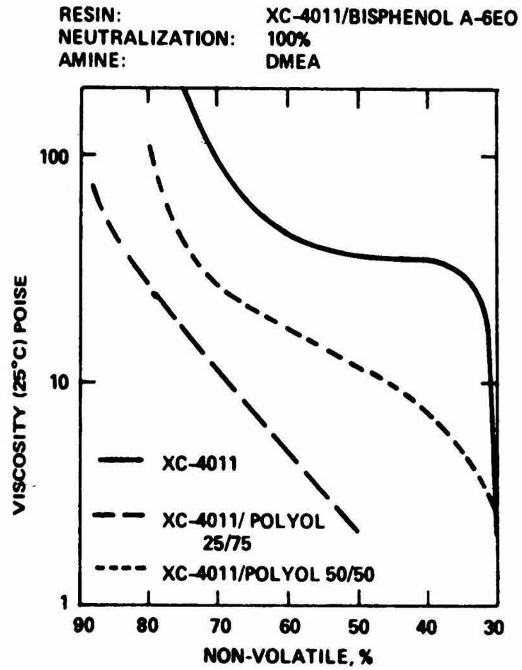


Figure 9—Dilution curves

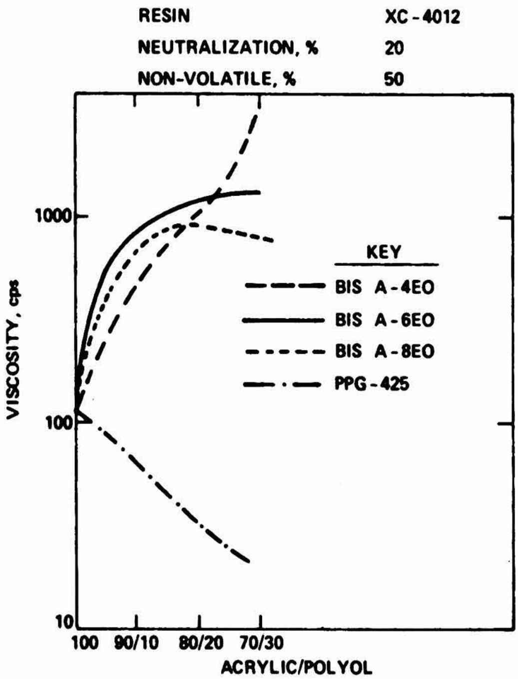


Figure 10—Influence of polyols to acrylic resin

The selection of the acid catalyst can also have an influence on the gloss. In some formulations, which utilize a carboxyl containing acrylic resin in combination with a polyol, the use of dodecylbenzene sulfonic acid gave reduced wrinkling compared to p-toluene sulfonic acid.

Viscosity/Solids Relationship Of Polyol Modified Water-Reducible Resins

The use of polyols as modifiers in water-reducible coatings offers numerous advantages. One of the main features is the replacement of co-solvents with reactive polyols which permit a significant reduction in polluting co-solvents. Other advantages can be found in improved flow, higher application solids, higher impact resistance, and better gloss.

Because most conventional water-borne coatings are not true aqueous solutions but colloidal solutions, the addition of a water-soluble polyol can raise the application solids in a manner difficult to predict. More hydrophobic polyols will generally be absorbed in the micellar structure of the backbone resin than hydrophilic polyols. Therefore, in most instances, a more hydrophilic polyol should give higher application solids than a more hydrophobic polyol. But there are exceptions to this rule because not only hydrophobicity but also hydrogen bonding between the polyol and the resin can significantly change the viscosity.

Figure 9 shows the effect of different polyol/acrylic resin blends on the solids/viscosity behavior of a polymer system. The acrylic resin without polyol modification gives the typical phase inversion curve. Wherein, over a broad solids range, no reduction in viscosity is found; at a phase inversion point, a significant reduction in viscosity takes place. The addition of polyol has a substantial effect on the dilution behavior. At the high polyol level of 75 wt% polyol/25 wt% acrylic resin, the dilution behavior of the blend is almost that of a true solution. Only in the 80-90% solids range is there a deviation from the solution behavior. The 50/50 blend already deviates considerably from the ideal solution behavior, but even this system does not give the extreme phase inversion point of the acrylic resin alone.

This solution-like behavior of the polyol/acrylic resin blend has, of course, a number of implications in some industrial application methods. Most existing solvent-borne coatings are basically solutions, and their application characteristics are close to that of a solution. Some of the application problems with water-borne coating systems, even the so called water-soluble systems, are caused by the unusual rheological properties and viscosity/solids relationship. The addition of polyol can in some systems correct this problem, without the need for high levels of co-solvents.

The influence of polyols with different EO content and polypropylene glycol addition to an acrylic resin with the acid number of 110 is shown in *Figures* 10, 11, and 12. The degree of neutralization of the acrylic polymer is changed from 20 to 60 and 100% using dimethylamino ethanol as the neutralizer. At the 20% neutralization level, the system is basically an emulsion, and the addition of different bisphenol A - EO adducts causes a significant increase in viscosity. Only the more hydrophilic polypropylene glycol MW-425

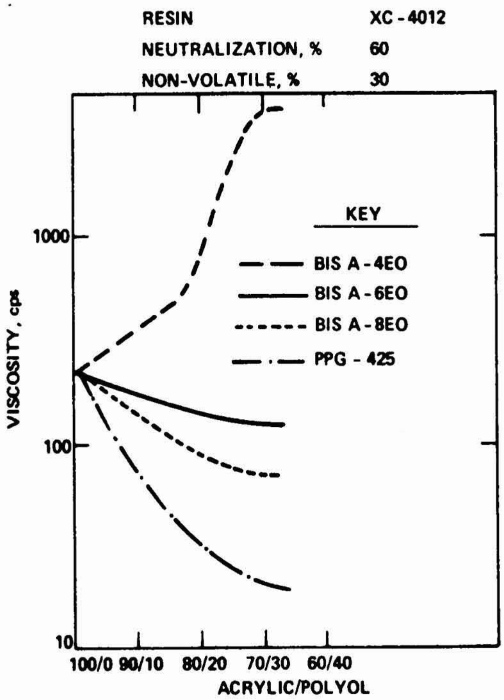


Figure 11—Influence of polyols to acrylic resin

with a uniform distribution of hydrophobic and hydrophilic groups gives a reduction in viscosity of the system. The higher neutralized acrylic resin, 60 and 100%, gives more of the expected results wherein, based on the hydrophobic/hydrophilic properties of the polyol, the more hydrophobic polyol (bisphenol A - 4 EO) gives an increase in viscosity of the blend, and the more hydrophilic polyol gives a reduction in viscosity. It is, therefore, necessary to balance the desire for a high application solids, which can be achieved with a more hydrophilic polyol, with the water and corrosion resistance needed, which is better utilizing a more hydrophobic polyol.

Properties of Polyol/Acrylic Resin Blends

Film properties of acrylic resins with different monomer compositions and blended with different levels of a bisphenol A - EO polyol were studied. The monomers used in this work were butylacrylate/methylmethacrylate/acrylic acid. The level of acrylic acid was kept constant at 9% which gives an acid number of 70. The butylacrylate level was varied between 35 and 50%. The methylmethacrylate level was adjusted accordingly. The system was crosslinked with a commercial grade of HMMM. Because of the changing functionality of the blend, an acrylic/HMMM ratio of 80/20 and a polyol/HMMM ratio of 70/30 was used in the mix. The neutralizing amine was methyl diethanol amine. All formulations were pigmented with titanium dioxide rutile pigment at a pigment/binder ratio of 80/100. As shown in *Figure* 13, the addition of

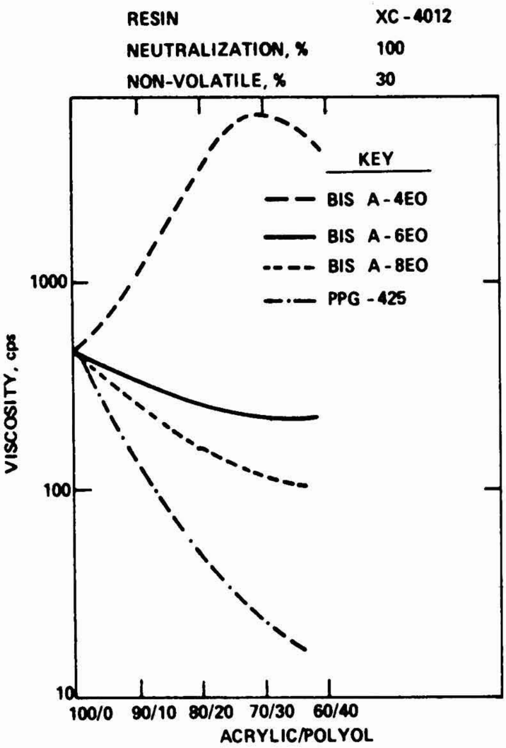


Figure 12—Influence of polyols to acrylic resin

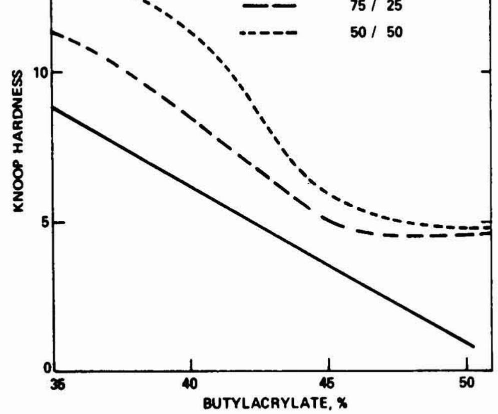


Figure 13—Increase of hardness with addition of polyol (acrylic/bisphenol A-6EO)

polyol causes an increase in hardness compared to the unmodified resin. Higher levels of polyol generally increase hardness to a larger degree, this being especially true for the lower butylacrylate resins.

As seen in *Table* 6, the gloss of the acrylic resin is also raised with increasing polyol levels. This result is not too surprising, assuming that a low viscosity polyol would increase flow and leveling characteristics. A more surprising result is the increase in impact resistance with polyol modification. This result has been seen with all acrylic resins. The pencil hardness of the formulation increases with higher levels of polyol modification. This increase in pencil hardness does not always go hand-in-hand with higher Knoop hardness, an indication that the film toughness is increased with higher levels of polyol.

The increase in impact resistance as seen in *Figure* 14 is significant even at the 25% polyol level. At the 25% polyol level, impact differences can be seen between the harder and softer acrylic combinations. At the 50/50 acrylic/polyol level, the impact contribution of the polyol diminishes the influence of the acrylic resin structure.

The humidity resistance of some coatings has been shown to improve by modification with a polyol. This improvement is without doubt, at least to some extent, a result of better cure at a lower baking temperature. Humidity results are shown in *Figure* 15.

The use of hydroxyl groups in combination with carboxyl groups in the backbone polymer is very desirable. Better cure response and improved performance can be obtained. Also, the possibility of differential cure between polyol and backbone resin is reduced.

ACRYLIC RESIN	BA/MMA/AA	
POLYOL	BISPHENOL A-6EO	
POLYMER/CLA	ACRYLIC/HMMM	80/20
	POLYOL/HMMM	70/30
TiO_2/BINDER	80/100	
SUBSTRATE	Bo -1000	
BAKING TEMP.	20 Min. @ 300°F (149°C)	

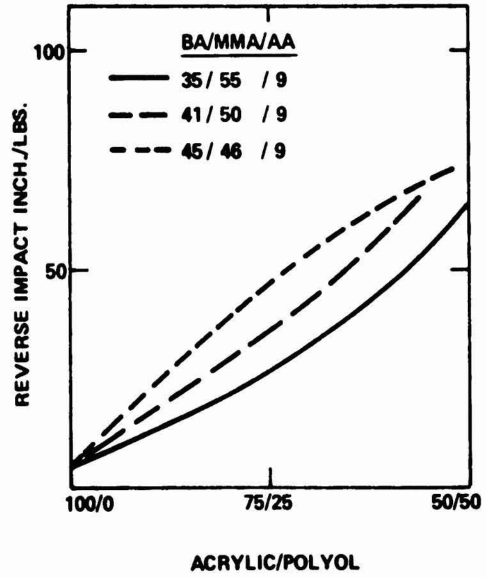


Figure 14—Increase of impact resistance with addition of polyol (acrylic/bisphenol A-6EO)

Table 6—Film Properties of Acrylic/Polyol Blends

Acrylic resin, A	BA[a]/MMA[b]/AA[c] 36/55/9
B	BA/MMA/AA 41/50/9
C	BA/MMA/AA 45/46/9
Polyol	bisphenol A - 6 EO
Amine	Methyl Diethanolamine
Amino resin	HMMM
Polymer/Amino ratio	Acrylic/HMMM = 80/20, Polyol/HMMM = 70/30
Titanium dioxide/Binder	80/100
Substrate	Cold-rolled steel Bonderite 1000 treated
Baking temperature	20 min at 300°F (149°C)

Acrylic resin	**A**			**B**			**C**		
Acrylic/polyol	**100/0**	**75/25**	**50/50**	**100/0**	**75/25**	**50/50**	**100/0**	**75/25**	**50/50**
Film thickness, mil	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
Gloss, 60°	88	92	95	86	90	89	86	90	94
Gloss, 20°	79	84	88	78	79	78	71	82	88
Hardness, Knoop, 25 g.	8.8	13.5	11.4	5.7	10.5	9.0	3.5	5.1	5.9
Hardness, pencil	F-H	H-2H	H-2H	B-HB	H-2H	2H-3H	2B-B	F-H	H-2H
Reverse impact, in./lb	0-10	20-30	60-70	0-10	30-40	70-80	0-10	40-50	70-80
Nonvolatile, %	44	45	51	43	46	52	45	47	53

(a) Butylacrylate
(b) Methylmethacrylate
(c) Acrylic acid

Figure 16 shows the improvement in impact resistance of a butylacrylate/styrene/acrylic acid/hy-

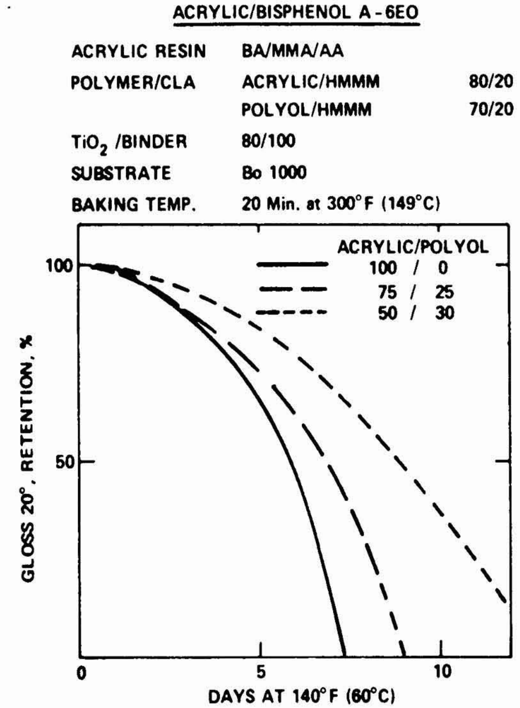


Figure 15—Humidity resistance of acrylic/bisphenol A-6EO

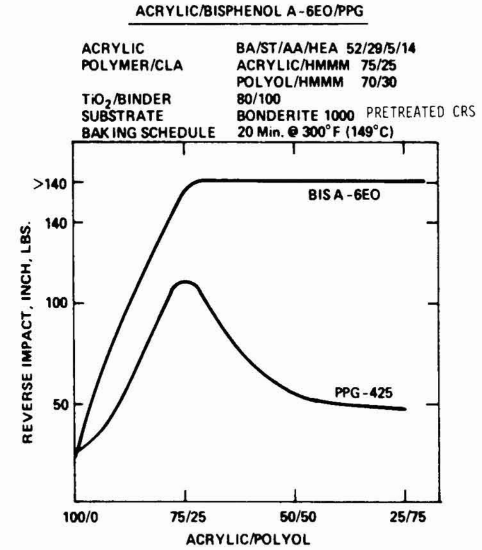


Figure 16—Increase in impact resistance of modified polymer

Table 7—Blends[a] of Acrylic Resin and Polyol

	100/0	87/13	50/50
Acrylic/Polyol			
Acrylic resin	80	69.6	40
Bisphenol A - 6 EO		10.4	40
HMMM	20	20	20
Pigment	80	80	80
Amine	7.6	7.8	3.8
Solvent	26.7	1.68	0.56
Water	214	193.2	155.3
Characteristics of Formulation			
Nonvolatile[b], %	42	47	53
Solvent composition, vol%:			
Water	85.2	94.9	97.3
2-Ethoxyethanol	11.4	0.8	0.3
Amine	3.4	4.3	2.4

(a) Prepared by polymerization of BA/ST/AA = 58/28/14 in the bisphenol A - 6 EO polyol.
(b) Equal viscosity of about 40-50 sec Ford Cup 4.

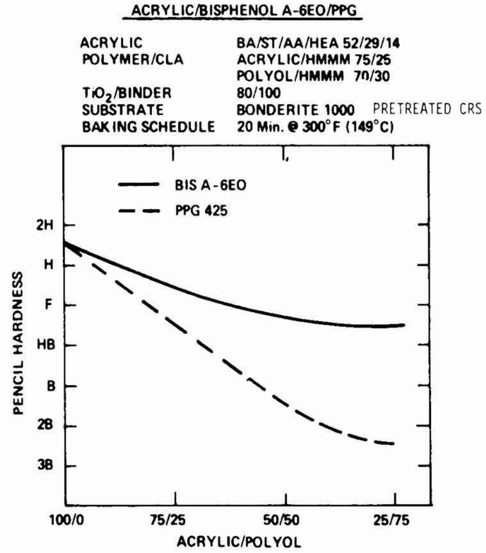


Figure 17—Decrease in film hardness of modified acrylic resin

Table 8—Reduction in Polluting Solvents

	Water-Reducible Coating			High Solids Solvent	Standard Solvent
Acrylic/Polyol	100/0	87/13	50/50		
Nonvolatile, %	42	47	53	85	55
Reduction in total solvent Emission vs. regular Solvent-Borne coating	81	94	97	66.7	0

droxyethylacrylate polymer = 52/29/5/14 modified with 25, 50, and 75% polyol. As polyols, a bisphenol A - 6 EO adduct and a polypropylene glycol MW-425 were chosen. Although the polypropylene glycol permits an increase in impact resistance at the 25% level, the bisphenol A - 6 EO adduct is superior in this respect. At higher polyol levels, the polypropylene glycol modified coating loses impact resistance, probably as a result of poor adhesion to the substrate. The film hardness is somewhat reduced with the addition of the bisphenol A - 6 EO polyol, but polypropylene glycol has a much greater effect on softening of this acrylic resin. Results are shown in *Figure* 17.

Blending of the polyol with an acrylic resin has certain limitations in reducing the level of co-solvents. A more promising route is the polymerization of the acrylic resin in the polyol with subsequent solubilization or emulsification of the polymer blend in water/amine solutions. *Tables* 7 and 8 list the solvent composition of an aqueous paint prepared from a water-soluble acrylic resin made by a conventional solvent polymerization technique, and the same acrylic resin polymerized in a bisphenol A - 6 EO polyol. The organic solvent and amine content in the unmodified acrylic paint formulation is about 14.8 vol% of the solvent, the 87/13 acrylic/polyol system prepared in the polyol has a solvent and amine content of only 5.1%, and this level is further reduced in the 50/50 system to 2.7%. This corresponds to significant reduction of organic solvent in the water-based system. Compared to presently used standard solvent-borne paint systems, the organic solvent emission of an optimized polyol/acrylic paint is reduced by about 97%.

Polyol Blends with Hydrosols

In addition to so called water-soluble polymers, water-dispersible systems are on the market which have properties between the low molecular weight solution polymers and the high molecular weight emulsion polymers. These systems are of interest because they overcome some of the application problems of emulsions, but still offer better performance than solution polymers. Under practical application conditions, it has been found that these polymers still offer problem areas, such as low application solids and very dry spray. Blends of the polyol and hydrosols are able to overcome some of the limitations of the system.

As shown in *Table* 9, the addition of the bisphenol A - 6 EO adduct can raise the application solids of the rather low value of 33 wt% of the hydrosol to about 63%. The spray viscosity can also be raised from 22 sec Ford Cup 4 to 70 sec Ford Cup 4. Gloss of the system also improves, probably because of the improvement in flow by the low molecular weight polyol modification. The impact resistance again does improve with polyol modification as has been shown with other acrylic solution polymers. The hardness of the polyol modified system is about one pencil lower. Surprisingly, the salt-spray resistance of the polyol modified system is better than the unmodified resin. This can be attributed to better wetting of the substrate or reduction in the surfactant level that the hydrosol might contain.

Table 9—Polyol/Acrylic Hydrosol Blend

Hydrosol	Acrysol WS-24
Polyol	Bisphenol A - 6 EO
Pigment/Binder	0.9/1
Substrate	Cold-rolled steel Bonderite 1000 iron phosphate treated
Baking cycle	20 min at 300°F (149°C)

Polymer	Bisphenol A - 6 EO/Acrysol WS-24 3/2	Acrysol WS-24
Crosslinking agent	HMMM	HMMM
Resin/CLA ratio	80/20	88/12
Application solids, %	63	33
Viscosity, Ford Cup 4, sec	70	22
Film thickness, mil	1.1	0.8
Color, Photovolt, blue	90	86
Gloss, 60°	97	88
Gloss, 20	95	87
Hardness, Knoop, KN_{25}	8	12
Hardness, pencil	H-2H	2H-3H
Reverse impact, in./lb	50	< 10
Solvent resistance, MEK rubs	> 200	> 200
Salt-Spray resistance, ASTM B 117-64, 240 hr	1-2 mm/10	3 mm/8F

Blends of Polyol with Polyester Resins

Blends of a bisphenol A - 6 EO polyol with water-soluble polyester resins have shown considerable promise in increasing stability, flow characteristics, application solids, and electrostatic spray behavior of polyester resins. The significant impact improvement seen with polyol modified acrylic resins is not observed with polyesters because polyester resins have sufficient impact resistance and flexibility. Combinations of bisphenol A - 6 EO polyols with polyester resin do, there-

Table 10—Properties of Polyester/Polyol

Binder:	
XC-4012 Resin	10
Cyplex 1600 Resin	32.5
Bisphenol A - 6 EO	32.5
HMMM	25
Amine	Methyl Diethanolamine
Pigment	Unitane OR-600, TiO_2
Catalyst	0.7% DDBSA

Paint Characteristics: **System**	**Polyester/Polyol**	**Comparative**
Nonvolatile, %	58.7	46.5[2]
Volume solids, %	45.1	32.7
Viscosity, Ford Cup 4 sec	45	55

Film Characteristics: **Substrate**	**Alodine® 1200S**	**Bonderite 1000**	**Bonderite 1000**
Film thickness, mil	0.9	1.0	1.2
Hardness, Knoop, 25 g	10.8	9.3	11.5
Hardness, pencil	2H-3H	2H-3H	H-2H
Gloss, 60°	94	93	90
Gloss, 20°	76	70	79
Reverse impact, in./lb	20	60	> 140
Solvent resistance, MEK rubs	> 200	> 200	> 200

Table 11—Blends of Bisphenol A - 6 EO Polyol with Solvent-Borne Polyesters

Polyester resin[a]	Isophthalic acid, Adipic acid, Propylene glycol, Trimethylol propane
Solvent blend	Solvesso 150/Cellosolve® acetate/ n-Butanol = 70/15/15
Catalyst, %	0.2, pTSA
Baking schedule	1 min at 500°F (260°C.)
Substrate	Alodine® 1200S
Film thickness, mil	0.9-1.0
Nonvolatile, %	67

Polyester	85	55	35	25
Bisphenol A - 6 EO	—	20	35	35
HMMM	15	25	30	40
Viscosity, Ford Cup, 4 sec	200	107	49	29
Hardness, Knoop, 25 g	12.2	10.7	9.3	7.7
Hardness, pencil	H-2H	F-H	F-H	F-H
Reverse impact, in./lb	60	60	60	40
T-Bend	T-0	T-2	T-3	T-3

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[a] Nonvolatile = 65%, viscosity = Z_1 in Solvesso 150, hydroxyl number = 50.

fore, have equal impact resistance to the unmodified polyester system or they are inferior. Film properties of a polyester/polyol combination are shown in *Table* 10.

This formulation can give film thickness as high as 1.8

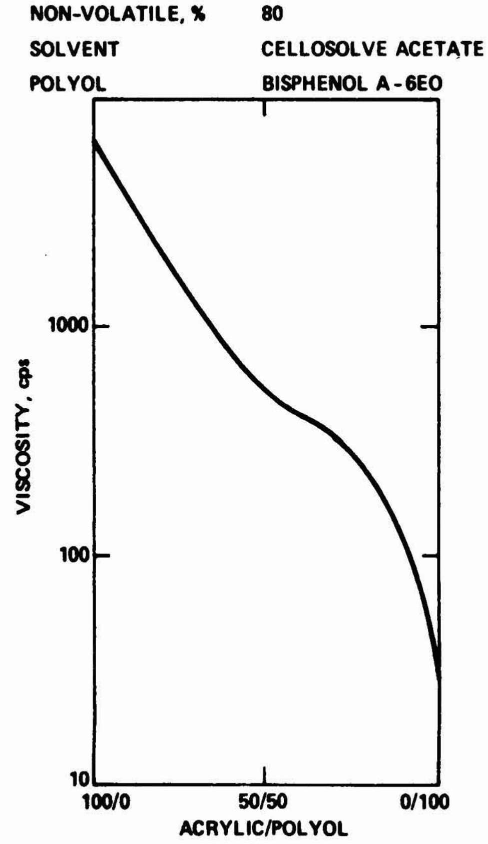

Figure 18—Viscosity of Acryloid/polyol resin

Table 12—Blends of Acrylic Oligomer/Polymer

Acrylic resin	Acryloid OL-42 resin
Polyol	Bisphenol A - 6 EO
Crosslinking agent	HMMM
Resin/Crosslinking agent	TiO_2
Pigment	80/100
Pigment/Binder	70/30

Paint Characteristics:

Resin Composition	Acryloid OL-42	Acryloid OL-42/ Bisphenol A - 6 EO = 50/50
Nonvolatile, %	80	80
Viscosity Brookfield, 25°C, cps	870	120

Film Properties:

Resin Composition	Acryloid OL-42	Acryloid OL-42/ Bisphenol A - 6 EO = 50/50
Baking conditions, 150°C (302°F)	20 min	20 min
Substrate	Bonderite 1000 CRS	Bonderite 1000 CRS
Film thickness, mil	1.0	1.0
Color, Photovolt, blue	90	90
Gloss, 60°	91	92
Gloss, 20°	77	79
Hardness, Knoop	15.6	12.1
Hardness, pencil	3H-4H	3H-4H
Reverse impact, in./lbs.	< 2	30

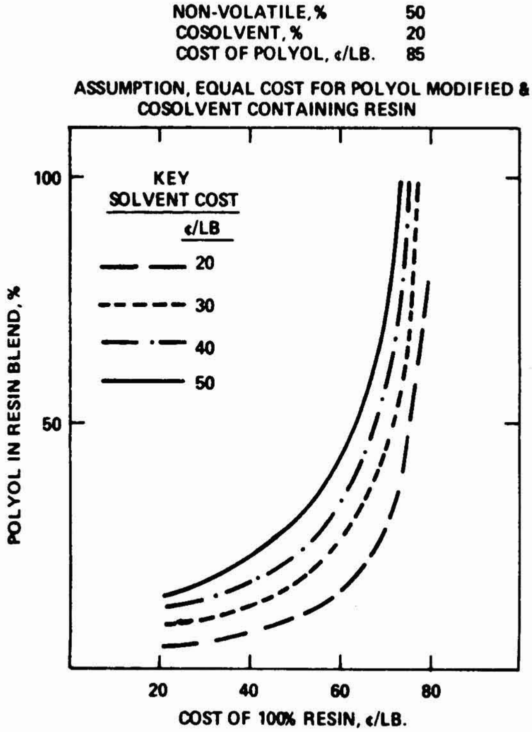

Figure 19—Cost of polyol modified water-borne coating

mil without blistering. The use of lower boiling dimethyl ethanol amine would result in severe blistering and wrinkling in the formulation.

Use of Polyol In Solvent-Borne Coatings

A bisphenol A - 6 EO polyol has a broad compatibility with most alkyds, polyesters, and acrylic resins. The benefits derived from these polyol blends are higher application solids and the possibility of using existing polymers to achieve the higher application solids. *Table* 11 shows the performance of an oil-free polyester resin crosslinked with HMMM and modified with different levels of polyol and also crosslinked with increasing levels of HMMM. It should be noted that the level of HMMM has been increased over the optimum level for impact and flexibility. Using the polyol modification and increasing HMMM levels, a reduction in viscosity from 200 sec Ford Cup 4 to 29 sec can be achieved. Not surprising is that the flexibility starts to suffer at the very high end of polyol and HMMM modification, but nevertheless, the system containing as much as 40% HMMM and 35% polyol modification, and only 25% polyester resin still gives a respectable impact resistance and T-bend.

Use of Polyol with High Solids Solvent-Borne Acrylic Resins

Oligomeric acrylic resins have found considerable interest[5] in high solids coatings. Although acrylic oligomers do permit narrow molecular weight distribution, which assures low weight loss by evaporation, these oligomers do, nevertheless, have limitations in the maximum solids attainable. *Figure* 18 gives the viscosity of Acryloid OL-42 resin in different blends of this acrylic with a polyol at a nonvolatile content of 80%. The viscosity of the unmodified acrylic oligomer solution drops from about 6,400 cps to about 1,500 cps at a 75/25 acrylic/polyol blend, and it is further reduced to 570 cps if a 50/50 acrylic/polyol blend is utilized. The modification with the polyol also increases the impact resistance of the acrylic resin with only a slight decrease in hardness of the coating as shown in *Table* 12.

Application Areas for Polyol And Polyol Modified Systems

The most immediate use of polyols in coating systems is in combination with existing backbone resins to reduce the solvent content and permit the formulator more flexibility to achieve certain performance and application characteristics. Although anti-pollution regulations do permit an 80/20 water/organic solvent ratio, the coatings industry expressed the desire to go to a 70/30 ratio to permit a greater formulation flexibility. The use of polyols as reactive diluents allows the paint formulator in many cases to go far lower in organic solvent content without sacrifice in application characteristics. The replacement of organic solvent in a water-borne paint with polyol also permits, at least under certain conditions, a reduction in cost of the paint formulation. The level of polyol in the formulation, which can be used at equal cost to a conventionally formulated paint system, depends on such factors as cost of the backbone resin, polyol, solvent cost, level of amine, and cost of amine. *Figure* 19 shows the level of polyol which can be used at equal cost.

The presently available polyol based on bisphenol A - 6 EO has some limitations in certain application areas. Its main limitation is exterior durability. Levels higher than about 10-15% of polyol in a paint formulation will impair the exterior durability of the system. Application areas where the polyol modification holds promise are general purpose spray application, metal decorating, flow coating, and dip applications.

ACKNOWLEDGMENT

I acknowledge the assistance of Dr. G. G. Parekh, N. J. Albrecht, and T. Fiorillo in this work. I also thank Dow Chemical Co., Designed Products Dept. and Jefferson Chemical Co. for providing some of the polyols used in this study. ☐

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(2) U. S. Patent 3,959,201.
(3) U. S. Patent 3,960,983, 3,969,202.
(4) Koral, J.N., and Petropoulos, J.C., JOURNAL OF PAINT TECHNOLOGY, *38*, No. 501, 610 (1966).
(5) Lunde, D.I., Wetzel, L.A., and Freund, W.J., *Mod. Paint Coatings, 65*, No. 3, 23 (1975).

Trademark References

Solvesso	Humble Oil & Refining Co.
Beetle, Cymel, Cyplex, XC-4011, XC-4012	American Cyanamid Co.
Acryloid, Acrysol, Rhoplex	Rohm and Haas Co.
Rezyl	Koppers, Inc.
D.E.R.	Dow Chemical Co.
Epon	Shell Chemical Co.
Carboset	B.F. Goodrich Chemical Co.
Ucar, Cellosolve	Union Carbide Corp.
Alodine	Amchem Products, Inc.
Bonderite	Hooker Chemical Co.

Development of Water-Borne Vehicles For Use in Industrial Wood Coatings

J. Hortensius
Synres International BV*

Water-borne vehicles for wood coatings consisting of an emulsion and a water soluble resin have been developed that exhibit properties equal to solvent-based coatings. Water-borne vehicles in clear coatings must possess very good surface wetting properties to show the natural grain of the wood as exhibited by solvent systems. The best effect is obtained when part of the water-borne vehicle is water soluble. The water soluble part is critical in developing the rheological properties in pigmented systems.

Water-borne coating systems based on these vehicles can be applied using existing coating equipment.

INTRODUCTION

In discussing industrial wood coating systems, it is important to realize that in the majority of cases the coated substrate is not natural wood, but rather processed wood in the form of chipboard, hardboard, or plywood. These processed substrates are then modified to achieve an attractive wood grain appearance by applying a thin layer of (decorative) veneer, or in many cases, printed to obtain a woodgrain reproduction.

In either case, natural wood or processed wood, the coatings systems must overcome porous, uneven surfaces and a substrate that swells when exposed to the solvent or water used in the coating.

Any new coating system for use in furniture or flat stock must demonstrate the advantages of conventional nitrocellulose coatings: ease of application, quick drying, ease of repairability; but without the disadvantages: poor build, poor alcohol resistance, poor abrasion resistance, extreme inflammability.

Use of water-borne coatings that meet or surpass the properties of nitrocellulose lacquers will inherently offer major advantages as measured in terms of reduced flammability, reduced air pollution, reduced energy requirements, and conservation of petrochemical-based solvents.

The advantages and disadvantages of solvent vs. water-based coating systems have been discussed many times and the foregoing comparison is adequate for this presentation.

Clear Coatings

Flat stock and furniture surfaced with decorative veneer need a clear coating system, not only for protection, but also to enhance the natural grain of the wood. When a clear emulsion coating is applied directly to veneer, it will result in a dull appearance since the emulsion particles do not penetrate the wood and do not sufficiently wet the woodfibers. Better results can be obtained by adding a wetting agent to the emulsion, but the best effect is obtained when a water-soluble binder penetrates into the wood pores, wetting the wood fibers. However, water-soluble binders often remain water-soluble, causing problems in overcoating and water resistance of the total finishing system. Water-soluble binders often have a high pH, which can cause discoloration of the wood or decorative veneer. When a combination of an emulsion with a water-soluble binder is used, the resulting coating meets the necessary application and film properties.

In acid-curing hydroxy acrylic emulsion coatings, the water-soluble part is a crosslinking urea resin which wets the woodfibers excellently, and produces the desired coating after curing.

Formulation 1 is a flat finish example of such an acid-curing coating, but other finishes can be obtained, such as: high gloss, semi-gloss, and full matte. The quality of these finishes is excellent when compared to solvent-based acid curing lacquers. They easily pass the RTMA standards for print resistance, cold check resistance, moisture and heat resistance, solvent resistance, color stability, and so on.

It will be readily understood why these finishes are of such excellent quality when one keeps in mind that emulsion polymers have a very high molecular weight, which can reach values of 100,000 and more. When these molecules are crosslinked, the molecular weights in the cured film can be in excess of one million. Therefore, hard, flexible, and tough films are easily made from emulsions.

In solvent-based systems, high molecular weight polymers, as formed with emulsions, cannot be used; the resulting solution viscosities are too high and solid content too low, which makes it more difficult to achieve the same flexible tough films.

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*Hoek Van Holland, The Netherlands.

Formulation 1—Flat Finish for Furniture

		p/b/w/
A.	Flatting agent	2.29
	Ethanol	3.07
	Ethyl glycol	3.07
	De-ionized water	6.87
	15 min swelling	
B.	Methylated urea formaldehyde resin (85% solids)	22.05
	Dipentine	0.36
	Surfactant	1.17
	Slip agent	0.58
	Defoamer	0.11
	Add A to B under slow agitation	
C.	Hydroxy acrylate emulsion (35% solids)	52.35
	Silicone oil	0.55
	Dimethyl ethanol amine, up to pH = 7.5	0.23
	De-ionized water	7.30
		100.00

Add mixture A/B to C, filter and add prior to use:

Para-toluene sulphonic acid, 48% in de-ionized water, up to pH = 1.5

APPLICATIONS

Application and curing of these emulsion finishes can be done in the same installations which use the solvent-based coatings. Thus, the same spray guns, roller coaters, and curtain coaters can be used but, of course, adjustments have to be made. One example is the filter installation on the curtain coater. See *Figure* 1.

It is well-known that emulsion coatings foam quite easily when they are pumped in such a coater. To form a good, stable curtain, the surface tension on the coating should be low, but the trouble is that the lower the surface tension, the easier foam will be formed. When antifoam additives are added, the curtain does not remain stable. For this reason, foam problems should be corrected by adapting the curtain coater rather than using antifoam additives. Good results were achieved by placing a cartridge filter between the pump and the pouring head, thus filtering the air out of the enamel. This process requires a specially constructed cartridge filter designed to de-aerate the coating as illustrated in *Figure* 1.

The enamel is pumped into the bottom of the housing of the cartridge filter where part of it is forced through the filter media and in this way the air is filtered out, and the enamel, which is then free of air, arrives at the pouring head. The enamel passing around the filter media remains aerated and returns via a valve to the enamel tank, into which the superfluous enamel from the curtain also flows. From this tank the enamel is again pumped through the filter, with only de-aerated material used to form the curtain.

The pressure in the filter can be controlled by a valve, otherwise the enamel would keep flowing around the filter and nothing would arrive in the pouring head.

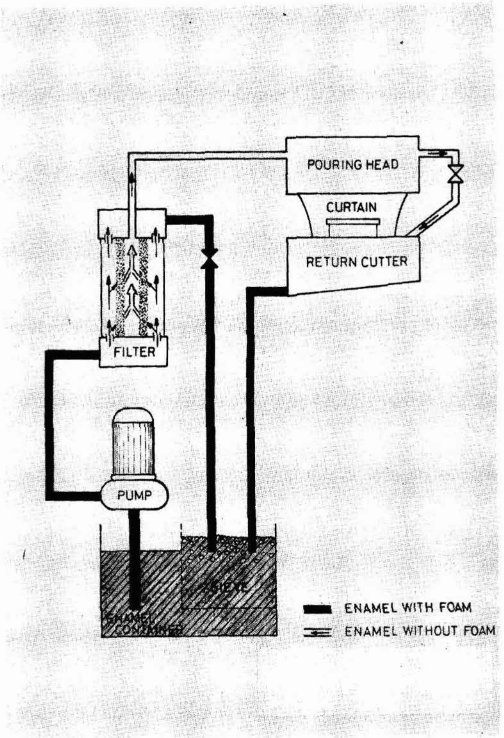


Figure 1—Cartridge filter installation on curtain coater designed to de-aerate coating

Generally, the enamel must be circulated for about 5-15 min before it is free of air.

The type of filter is important since it has been found that different types of paint require different filter types to obtain optimum results, from a cotton type to a propylene type.

The size of the pores also has significant influence in the operation of the filter. The best results so far have been obtained with a pore size of between 80 and 350 microns (μ).

Filter systems of this type could also be used for flow coating installations, to reduce the amount of foam developed.

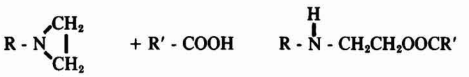
Curing cycles of acid-curing emulsion coatings are about the same as used for the solvent-based coatings, and therefore, in most cases, the drying and heating installations do not need to be changed (See *Table* 1).

Table 1—Curing Cycles of Water-Borne Acid-Curing Emulsion Coatings

Type	Temperature	Time
Room temperature	21°C (70°F)	10-15 min
Convection oven	60°C (140°F)	4-5 min
Convection oven	100°C (212°F)	2-3 min
Infrared radiation	80°C (176°F)	45-60 sec
Infrared radiation	120°C (248°F)	30-40 sec

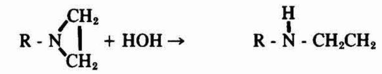
POLYAZIRIDINE CROSSLINKERS

Besides acid curing systems, it is possible to use other crosslinking systems such as carboxylated acrylic emulsions with polyaziridine compounds. The chemical reaction of aziridine with a carboxyl group can be represented by:



(1)

This is an addition reaction and no small molecules are split off, which is an advantage over the urea crosslinkers, where during cure formaldehyde is emitted resulting in odor problems that must be corrected with good ventilation. On the other hand, the aziridine carboxyl reaction is rather slow and cured films will not possess the same surface hardness as acid cured films. As with all two-component systems, polyaziridine carboxylated acrylic emulsion coatings also have a limited potlife. This does not result in a gelled product as with urea crosslinkers, because aziridine hydrolyzes with water:



(2)

The cause of the limitation of the potlife is the disappearance of the crosslinker and, when after about 72 hr the polyaziridine is broken down, the liquid coating can still be used by adding a new amount of crosslinker. A drawback of the polyaziridine crosslinkers is their toxicity and high price.

Also, the amount of water-soluble binder in the coating is not enough to obtain sufficient wetting of the substrate to attain, without special precautions, an acceptable appearance of the woodgrain.

THERMOPLASTIC COATINGS

Finally, thermoplastic emulsions have to be mentioned as binders for clear coatings. Fast drying, without smell, and an unlimited potlife are the advantages of these coatings, but, of course, a similar surface hardness and resistance, as with crosslinked systems, cannot be reached.

Needless to say, all the clear coatings discussed have an excellent adhesion on wood, veneer, paper, and a wide variety of plastics, and, therefore, can also be used as a topcoat over woodgrain reproduction and many other substrates which need clear topcoats.

PIGMENTED COATINGS

Pigmented woodcoating systems have their own special problems. They are mostly used on chipboard and hardboard. As a first treatment, these substrates need a filler and base coat to provide a surface of uniform absorption for the subsequent coats.

The use of water-dilutable vehicles for products of this type is not new, but there is a demand for more sophisticated products. Polyvinyl alcohol, for instance, has been used for some time now as a binder in water-thinnable fillers, but for more general applications the water resistance of this kind of filler is insufficient.

Better water resistance can be obtained if aqueous polymer emulsions are used as binders. Filler or base coats based on these emulsions are, however, much more difficult to apply mechanically than those based on polyvinyl alcohol. This is caused by the following:

- The rheological behavior of emulsions makes it difficult to achieve fillers with good application properties on roller coaters.
- The often insufficient mechanical stability of emulsions sometimes causes coagulation on the rollers.
- The fast skin formation of emulsion coatings with high PVC are not redispersable, and make it impossible to clean the rollers with water.

Therefore, it is necessary to develop a vehicle to produce filler and base coats which are as easy to apply as fillers based on polyvinyl alcohol, with water resistance equal to fillers based on emulsions.

Water-soluble vehicles offer optimum rheological properties to filler systems and, if these vehicles can be made water-insoluble after drying then, theoretically, the ideal vehicle has been found. Carboxylated acrylate emulsions, which meet these requirements, become water-soluble with the addition of ammonia. After drying with the loss of ammonia, they exhibit the water insolubility characteristics of emulsions.

An investigation in this direction proved that the viscosity of most of these types of vehicles was too high, resulting in too much water in the filler system before the correct application viscosity had been obtained. This excess water in the filler means:

- shrinking of the filler during drying, resulting in insufficient filling and cracks;
- slow drying;
- fiber lifting; and
- excess energy for drying necessitated by the excess water.

Therefore, low viscosity acrylate vehicles were developed to make filler systems with a water content of about 35%, which had excellent application properties. On high quality chipboard and hardboard, these filler systems gave very good results, but for low density chipboards, the water proportion was still too high—filling properties were poor and there was too much fiber lifting. Therefore, a lower viscosity vehicle was developed, where 30% of the filler system was water. This was acceptable for many applications, but there was still some difficulty with fiber lifting on substrates of poor quality. The PVC of the filler systems could be raised, but then the filler coat would be very brittle and the total finishing system could become weak and easily damaged. It was then decided to keep the PVC at the same level and to add a hard polymer emulsion, increasing the solids content and thereby decreasing the water content. Moreover, filler properties would be better when the correct polymer was chosen, resulting in better adhesion and toughness.

Table 2—Some Properties of Extenders in Water-Borne Fillers

	Foam	Rheological Properties	Settling	Redispersing	Enamel Hold Out of Top Coating
Omya BLP 2	–	Newtonian-G	Hard	Difficult	G
Barytes	++	Newtonian-G	Slight	Easy	F
ASP 400	–	Thixotropic-P	Slight	Easy	G
ASP 170	–	Newtonian-F	Hard	Difficult	G
Talc, 20 um	–	Newtonian-G	Slight	Easy	F
China clay	+	Newtonian-F	Slight	Easy	P
Celite 110	–	Thixotropic-P	Hard	Difficult	F

Legend:
– = much
+ = slight
++= very slight
P = poor
F = fair
G = good

The idea was excellent, but it turned out to be difficult to find a hard polymer emulsion which improved the quality of the filler system without destroying stability, viscosity, and rheological properties. The correct combination of hard polymer and water-soluble polymer proved that fillers based on this type vehicle had better adhesion, better toughness, and ease of application.

The water content of the filler system was decreased to about 20% by weight (38% by volume). In solvent-based filler systems, it is common to have a solvent concentration of about 15% by weight, corresponding to about 38% by volume. Thus, the volatile content of water-borne and solvent-based filler systems is about the same by volume. This means that the solid contents by volume and the filling properties of water-borne and solvent-based systems are approximately the same.

Therefore, it was concluded that with this water-borne vehicle it is possible to produce filler and base coatings which:

- dry very fast.
- are hard, tough, water resistant, and easy to sand.
- have excellent adhesion.
- have good rheological properties and, therefore, can be easily applied by direct roller coaters and reverse roller coaters.
- have no skin formation, hence are easy to work with.
- offer easy machine clean-up.

It must be noted that formulating and applying water-borne filler and base coatings requires a lot of experience. The extenders have a great influence on the properties of filler and base coatings and have to be selected very carefully.

Some of the most striking properties, which some extenders give to fillers based on the above mentioned water-borne vehicles, are mentioned in *Table* 2. It is clear that, for instance, Celite® 110, which gives much foam and poor rheological properties, is not suitable, whereas barytes is very suitable.

Also, small amounts of organic solvents can be very useful in filler and base coatings to decrease viscosity (See *Table* 3).

Some solvents have a great influence on the evaporation of the water and retard skin formation. Propylene glycol, for instance, is very effective.

Formulation 2 is an example of a water-thinnable filler system which is easy to produce and apply with a reverse roller coater and has excellent filling properties, adhesion, and resistance to water and solvents.

Table 3—Influence of Solvents on the Viscosity of Dissolved Acrylate (Dispersion at pH = 9.3)

Type of Solvent	Total Solid, %	Viscosity (cP)[a] After 1 day
None	33	3,792,000
Ethanol	33	344,000
Isopropanol	33	107,600
Butanol	33	16,640
Isobutanol	33	7,840
Hexylene glycol	33	40,850
Methyl isobutyl ketone	33	81,200
Di-isobutyl ketone	33	193,200
Di-acetone alcohol	33	744,000

(a) 20°C., Brookfield, spindle 6
The amount of solvent is 22%, calculated on the solids content of the acrylate dispersion

Formulation 2—Water-Borne Filler for Chipboard

	p/b/w/
Acrylic emulsion	18.34
Water	10.03
Isobutanol	1.12
Corrosion inhibitor	0.16
Defoaming nonionic surfactant	0.27
Ammonia (25%), up to pH = about 8	1.34
Mix slowly, and after swelling, add:	
Titanium dioxide	3.82
Barytes	43.71
Mica, Mg, Al hydrous silicate (abt 10 μm)	17.39
Ca/MgCO$_3$ Mg hydrous silicate (abt 20 μm)	3.82
	100.00

Grind in Cowles for approximately 5-10 min

Celite is a registered trademark of Johns-Manville Products Corp.

The acrylic emulsion is mixed with water, solvent and other water-soluble ingredients, then ammonia is added to a pH of about 8, and when the emulsion has been swollen, pigments and extenders are added and ground.

Base coatings can be formulated in the same way, but it is advisable to make them with a lower PVC (about 50%-60%) to achieve less porous films. This makes printing or application of a topcoat much easier. Some water-borne acid-curing coatings are very sensitive to porous base coatings, since they easily absorb the water in which the acid catalyst is dissolved, thus inhibiting the cure of the acid hardening coating.

CONCLUSION

With water-borne vehicles it is possible to formulate fillers, base coatings, and clear finishes that can be applied and cured with existing installations with equal or better film properties as compared with solvent-based systems.

The best results will be obtained when polymer emulsions with high molecular weights are combined with water-soluble vehicles.

The emulsions exhibit the desired properties of hardness, toughness, and resistance to solvents and chemicals, while the water-soluble part guarantees good wetting of the substrate and good adhesion, and moreover give the correct rheological properties for roller-and curtain-coating application. This applies to both clear and pigmented systems.

Experiences indicate that in many cases the water-borne systems offer favorable cost/performance when compared with other coatings, as measured in terms of raw material costs and energy costs for curing. □

High Performance Isocyanate-Oxazolidine Coatings

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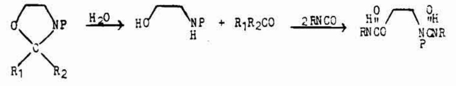
Rohm and Haas Company*

The 2,2-dihydro and the 2-isopropyl oxazolidine moieties possess the features of low basicity, facile hydrolysis by ambient moisture and high reactivity with isocyanate of the unblocked ethanolamine functionality that permit design of coatings that display long pot-life as well as rapid cure under ambient conditions. Furthermore, the incorporation of these groups into carefully tailored acrylic polymers and oligomers as well as into monomeric esters provides high solids coatings with low solvent demand for application. The ambient or force dry cure of these compositions provides a low energy route to coatings with mechanical and resistance properties at least equal to those of high performance baking finishes. Florida exposure of test panels demonstrates that the exterior weatherability of the acrylic-isocyanate coatings is comparable to that of currently used automotive top-coats.

INTRODUCTION

Reactive polyurethane coatings may be divided, in a broad sense, into three major groups. These include moisture cured isocyanate-terminated prepolymers, two-component coatings based on an isocyanate or isocyanate-terminated prepolymer and a polyol, and coatings based on blocked isocyanate.[1] Each of these systems has unique characteristics. The first is generally difficult to use with pigmented systems and is slow curing, the second suffers from very limited pot-life (particularly when the usually necessary catalyst is employed) and the last requires considerable heat to achieve full cure.

We have developed a new two-component coatings system based on blends of a polyfunctional oxazolidine with isocyanate.[2] Properly chosen oxazolidines are weak bases, have no active hydrogen, and are very rapidly converted by atmospheric moisture to the parent alkanolamine which reacts with a polyisocyanate to form an excellent coating. These hydrocurable coating compositions are, in the absence of moisture, stable indefinitely and even in pigmented systems offer a unique combination of speed of cure and long pot-life. Furthermore, the chemistry of the oxazolidine ring is such that it may be conveniently introduced to a variety of polyfunctional and polymeric matrices and is available from relatively low cost materials.



P = Polymeric Substrate

CHEMISTRY OF N-ALKYL OXAZOLIDINES

Formation of Oxazolidines

Oxazolidines are classically synthesized by the cyclodehydration of alkanolamines with aldehydes or ketones.[3] This synthesis is generally carried out under nonequilibrium conditions in which removal of the water drives the reaction to completion. A brief investigation of the influence of the aldehyde or ketone on the rate and extent of oxazolidination under equilibrium conditions was undertaken. Equimolar amounts of N-ethylethanolamine and the aldehyde or ketone were mixed neat and oxazolidine formation was determined by GLC analysis. Results are summarized in *Table* 1. The rapid quantitative formation of the 2,2-dihydro and the 2-isopropyloxazolidines is the striking feature of the data and simply reflects their relatively high thermodynamic stability.

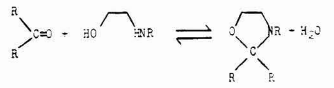
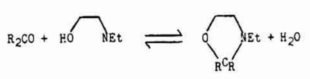


Table 1—Formation of Oxazolidines



Carbonyl Reagent	Exothermic	Reaction Time	% Oxazolidine
CH_2O	yes	5 min	100
$(CH_3)_2CHCHO$	yes	15-20 min	98-100
ØCHO	yes	2-3 hr	90
$(CH_3)_2CO$	no	20 hr	45

Presented at the 13th Biennial Western Coatings Societies Symposium in Los Angeles, Calif., March 3, 1977.

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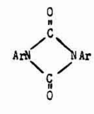
Oxazolidine Basicity

It is a well known fact that nucleophilic tertiary amines and phosphines are effective catalysts for dimerization and trimerization of isocyanates to form ring compounds such as I and II. Aromatic isocyanates form both dimers and trimers while aliphatic isocyanates form only trimers.[4] In either case, however, such reactions, if they occur, will irreversibly drain off isocyanate functionality at least under the conditions normally encountered in coatings practice. The basicity of the oxazolidine component of this system must be adjusted so that this does not occur. Determination of oxazolidine basicity is not a simple measurement because of facile hydrolysis in water to form the alkanolamine IV. Accordingly, oxazolidine basicity was determined in acetonitrile-dioxane mixed solvent by a potentiometric titration technique. Half neutralization potentials were converted to aqueous pK_a values by correlation with the half neutralization potentials and pK_a's of hydrolytically stable compounds of similar structural types. Typical data is summarized in *Table* 2. The nonaqueous pK_a's determined in this fashion were also in good agreement with those calculated by an empirical predictive method.[5] In addition, *Table* 2 summarizes the pK_a's of the same compounds determined by aqueous titration and also the aqueous pK_a's of the parent alkanolamine. In the general case, these two values are identical since, on titration with aqueous acid complete hydrolysis to the alkanolamine IV normally occurs. However, in the case of the 2,2-dihydrooxazolidines derived from formaldehyde, the intermediate species, probably III-i, is sufficiently stable for intermediate values to be obtained. The data can generally be rationalized by consideration of polar inductive effects and the relatively low basicity induced by the 3-(β-acyloxyethyl) substituent is obvious. It is also noteworthy that conversion of the parent alkanolamine to the oxozolidine not only removes its active hydrogen but reduces its basicity by approximately three powers of ten.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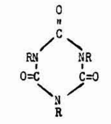
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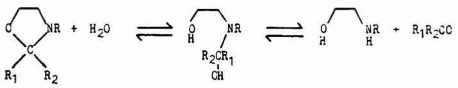

III III-i IV

Table 2—Oxazolidine Basicity

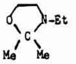
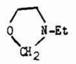
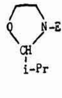
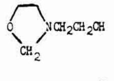
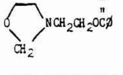
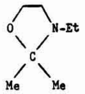
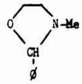
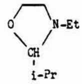
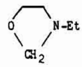
Oxazolidine	pK_a (Nonaqueous)	pK_a (Water)	pK_a (Parent Alkanolamine in Water)
	7.5	10.0	10.0
	7.0	9.0	10.0
	6.8	10.0	10.0
	6.9	8.0	9.0
	5.9	insoluble	8.5

Table 3—Equilibrium Hydrolysis of Oxazolidines

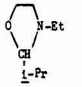
Compound	Hydrolysis Rate Time to 10%, Hr	Equilibrium Composition % Oxazolidine	% Alkanolamine	Time to Equilibrium, Hr
	0.2	0	100	4.0
	1.3	75	25	5.2
	2.4	83	17	6.0
	[a]	~100	~0	---

[a] Rapid hydrolysis is known to take place from competitive isocyanate-oxazolidine hydrolysis reactions.

Hydrolysis of Oxazolidines

Although hydrolysis of oxazolidines to β-alkanolamines (IV) has long been recognized, especially at low pH, no quantitative data have been reported on this system.[3] Accordingly, the hydrolysis rate and equilibrium composition of a number of oxazolidines were examined. The oxazolidine in acetonitrile solution was allowed to react with 5.5 moles of water; the reaction and equilibrium concentration were obtained by GLC techniques. Typical data are summarized in *Table* 3. These rates of hydrolysis generally parallel those of acid-catalyzed hydrolysis of acetals and ketals where acetone ketals are much faster than aldehyde acetals.[6] It is also obvious that, with the exception of the acetone oxazolidine, significant amounts of oxazolidine remain under equilibrium conditions even in the presence of excess water. A brief investigation of the effect of catalyst on this hydrolysis was also conducted and the data are summarized in

Table 4—

Catalyzed Hydrolysis of 

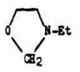
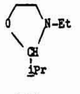
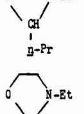
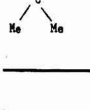
Uncatalyzed Time, Hr	Uncatalyzed % Hydrolysis	5 mole % of HCl Time, Hr	5 mole % of HCl % Hydrolysis	2.5 mole % $Bu_2Sn(Oct)_2$ Time, Hr	2.5 mole % $Bu_2Sn(Oct)_2$ % Hydrolysis
1.0	1.9	1.2	10.4	1.1	15.0
3.2	13.8	2.8	17.0	2.8	18.0

Table 4. Both hydrogen chloride and dibutyltin dioctoate show significant acceleration of hydrolysis and the latter catalyst is more effective.

Oxazolidine-Isocyanate Stability Studies

The first requirement of an oxazolidine-isocyanate coating system is that the reactants are stable in the absence of moisture for long periods of time at ambient temperature. The reactivity of various oxazolidines at 100°C with equimolar amounts of n-hexyl isocyanate was examined neat and the data are in *Table* 5. It is notable that simple changes in the 2-substituents have profound influence on oxazolidine stability. The 2,2-dihydro and the 2-*s*-alkyl oxazolidines are relatively stable, while those derived from n-butyraldehyde and acetone are reactive with oxazolidines even in the absence of water. Behavior at room temperature is comparable in that for years, the 2,2-dihydro and 2-isopropyloxazolidines are unreactive with aliphatic isocyanates. The chemistry of the dry oxazolidine-isocyanate reaction is complex. The only reaction identified between the 2,2-dihydro-oxazolidine and n-hexyl-isocyanate was slow trimerization of the latter compound; a moderate yield of the isocyanurate trimer II was isolated. In the case of the more reactive oxazolidines, such as those derived from acetone, it is apparent that isocyanate disappears from the reaction mixture at a much faster rate than oxazolidine is consumed. The chemistry here is complex and a number of competing reactions result in a very complex mixture of products which could not be characterized.

Table 5—Neat Reaction of Oxazolidines With n-Hexyl Isocyanate at 100° C

Compound	Oxazolidine Half-Life	Oxazolidine-Isocyanate Ratio (Time)
	>3 Weeks	1:1 (7 days)
	2 Weeks	1:1 (7 days)
	5 Hours	1:1 (5 hours) 2:1 (20 hours)
	>3 Hours	3:1 (3 hours)

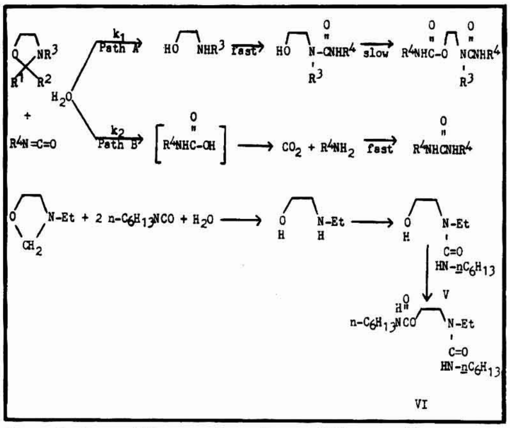


Figure 1—Competitive reaction of oxazolidines and isocyanates with water

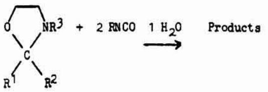
The stability of weakly basic oxazolidines with phenyl isocyanate was also examined qualitatively. The aromatic isocyanate was much more reactive and in no case was the reaction mixture stable even at temperatures as low as 25°C. The obvious conclusion is that coating systems based on blends of aromatic isocyanates and oxazolidines are not attractive if long pot-life of the blend is required.

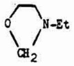
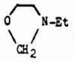
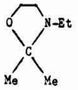
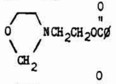
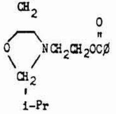
Wet Oxazolidine-Isocyanate Reaction

It is obvious that the utility of an isocyanate-oxazolidine coating system requires that the reaction of oxazolidine with water will be much faster than that of the isocyanate. Otherwise, the isocyanate content of the system will be drained to an unproductive sinkhole. This situation is summarized in *Figure* 1. The synthetic parameters of the system must be chosen such that $k_1 > k_2$ and Path A is predominant. Prior to detailed examination of this chemistry one preparative experiment was completed. The reaction of two equivalents of n-hexylisocyanate with one equivalent of N-ethyl-oxazolidine and one equivalent of water in acetonitrile at 26°C was examined. The products were separated by thin layer chromatography and characterized by comparison with authentic samples. The major product, as expected, was the hydroxyurea V and the minor product the ureaurethane VI. The fate of formaldehyde in this system is not clear since the work-up procedure would not distinguish between V and VI and their methylol derivatives. This reaction was not allowed to "age" long enough to evolve carbon dioxide and the material balance was poor; however, it does support the overall validity of *Figure* 1 as a model for the system.

The wet reaction of oxazolidines and isocyanates was then investigated in detail. These experiments

Table 6—Wet Reaction of Oxazolidines With n-Hexylisocyanate, 26° C



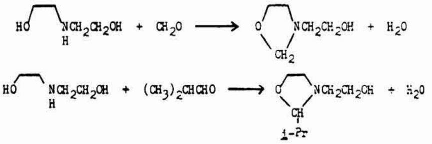
Oxazolidine	Time (Hr)	% Oxazolidine Consumed	% Isocyanate Consumed	% CO₂
	1	<30	>90	75
 + 5% HCl catalyst	1	30	60	12
	1 16	20 40	30 90	10 50
	0.75 3.2	32 41	-- --	2 9
	3 29	78 97	-- 50	0 0

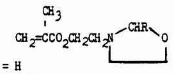
were also carried out in acetonitrile at 26° using GLC techniques for analysis of oxazolidine and isocyanate and a gas burette for determination of CO_2 evolution. Typical data are summarized in *Table* 6.

Inspection of this data leads to a number of conclusions. With simple oxazolidines the rate constants k_1 and k_1 are comparable in magnitude, and Path A and Path B of *Figure* 1 are competitive; however, the 2,2-dihydro and the 2-isopropyl N-benzoyloxyethyl oxazolidines are especially interesting cases in that little or no CO_2 is generated. These oxazolidines are unique in that they are weaker bases (see *Table* 2) and obviously hydrolyze much faster in water than the corresponding N-alkyl compounds. Finally, it is worth noting that Lewis acids, again because they accelerate oxazolidine hydrolysis, encourage Path A.

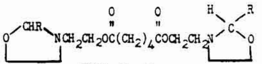
Selection of Synthetic Parameters Of Polyfunctional Oxazolidines

The basic building block for commercial synthesis of polyfunctional oxazolidines is diethanolamine. This low cost amine is readily converted in high yield by reaction with formaldehyde or isobutyraldehyde to the corresponding oxazolidines. These are in turn converted to the methacrylate esters VII by base catalyzed transesterification with methyl methacrylate.[7] Copolymers containing VIIa or VIIb can readily be prepared in conventional molecular weight ranges by free radical solution polymerization in organic solvents. Low molecular acrylic oligomers containing VIIa or VIIb can also be prepared by an anionic process.[8] In addition, a variety of esters and polyesters can be obtained which have oxazolidine functionality. Typical examples include the bis adipates VIIIa and VIIIb which are available from transesterification of dialkyl adipates with the oxazolidines. These low viscosity liquids are tetrafunctional in their reactivity with isocyanates and are interesting intermediates for a variety of polyurethane coatings.





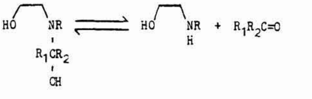
VIIa R = H
VIIb R = i-Pr



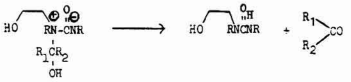
VIIIa R = H
VIIIb R = i-Pr

It is a fortunate fact that the polyfunctional oxazolidines most readily prepared from diethanolamine, formaldehyde, or isobutyraldehyde, and an ester are uniquely good candidates for polyurethane coating systems based on alipathic isocyanates. These particular oxazolidines are rapidly hydrolyzed, are stable with aliphatic isocyanates in the absence of moisture, and effectively coreact with isocyanates to form high performance coatings. The superiority of this particular type of oxazolidine is undoubtedly a reflection of its low basicity and rapid hydrolysis; the mechanism pictured in *Figure* 2 provides a reasonable explanation of this behavior. Strongly basic oxazolidines will be protonated largely on nitrogen and the population of the likely hydrolysis intermediate X is presumably much lower in such circumstances.

One other mechanistic point concerns the reaction of III-i or IV with isocyanate. The reaction of the alkanolamine IV with isocyanate to give urea is straightforward. However, it is worth noting that III-i can also react directly with isocyanate through an intermediate III-ii to give an identical product, and prior dissociation of III-i to alkanolamine is not necessary.



III-i IV



III-ii

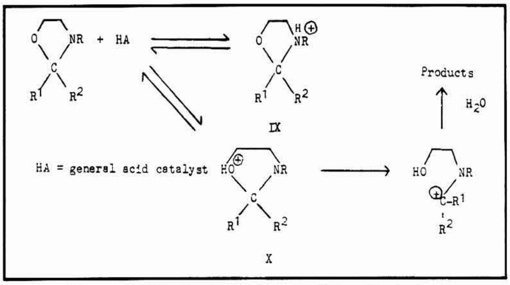


Figure 2—Mechanism of Oxazolidine Hydrolysis

Most of the chemical conclusions developed in this work were obtained from examination of oxazolidine-isocyanate reactions is dilute solution. The primary concern is, of course, what happens in a high viscosity coating film but the general trends observed in model systems are consistent with the behavior of polymeric hydrocurable oxazolidine-isocyanate systems.

PERFORMANCE OF PRACTICAL COATING SYSTEMS

Description of Materials

A large variety of oxazolidine functional compositions can be designed to offer properties from soft, adhesive-like solids to hard and inflexible plastics. This discussion will be limited to compositions with an intermediate performance profile, i.e., with a balance of hardness and flexibility that is useful in coatings. Moreover, five resins with diverse physical parameters have been selected to illustrate the versatility of oxazolidine-isocyanate coatings; their general constitution and physical characteristics are listed in *Table* 7. The resins selected encompass a broad range of molecular weights (and associated application solids), from the monomeric oxazolidine esters to a novel acrylic oligomer to polymers of conventional molecular weight. Furthermore, the level of oxazolidine functionality increases ten-fold in proceeding from Polymer A to the DOEA ester.

Polyisocyanates of both the aromatic and aliphatic type have been screened as coreactants for oxazolidines. As predicated by the model system work, blends of oxazolidine functional resins with aromatic isocyanates offer only one or two days of pot-life, whereas the aliphatic isocyanate blends are indefinitely stable in the absence of moisture. Also, the coatings based on aromatic isocyanate tend to yellow as well as to deteriorate early when exposed to weathering. These shortcomings are not displayed by the preferred aliphatic coreactants.

Table 7—Description of Oxazolidine Functional Resins

A. Constitution

Abbreviation	Oxazolidine Functionality	Method of Preparation
Polymer A (acrylic)	Oxazolidinylethyl methacrylate	Free radical solution polymerization
Polymer B (acrylic)	Oxazolidinylethyl methacrylate	Free radical solution polymerization
Oligomer (acrylic)	Oxazolidinylethyl methacrylate	Anionic process[8]
BIPOT	Bisisoprophyloxazolidinylethyl-terephthalate	Transesterification of dimethyl terephthalate
DOEA	Dioxazolidinylethyl adipate	Transesterification dimethyl adipate

B. Physical Characteristics

Resin	Approx $\bar{M}n$	% Solids	Solvent	Viscosity (cps)	Oxazolidine Equivalent Weight
Polymer A	15,000	55	MT/CA	3000	900
Polymer B	15,000	60	Toluene	500	450
Oligomer	1,200	85	C.A.	7000	265
BIPOT	448	100	—	1500	112
DOEA	344	100	—	100	86

Code: $\bar{M}n$ is number average molecular weight; MT is mineral thinner; CA is cellosolve acetate.

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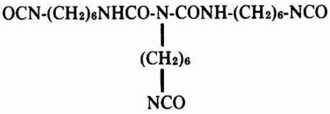
Polisocyanate prepolymers based on isophoronediamine diisocyanate and 4,4 'methylene bis (cyclohexyl isocyanate) have offered good properties in conjunction with oxazolidines; but, extensive work with them has been avoided due to the potential toxicity problems stemming from presence of unreacted diisocyanate in the prepolymers. In these studies, the relatively nontoxic triisocyanate, Desmodur® N[9] and the innocuous DDI® diisocyanate have been used exclusively. The idealized structural formula of Desmodur N has been reported as follows.[10]



$$OCN\text{-}(CH_2)_6NHCO\text{-}\underset{\underset{\underset{NCO}{|}}{\underset{(CH_2)_6}{|}}}{N}\text{-}CONH\text{-}(CH_2)_6\text{-}NCO$$

The commercial product in its 100% form has 22% NCO groups and a room temperature viscosity of 7000 cps.

Desmodur N is a registered trademark of Farbenfabriken Bayer AG.
DDI diisocyanate is a registered trademark of General Mills, Inc.

Table 8—Properties of BIPOT/Desmodur N Coatings at Varying Stoichiometry

Functional Group Ratio (Oxazolidine/Isocyanate)	Zapon Tack-free Time (Hr)	Properties After 1 Week at 77°F/50% RH			
		Tukon Indenter Hardness - KHN	Swelling Ratio DMF	5% NaOH	5% H_2SO_4
1/1	1¾	<1	2.3	0	4
1/1.5	2½	8	1.7	8	9+
1/2	3	14	1.1	9	9+
1/4	8	13	1.1	9+	10
1/6	>18	14	1.1	9+	9+
Neat Desmodur N	>18	12	1.0	9+	9+

Notes: (1) BIPOT/Desmodur N blends are cast from xylene/C.A. solution onto aluminum panels to give 1.5 mil dry films. All blends contain 0.02% on solids of dibutyltin dioctoate catalyst.
(2) Zapon tack-free time and Tukon Indenter Hardness (KHN = Knoop Hardness Number) tests are described in reference (12).
(3) Swelling Ratio is the ratio of equilibrium swollen volume of detached film in dimethylformamide to unswollen volume.
(4) Coatings are immersed in aqueous NaOH or H_2SO_4 to qualitatively assess resistance on a scale from 10 (no effect) to 0 (coating disintegrates).

The DDI diisocyanate crosslinker is described as OCN-[36 carbon hydrocarbon radical]-NCO, with a NCO content of 14% and a room temperature viscosity of 150 cps.[11]

Stoichiometry of Oxazolidine Ring

The reaction products identified in the model system work (*Figure* 1, Path A) indicate that the oxazolidine ring is difunctional in its reaction with isocyanates. Infrared spectra on selected oxazolidine-isocyanate coatings which have been allowed to coreact in the presence of moisture are qualitatively consistent with this, since peaks of substantial height that can be associated with both urea and urethane structures appear in the spectra. More rigorous chemical analysis of the coatings is difficult due to their crosslinked, intractable nature.

A separate, and perhaps definitive, confirmation of difunctionality for the oxazolidine ring is offered by evaluation of coatings properties for different ratios of BIPOT ester to Desmodur N, as enumerated in *Table* 8.

The neat Desmodur N is very sluggishly reactive with ambient moisture, even in the presence of 0.02% tin catalyst. Nonetheless, it eventually self-condenses, presumably by Path B of *Figure* 1, to give a hard and highly crosslinked coating. Addition of BIPOT to the Desmodur N accelerates cure rate, but clearly, not in a catalytic fashion. Rather, fast cure rate (Zapon tack-free time) is not achieved until one mole of oxazolidine groups is present for each two isocyanate groups. Furthermore, the hardness, solvent swelling ratio, caustic and acid resistances of the coatings display a noticeable optimization at the same ratio, with much poorer properties at lower levels of isocyanate. The somewhat fas-

Table 9—Viscosity Stability of Oxazolidine-Isocyanate Resin Blends

System	Ratio (Solids Basis)	Total Solids Content (%)	Variable	Viscosity Progression at 77°F (22°C) cps			
				Initial	1 day	1 wk	1 mo
Polymer A/DDI	75/25	40	None	23	23	26	26
	85/15	40	NCO at half stoichiometry	31	32	32	38
	75/25	40	30% of solids is TiO_2	19	25	39	76
	85/15	40	30% TiO_2, ½ stoich. NCO	23	31	55	182
	85/15	50	30% TiO_2, ½ stoich. NCO	74	145	265	580
	85/15	50	50% TiO_2, ½ stoich. NCO	32	78	Gels	2 da.
Polymer B/Des N	70/30	40	None	22	25	26	28
		45	None	125	140	200	340
		45	0.1% H_2O on solids	160	225	950	Gel
		45	0.2% H_2O on solids	210	450	Gel	—
		45	0.4% H_2O on solids	360	Gel	—	—
		45	0.1% T-12 on solids	240	500	Gel	—
		40	3% of solids is al. flake	22	25	32	50
Oligomer/Des N	60/40	70	None	100	105	110	150
BIPOT/Des N	37/63	83	0.02% T-8 on solids	200	—	—	500
DOEA/Des N	31/69	100	None	2000	—	—	3500

Notes: (1) All unpigmented blends are sealed directly in glass vials suitable for measurement of viscosity. Pigmented formulations are stored in metal cans, and are periodically opened, in a dry box to measure viscosity by spindle method.
(2) Water is post-added to blends as a solution in dimethylformamide.
(3) T-8 is dibutyltin dioctoate and T-12 is dibutyltin dilaurate.
(4) Aluminum flake is added as a 60% solids slurry in aliphatic solvent.
(5) Rutile TiO_2 is incorporated by ball milling in Polymer A under dry nitrogen

Table 10—Speed of Cure of Oxazolidine-Isocyanate Coatings

System	Ratio (Solids Basis)	Curing Conditions	Zapon Tack-Free Time (Hr)	Tukon Indenter Hardness-KHN 1 day	3 days	1 week	1 month
Polymer A/DDI	85/15	77°F, 50% RH	1	3	5	6	8
Polymer B/Des N	70/30	77°F, 10% RH	—	2	—	10	12
		77°F, 50% RH	2	5	9	11	12
		77°F, 85% RH	—	7	10	12	12
		77°F, 50% RH 0.1% T-12	1	6	9	10	10
		180°F, 25% RH	0.25	Coating is hard enough to handle after 0.5 hr			
		180°F, steam	0.10	Coating is hard enough to handle after 0.25 hr			
Oligomer/Des N	60/40	77°F, 50% RH	4	1	3	8	9
BIPOT/Des N	37/63	77°F, 50% RH	6	1	—	14	13
		77°F, 50% RH 0.02% T-8	3	3	—	13	14
DOEA/Des N	31/69	77°F, 50% RH	3	< 1	1	1	2

Notes: (1) Formulations are cast on steel panels to produce 1.5 mil dry films and allowed to cure under the conditions indicated.
(2) RH is relative humidity

ter cure rate at the lower levels of isocyanate is probably a reflection of differential reactivity of the two active hydrogens released by oxazolidine ring hydrolysis, with the amine hydrogen more reactive than the hydroxyl hydrogen. Nonetheless, the ultimate film properties are consistent with complete reaction of isocyanate with both active hydrogens.

Similar blend ratio studies have been conducted with oxazolidine functional polymeric resins in combination with Desmodur N or DDI diisocyanate. These show more gradual loss of properties at levels of isocyanate less than two per oxazolidine. This is not surprising in view of the polyoxazolidine functionality of polymer *vs.* the dioxazolidine functionality of BIPOT and the need to crosslink only a fraction of the oxazolidine groups in the polymer to achieve useful film properties.

Package Stability Of Oxazolidine-Isocyanate Blends

Analogous to commercial moisture-curing isocyanate-terminated prepolymers, it is possible to achieve long pot-life with oxazolidine-isocyanate blends by rigorous exclusion of moisture during storage.

The data of *Table* 9 illustrate essentially that indefinite stability has been achieved in several "dry" oxazolidine-isocyanate resin blends. Also evident is the favorable solids-viscosity relationship for some of the blends that permit application at high solids with low solvent demand and greatly reduced solvent pollution upon curing.

Also illustrated in *Table* 9 are factors which aggravate stability. In order of decreasing importance, these factors are: (a) purposely introduced water; (b) addition of tin salt catalysts; (c) incorporation of rutile TiO_2, with higher levels noticeably worse than lower levels; and (d) storage of blends at higher initial viscosity through higher solids. In the case of the TiO_2 pigmented enamels, our handling precautions were to store commercial grade pigment in a dessicated area prior to use and to incorporate it by ball milling into Polymer A in a dry nitrogen atmosphere. No attempt was made to drive absorbed moisture from the TiO_2 surface by baking. Consequently, the instability that it produces probably relates to introduction of moisture.

There are practical limitations to rigorous exclusion of moisture when formulating coatings on a large scale. Thus, it is prudent to treat these blends as two-package coatings, but with extended pot-life compared to conventional two-package urethanes, which typically gel within several hours to two days after mixing. The degree of extended pot-life will be a direct function of the degree to which moisture has been excluded. Be aware, however, that as little as 0.4% of water on coating solids is sufficient to reduce pot-life to less than one day.

Speed of Cure Profile

Conventional two-package coatings based on aliphatic isocyanates cure very sluggishly under ambient conditions.[10] This deficiency can be partially rectified by catalysis with tin or zinc salts, but only by accepting the associated problems of very short pot-life and impairment of ultimate properties. The catalysts are known to consume isocyanate through promotion of the water-isocyanate reaction. (*Figure* 1, Path B) with evolution of CO_2 and the production of very reactive primary amine. The contrast, the aliphatic isocyanate-oxazolidine blends cure rapidly enough not to require external catalysts, although judicious use of very low catalyst levels is helpful in some cases.

Table 10 documents the rapid room temperature crosslinking of a variety of formulations with and without low levels of tin catalysts. Also demonstrated is the measurable influence of relative humidity on speed of cure. The general trend is for coatings to become tack-free within several hours, with substantial hardness development after one day and nearly full hardness

Table 11—Physical Properties of Fully Cured Oxazolidine-Urethane Films

A. Properties of 1.5 mil Clear Coatings on Steel

System (wt. ratio)	Tukon Indenter Hardness—KHN	Pencil Hardness	Mandrel Flex.	Gardner Reverse Impact (in-lbs)	Taber Abrader (mg lost)
Polymer A/DDI (75/25)	9	H	pass ⅛″	> 50	65
(85/15)	8	H	pass ⅛″	< 2	Very high
Polymer B/Des N (70/30)	12	3H	pass ⅛″	> 50	32
Oligomer/Des N (60/40)	9	H	pass ⅛″	> 50	30
BIPOT/Des N (37/63)	13	5H	pass ⅛″	> 50	3
DOEA/Des N (31/69)	2	2H	pass ⅛″	> 50	4

B. Properties of Free Films
(100%/min, Strain Rate)

System (wt. ratio)	Tensile Strength (psi)	% Ultimate Elongation
Polymer B/Des N (70/30)	4000	40
Oligomer/Des N (60/40)	3800	40
BIPOT/Des N (37/63)	8400	60
DOEA/Des N (31/69)	4200	170

Notes: (1) Tukon Indenter Hardness, Pencil Hardness, Mandrel Flexibility, and Gardner Impact tests are described in reference (11).
(2) Taber Abrasion test is run for 500 cycles with a CS-17 wheel and a 1000 load.
(3) Free films were evaluated on an Instron Tenxile Tester.[14]

development after three days. It has been our experience, and BIPOT exemplifies this, that the 2-isopropyl oxazolidines are somewhat slower reacting than the 2,2-dihydro-oxazolidines. In these cases, low levels of tin catalyst can be gainfully employed.

For production line application, cure rate can be substantially enhanced by placing coated articles in humid (steam), hot ovens. *Table* 10 lists results for a Polymer B/Desmodur N coating at 180°F (60°C), wherein tack-free time was reduced to about five minutes and the coating became hard enough to be handled in 15 minutes. Such low temperature curing capability may be of particular value in these times of limited energy resources to fuel high temperature baking ovens.

At each temperature, moisture is an essential cocatalyst; subjection of oxazolidine-isocyanate coatings to high temperature "dry" ovens alone is a generally ineffective method of curing.

Cure Volatiles—Fate of Formaldehyde

A version of Polymer B containing 2,2-dihydro-oxazolidine based on radioactive formaldehyde (carbon 14) has been utilized to follow the fate of the formaldehyde blocking group as cure proceeds. In the absence of moisture the formaldehyde is largely retained in a two mil film. However, in the presence of moisture and Desmodur N, and as cure proceeds, substantial formaldehyde is evolved. A number of replicate experiments, run at 77°F and 180°F, provide a range of results centering around 50% of the formaldehyde emitted and 50% retained. Although we are not certain of the position of the retained formaldehyde, it is speculated that it attaches to the urea and urethane crosslink structures in the form of methylol groups.

The evolved formaldehyde is approximately 1% by weight of the Polymer B/Desmodur N (70/30) cured solids. Most of the chemical reaction at room temperature is completed in the first hours of curing, even though ultimate hardness may require several days to develop. Consequently, care must be taken to provide proper ventilation of the coating area, especially during the early period of cure.[13]

Mechanical Properties

In the design of conventional acrylic coatings, it is usually necessary to sacrifice film hardness to achieve flexibility and vice-versa. By combining oxazolidine functional acrylics with selected aliphatic isocyanates, a desirable combination of hardness and flexibility is achieved. The blends of the dioxazolidine esters with Desmodur N offer even more impressive physical properties.

The excellent mechanical properties of the completely cured oxazolidine-urethane coatings are documented in *Table* 11, utilizing a standard battery of coating tests. Moreover, it should be noted that the highly crosslinked nature of the films provides excellent chemical, solvent, and humidity resistance. As a group, these coatings display a level of performance that is at least equal to that of high quality baking finishes, even though all of the coatings were cured under ambient or forced dried conditions.

The elongation of most of the coatings exceeds the ability of the Mandrel Flexibility and Gardner Impact tests to distinguish among them. Consequently, free films were obtained by mercury amalgamation of coated tin foil to allow determination of ultimate properties on an Instron Tensile Tester.[14] Perhaps, not surprisingly, the DOEA/Desmodur N coating with the

Table 12—Gloss Retention of Coated Steel Panels at Florida, Facing South, 5° from Horizontal

System (wt. ratio)	Pigmentation	Initial 20° Gloss	Gloss Retention% 6 months	11 months	17 months
Polymer B/Des N (70/30)	None	99	100	100	—
	3% Aluminum flake	77	83	57	36
	20% Molybdate orange	67	93	91	97
	40% TiO_2	82	100	95	79
Oligomer/Des N (60/40)	3% Aluminum flake	70	46	13	—
	20% Molybdate orange	94	90	76	62
	30% TiO_2	91	93	85	67
	40% TiO_2	91	86	69	44

Notes: (1) Coatings are applied to steel panels by an air assisted spray gun to provide 1.5 mil dry film thickness.
(2) Gloss measured with Lockwood-McLorie Gloss Meter at 20° angle.

lowest Tukon Indenter Hardness has the highest ultimate elongation, about 170%; but, even the very hard BIPOT/Desmodur N has a respectable elongation, about 60%, while displaying exceptional tensile strength. These properties plus impressive Taber Abrader resistance suggest that the coatings may perform well as wear layers on flooring.

Exterior Weathering

Weather-O-Meter testing^{15} of the various oxazolidine-isocyanate coating candidates predicts good exterior performance except for the BIPOT/ Desmodur N coating, which probably suffers from the aromatic structure of BIPOT. Actual exposure data on acrylic oxazolidine coatings is presented in *Table* 12. The exterior weathering itself is accelerated by utilizing the Florida location and the south, 5° from horizontal inclination, for exposure panels. The gloss retention results for the clear, metallic (aluminum flake), red (molybdate orange with violet toner) and white (rutile TiO_2) coatings of *Table* 12 generally approach those of automotive topcoat enamels of the acrylic/melamine resin baking finish type.

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Economic And Technical Parameters Of Pigment Dispersions

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High-speed dispersers and sand mills are excellent tools for dispersing TiO_2 and most other bulk pigments, but they have definite limitations when it comes to dispersing hard-to-grind pigments. Alternate approaches to full tint strength development, especially for expensive organic pigments are discussed. Buying ready-made dispersions from subcontractors is one way to solve the problem. The higher visible cost of such out-of-house dispersions is often offset by indirect economic and technical advantages. Some of the technical benefits derived from intensive grinding are illustrated. The effects of pigment/vehicle interactions on tint performance are also demonstrated.

Introduction

The behavior of pigment dispersions depends on the total coating composition, on subtle differences in raw materials, on application methods, and even on manufacturing techniques. All of these determinants have undergone drastic changes in the last 30 years.

Influence of Particle Size on Manufacturing Technique

The radical changes in manufacturing methods were triggered by the development of fine particle inorganic pigments. Around 1945 the TiO_2 manufacturers and some functional pigment producers learned to control the particle size of many dry pigments so well that true grinding of these pigments was no longer needed. The required wetting and de-agglomeration could be accomplished quickly with low shear-stress tools, such as high-speed dispersers (HSDers) alone or in combination with sand mills. The far-reaching consequences of this achievement are shown in *Table* 1.

Considering the many technical and economic advantages listed in *Table* 1, the trend away from the old equipment and towards HSDers and sand mills seems justified since TiO_2 and extenders represent the bulk of the pigments used in coatings. However, other pigments which are not so easy to disperse now present a problem that didn't exist in the old roller mill days. The options open for dealing with hard-to-grind pigments in a modern plant are as follows: (see *Table* 2)

(1) Use sand mills at very low output rates (multiple passes) or sacrifice tint strength, or both. This makes for poor overall economy and sometimes poor product quality too.

(2) Keep some powerful mills such as Attritors, Roller Mills, Ball Mills, etc., to handle hard-to-grind pigments only. This means a larger plant and higher capital outlay than is needed for an all HSDer/Sand Mill plant. It also means that the plant operation becomes more complicated in regard to manpower and equipment utilization, inventory control, etc.

(3) Use jet-milled inorganic pigments where available. They justify their higher cost, provided high speed dispersion alone, or sand milling at high rates, can produce the required fineness of grind and good color development.

(4) Use surface-treated (soft textured) pigments. They disperse readily in the sand mill to an often acceptable particle size; however, they do not always yield ultimate tint strength. For expensive pigments this presents an economic handicap.

(5) Use flushed colors when possible. They are an excellent and economical source of fully-dispersed colors, but (up to now) only a few pigments are available in this form. The choice of vehicles in which pigments can be flushed is limited. Reproducibility of hue can be a problem.

(6) Buy suitable ready-to-use pigment dispersions from outside sources. They simplify plant operation greatly, but at a price. The trade-off between higher material cost vs. direct and indirect savings and benefits is often difficult to quantify. The decision whether to manufacture in-house or to buy dispersions should be based on a composite of economic, operational, and technical considerations. A superficial analysis based only on comparative raw material cost plus an averaged manufacturing cost often leads to erroneous conclusions. The purpose of this paper is to review some of the important economic and noneconomic parameters that should enter into the "do-it-yourself" vs. "buy dispersions" decision.

Tint Strength

Obviously, the tint strength obtained from a given pigment should be a prime economic consideration of the coatings manufacturer. The more expensive the pigment, the greater becomes the economic benefit of reaching maximum strength. Color development varies greatly with the pigment grade, the milling process, and the milling time, as shown in *Table* 3. At normal sand milling rates, the surface-treated (easy grinding) phthalo blue performs distinctly better than the untreated version. Both pigments produce approximately the same tint strength at very low sand milling rates, and likewise in pebble mills after 24 hr or more, and in 24-hr attritor grinds. Only

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Table 1—Effects of Particle Size of Prime Pigments And Extenders on Paint Manufacturing Methods and Economics

	Before 1945	After 1950
(1) Particle condition	Coarse; hard aggregates; wide scatter	Fine; loose agglomerates; narrow scatter
(2) Equipment needed	Premixer/roller mill. Pebble or ball mills. Heavy duty mixers.	High speed disperser; HSDer/Sand Mill combination.
(3) Pigment cost	Low	Low
(4) Output rate	Low	Very high
(5) Manpower demand/gallon	High	Low
(6) Operator skill	Very high	Moderate
(7) Equipment cost	High	Low
(8) Maintenance cost	High	Low
(9) Space requirements	High	Low
(10) Power consumption	High	Moderate

Result of Change: Marked improvement in all respects.

after 48 hr in the attritor is the ultimate strength obtained with either pigment—but then the treated pigment lags behind by 9%, i.e., by the approximate percentage of the surface treating chemical added to the pigment by the manufacturer.

At a pigment price of over $5 per pound, a 30% loss of tint strength in the sand mill operated at any reasonable production rate is clearly wasteful. The merit of doubling the grinding time in the attritor for the sake of a 15% gain in tint strength is perhaps debatable economics for medium-priced pigments, but it becomes compelling reasoning for pigments in the $20 per pound range. Besides the economic gain, extensive grinding often produces technical advantages.

For example, grinding the expensive carbazole violet pigment for 96 hr in a pebble mill yields only 90% of the tint strength achieved by a 48-hr attritor grind. Perhaps more important than the 10% loss in tint strength is the unexpected difference in the behavior of the two dispersions upon incorporation into a white tint base. The attritor dispersion yields 100% tint strength, regardless of whether it is merely shaken into the base for two minutes on the "Red Devil" shaker or is mixed under the powerful "Osterizer" which duplicates the effect of high speed dispersers or paint brush action. By contrast, the 96-hr pebble mill dispersion produces only 78% tint strength on the "Red Devil" shaker as compared to 90% on the "Osterizer." The additional 12% loss in tint strength is accompanied by a hue shift from a cleaner, redder violet to a grayer, bluer violet.

This hue shift is clearly due to flocculation since it can be reversed by rubbing the wet film. Carr[1] has documented that extreme grinding reduces, or even eliminates, flocculation of some organic pigments. The reason for this phenomenon has not been explained satisfactorily. It is unreasonable to assume that mixing for one minute in the "Osterizer" can reduce the particle size further than a pebble mill does in 48 or 96 hr. It seems more likely that the observed 12% pick-up in tint strength is due to the deflocculation of the tinter under intensive mixing action. The single (deflocculated) pigment particles are more likely to coflocculate[2] with TiO_2 particles than tinter flocculates. The postulated coflocculation of colored and white pigment particles would effectively prevent a reflocculation of the colored pigment particles with each other and thereby prevent loss in color strength and hue shifts.

Regardless of whether or not this is the correct explanation of the observed phenomena, it is a fact that better grinding often produces greater tint strength as well as trouble-free incorporation into a base. This benefit can be of practical importance, especially for tinting at the paint store where only weak mixers are available.

Table 2—Alternate Approaches to Utilizing Hard-to-Grind Pigments

Method	Advantages & Disadvantages
(1) Forced sand milling	Multiple passes, Low output, Often incomplete pigment utilization.
(2) Roller mills, attritors, etc.	Larger plant, Higher capital outlay, Costlier plant operation.
(3) Jet-Milled pigments	Limited availability, Intermediate size particles, Premium price.
(4) Surface-Treated pigments	Good for inexpensive pigments. Loss of up to 30% in ultimate strength.
(5) Flushed colors	Good solution if available in suitable vehicle. Questionable reproducibility.
(6) Dispersions	Higher visible RMC, often outweighed by savings in overall plant operation. Convenience and reproducibility.

Table 3—Effects of Milling on Color Development

	Pigment Utilization	
	Surface-Treated Phthalo Blue	Untreated Same Phthalo Blue
8 GALLON SAND MILL		
Gal/Hr	%	%
60	69	27
30	71	40
20	71	50
15	71	69
12	—	71
PEBBLE MILL		
Hr	%	%
24	82	80
48	83	84
72	84	85
96	84	87
ATTRITOR		
Hr	%	%
24	85	85
48	91	100

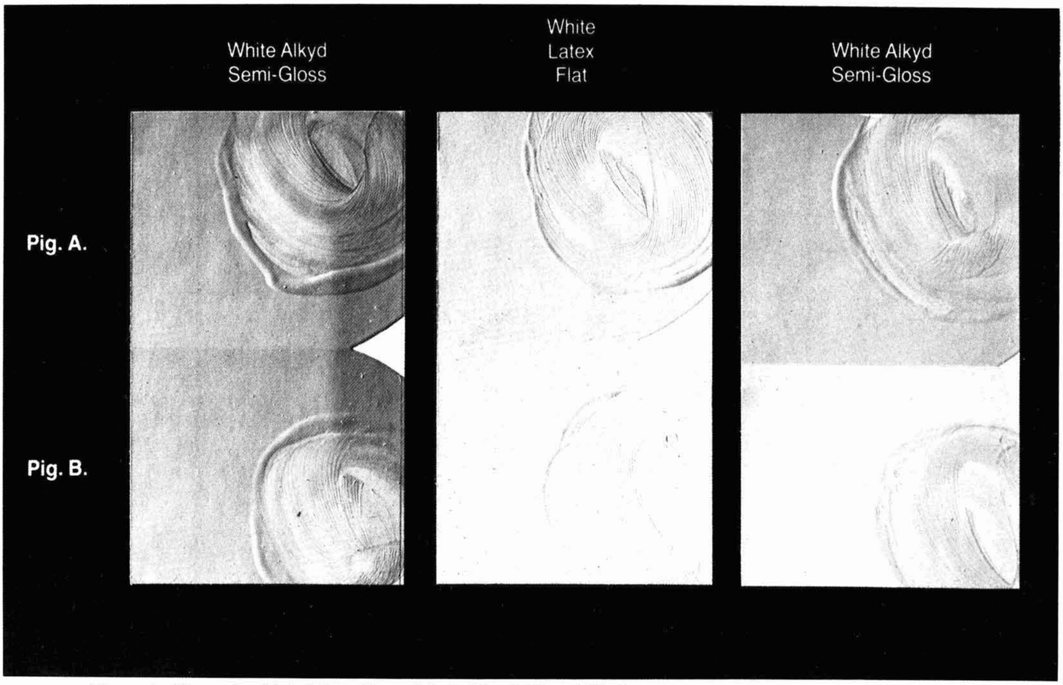

Figure 1—Pigment vehicle interaction: phthalo blue "A" vs. "B" dispersed in alkyd and universal tint vehicle

Pigment/Vehicle Symbiosis

Unfortunately, good grinding alone does not solve all technical and economic problems of tinting colors. Supposedly interchangeable pigments from different manufacturers, or similar grades from the same pigment manufacturer, differ greatly in their tint behavior, depending upon the vehicle in which they are dispersed and the composition of the tint base to which each dispersion is added. A typical reversal of pigment behavior is shown in *Figure* 1. Phthalo blue "A" produces a little less color in a semi-gloss alkyd enamel than phthalo blue "B," dispersed in the same medium, both pigments being ground for 48 hr in the attritor to ultimate and equal fineness.

The same two pigments, dispersed the same way in a widely used glycol-based "universal" grinding liquid, show the inverse tint strength relationship in a latex flat tint base. No significant pigment floating, flooding or rub-up was evident with either tinter in the alkyd or latex base. However, adding the same two "universal" tinters to the above semi-gloss enamel produces a dramatic qualitative difference: Pigment "A" performs excellently, whereas Pigment "B" (in the same total formulation) flocculates so strongly that the tinter is unusable. These results clearly indicate that the merit of a pigment can vary greatly with the total tinter/base composition.

Sorensen[3] has recently proposed a very interesting new concept that may explain the observed elusive nature of the pigment/vehicle interactions. He classifies pigments, binders, and solvents according to their quantitative electron donor or acceptor (acid/base) properties and predicts flocculation or deflocculation from their similarities and dissimilarities. Optimum properties result from combining a pigment of a given acid or base character with a binder system of the opposite acid/base character. Minute differences in any component used in the finishing treatment of a pigment may, and often does, greatly affect the electron donor/acceptor balance.

The determination of the acid/base values of all raw materials should facilitate the selection of suitable complementary components. However, there is no assurance, or even likelihood, that such combinations exist for all coating formulations. Even if they exist, a change from a predominantly acid to a predominantly basic vehicle system requires a change from a basic to an acid pigment, and vice versa. Hence, no one pigment can be suitable for all binder systems.

Thus, Sorensen's hypothesis confirms the experimental findings that truly "universal" tinters do not exist even for systems with fully compatible vehicles.

Hansen,[4] too, has pointed out that the solubility parameter concept of compatibility applies not only to vehicles but also to vehicle/pigment combinations. This higher order of compatibility or incompatibility is the root problem (largely ignored by industry), that makes the search for a single all-purpose tinter line a futile pursuit. However, an attainable and highly desirable goal is to keep the number of tint lines to a minimum.

The implementation of this goal is not an easy task. New coating systems often require different tinters, thus adding to the existing lines; but a new line, formulated judiciously, may also make existing tinters obsolete. The continuous updating and consolidation of tinters to meet the needs of old as well as new coating systems is a never ending job which few individual coatings manufacturers are equipped to handle efficiently. It is significant that even large paint companies which start out manufacturing the colorants for their

Table 4—Economic Benefits of Ready-Made Dispersions

Tangible

(1) Better pigment utilization
(2) Elimination of the above-average cost of grinding relatively small batches for long cycles
(3) Elimination of manufacturing losses
(4) Reduction of losses due to hard pigment settling, skinning, or flaking
(5) Reduction of inventory in raw materials
(6) Elimination of extra grinding equipment
(7) Reduction of manufacturing space and personnel

Intangible

(1) Increase in plant capacity
(2) Faster deliveries
(3) Elimination of production bottlenecks
(4) Simplification of order processing
(5) Savings in skilled manpower in production, control, and scheduling
(6) Reduction of leadtime in new product development
(7) Improvement of overall manufacturing flexibility and efficiency

Table 5—Technical Advantages of Ready-Made Dispersions

(1) Wider compatibility range with fewer tinting lines
(2) Minimum adverse side effects through—
  (a) Finer grinds
  (b) Selection of suitable pigment/vehicle combinations
(3) High degree of standardization and close tolerances permitting shading by computer
(4) Optimum rheological properties, assuring—
  (a) Ease of handling
  (b) Absence of hard sediment or syneresis
(5) Better color development with moderate mixing energy

in-store "Universal Color Systems," (expecting thereby to save money and to minimize the technical compromises inherent in all such systems) usually turn this business over to dispersion houses. Even these specialists cannot eliminate all technical problems, but they can justify a greater continuing investment of time and effort because they distribute the R&D and manufacturing costs over a broader market. Hence, they can often outperform and outprice the coatings manufacturer who is aware that the RMC and direct manufacturing costs alone are no true yardstick of economic and technical value. A valid judgement whether to disperse some or all tinters in-house or buy them from outside sources should always be based on a balanced consideration of all aspects of the dispersion problem as summarized in *Tables* 4 and 5.

Obviously, not all the listed advantages of ready-made dispersions accrue in every instance, nor are all advantages of equal value to all coatings manufacturers. For example, batch-to-batch tinter uniformity may be of little value to the small trade sales paint manufacturer, but it is of the utmost importance to the manufacturer who shades by computer and, therefore, depends upon a degree of tinter standardization which he cannot easily enforce on his own organization.

Conclusions

Generally speaking, the value of subcontracting dispersions and other minor coatings components is greatest where the proliferation of product lines and a shortage of skilled manpower in the factory and laboratories call for streamlined operation along mass production principles. However, no modern coatings manufacturer, regardless of size or product mix, can afford to overlook either the obvious or the hidden profit potential of ready bought dispersions. The emergence and growth of dispersion houses in recent years is no accident; they fill a distinct need of our industry.

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News from British Paint Research Association

This is another in a series being published on a regular basis to acquaint readers of JCT with the activities of the British Paint Research Association. More complete data may be obtained by writing to the Head of Information Department, Paint Research Association, Waldegrave Road, Teddington, Middlesex TW11 8LD, England.

WATER ECONOMY IN THE PAINT INDUSTRY

Costs of water and disposal of aqueous effluent are increasingly rapidly, and authorities are becoming more and more restrictive about the effluent they will accept. To focus attention on this problem, the PRA recently sponsored a panel discussion on "Water Economy in the Paint Industry" which featured representatives from industry and government.

Some general observations emerged from the discussion: In paint manufacture, the main uses for water are for cooling, plant washing, and as a raw material. Many firms are saving cooling water by using closed-circuit cooling towers and valves on cooling plant; Washing water is saved by using pistol grips or time switches on hoses; Major problem of in-plant waste treatment for recovering clean water for recycling or for providing an easily disposable or reusable residue has not been resolved—possible techniques include centrifugal separation, electrodialysis, electroflotation, ultrafiltration, and reverse osmosis (particular problem in this regard is microbiological degradation of the effluents awaiting treatment); Saving of water as a raw material is not considered to be a problem; In painting metal goods, there are several other areas in which substantial savings are possible, namely in phosphating and in the electrocoat rinse.

AIR POLLUTION IN PAINT PLANTS — AN INTERFIRM COMPARISON

In the manufacture of solvent-based paints, solvent vapor enters the working environment in concentration depending on the nature and quantity of the solvents in use, the temperature and ventilation of the workplace, and the method of manufacture. Because of the danger of explosion and toxicity, paint manufacturers generally take precautions. Some monitor solvent vapor concentrations using commercially available detectors analogous to "Breathalyzer" tubes in that they give an immediate reading of the concentration of selected solvents; but tubes are not available for all paint solvents, and there is often interference by solvents other than the one being measured.

Accordingly, the British Paint Research Association last year proposed an interfirm comparison of air pollution using the Airchek component concentrator method of analysis, developed during investigations into pollution from paint stoving operations. This involves the on-site absorption of atmospheric pollutants followed by laboratory analysis using gas-liquid chromatography. It is, therefore, considerably more useful in the analysis of complex solvent mixtures than the indicator tube method. As a result, requests were received to sample 33 plants throughout Europe, approximately half of which have been completed.

A typical plant visit involves the collection of four atmospheric samples from representative areas such as milling, thinning, tinting, and can filling. When the plant visits have been completed, a report will be circulated to all participants, with a coded list of results. The report to each participant will disclose the coding for his plant only.

This project has already prompted a number of requests for further, more detailed monitoring to study the effect of changes in temperature, work load, and ventilation conditions on solvent vapor concentrations.

ROCKS AND CLAYS AS A SOURCE OF RESINS

Certain polysilicate rock and clay minerals have exchangeable cations which offer a means for introducing organic groups by chemical reaction to produce novel products. A well-known example is modification of bentonite, with an organic ammonium radical to give a product (bentone) for non-aqueous use. Modification of clays by anionic groups has been reported, but the products do not appear to have commercial application.

A room temperature simple conversion of certain minerals to polyorganosiloxanes has been developed at PRA based on a trimethylation reaction first developed by Lentz for structural analysis. A high yield of products soluble in several organic solvents including white spirit is obtained. In certain cases, as much as 65% of the product is derived from the mineral. This method has great possibilities for producing cheaper polysilozanes shown to be suitable for waterproofing textile and building materials. Research under the current Research Program now with 50% support from National Research Development Corp., has led to the development of true polysiloxane film-forming resins with long-life and high temperature resistance.

Trialkylsilylation of sheet-like mineral polysilicates, e.g., chrysotile, forms insoluble organosilicon polymers which retain the sheet structure of the mineral. Vinyl substituted silylating groups have been used to provide a cation-leached mineral with reactive sites for grafting vinyl polymer chains. It is said that fillers with improved reinforcing characteristics for polymeric composites are produced.

Ionic polymers formed from mineral with acid-leachable cations and polyacids provide another promising area for investigation particularly into fire resistant building materials and high temperature resistant coatings. Preliminary work at PRA has already demonstrated the feasibility of producing mouldings and coatings with reasonably good water resistance, adhesion and scratch resistance.

CHEMICALS FROM SUCROSE

Sucrose is one of the purest and cheapest of widely available organic compounds, and a great deal of work has been carried out to seek new commercial applications.

Very few sucrochemicals have reached commercialization, largely because of high costs of development and production. In view of dwindling petrochemical resources, the outlook is expected to change and markets develop for products in specifically favorable areas, including coatings, plasticizers, plastics and surfactants.

Sucrose diacetate hexaisobutyrate and octabenzoate are being offered commercially, e.g., for use as plasticizers for cellulosics. Sucrose allyl ethers have been extensively investigated. They make good wood coatings, but the high cost of production has prevented commercialization. The hepta substituted cyanoethyl ether is a commercial product suggested as a modifying plasticizer in phosphor carriers for electroluminescent components.

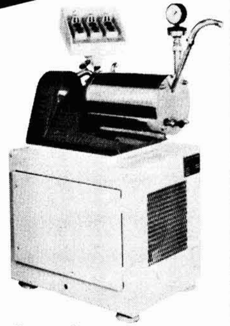
Sucrose is the source of a large number of chemicals produced by fermentation, e.g., ethanol, butanol, acetone, acetic acid, citric acid, lactic acid, itaconic acid and 2,3 butylene glycol. Other interesting intermediates are octakio (2 hydroxylpropyl) sucrose containing eight hydroxyl groups from sucrose and propylene oxide, the hexitols, sorbitol and mannitol by hydrogenation and hydroxymethyl furfural by acid degradation.

Sucrose is a disaccharide with eight hydroxyl groups, of which about five (presumably the three primary and two reactive secondary groups) show similar reactivity. However, it is a difficult molecule to use for synthesis, being insoluble in common organic solvents, decomposed by heating at temperatures above about 120°C and by mineral acids via the glycoside linkage. Direct esterification with acid catalysts or use of the high temperatures of alkyd manufacture are, therefore, unsuitable. Alternative methods have been used depending on the type of ester, for example, with long fatty ester derivatives. Ester interchange is most feasible using sucrose, methyl fatty esters, and potassium carbonate catalyst in an aprotic solvent, e.g., dimethylsulphoxide at 90-100°C. Substitution of 4 to 5 sucrose hydroxyl groups is readily achieved in high yield using 1:5 mole ratio of sucrose and methyl ester, whereas synthesis of hexa/hepta esters is less attractive, requiring 100% excess of methyl ester. Studies at PRA sponsored by the International Sugar Research Foundation have demonstrated the potentialities of the tetra/penta ester as an intermediate for synthesis of (air drying) coating resins of good quality, e.g., epoxy esters by stepwise reaction with phthalic anhydride and diepoxide, and polyurethanes by reaction with diisocyanate. Recent work has shown that it is possible to synthesize a sucrose ester intermediate of good color avoiding use of expensive solvent, which now makes these materials economically attractive.

Synthesis of sucrose derivatives, e.g., esters, ethers, acetals and metal derivatives with a variety of fungicidal and biocidal groups has been widely investigated. In general, however, the products showed the types of activity associated with the toxicant moiety, or in many cases reduced activity.

Incorporation of sucrose into resins such as melamine/formaldehyde and phenol/formaldehyde has been investigated with the aim of reducing cost. Although there is some evidence that chemical reaction occurs between sucrose hydroxyl groups and methylol groups, the products show low water resistance due to unreacted sucrose in the matrix. Other types of sucrose-based resins include polycarbonates from reaction of sucrose and chloroformates and polymers obtained from sucrose and silicon-containing intermediates.

Basic research has evolved methods for synthesis of a wide range of sucrose chemicals with reactive groups, e.g., halogen at known locations, mainly 6, 6^1 and 1^1. This should provide another route for introducing the hydrophilic sucrose moiety into resins.



1976 - 1977 Federation Committee Chairmen

THOMAS J. MIRANDA

Publications

is a Staff Scientist at the Elisha Gray II Research and Engineering Center, Whirlpool Corp. Dr. Miranda is a Past-President of the Chicago Society (1966–67), and is the 1977 recipient of that Society's Outstanding Service Award. He has served as Technical Editor of the Journal of Coatings Technology for the past four years.

HELEN SKOWRONSKA

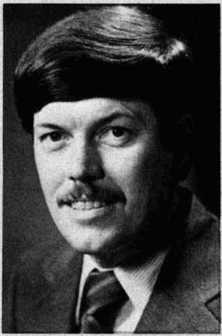
Technical Information Systems

has been Technical Librarian of Sherwin-Williams Co. for 28 years. She is the President-Elect of the Cleveland Society, and is a member of the Federation's Program Committee. Miss Skowronska is a member of the JCT's Editorial Review Board and her committee contributes "Technical Articles in Other Publications" to the JCT.

JOSEPH T. SULLIVAN

Public Relations

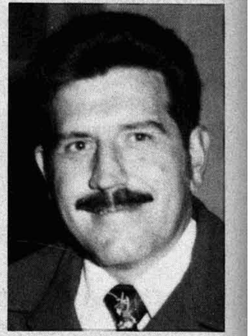
is Advertising Manager of Rohm and Haas Co., Coatings Dept. Mr. Sullivan has been with the company since 1963, first as a Technician, and in 1966 he was named a Process Development Chemist. He is a member of the Philadelphia Society and has served on the Federation's Public Relations Committee since 1974.



ANDREW NOGUEIRA

Trigg Awards

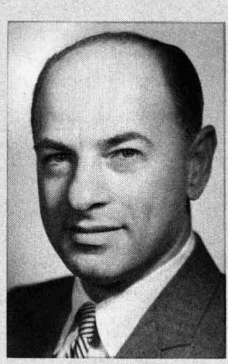
is currently a Senior Chemist with DuBois Chemical Div. of Chemed Corp. His duties include the research and development of products for paint booth maintenance and paint removal. Mr. Nogueira received the B.S. Degree in Chemical Engineering from Indiana Technical College. He has been with DuBois since 1968.



JOHN A. J. FILCHAK

Specifications

is Director of the Quality Control Div., Region 10, General Services Administration. A Past-President of the Pacific Northwest Society, he is its current Council Representative. He is a founding member of that society's Specifications Committee and has served as Chairman for 16 years.



SIDNEY B. LEVINSON

Delegate to NPCA Scientific Committee

is President of D/L Laboratories, Inc. He is a Past-President of the New York Society and was a recipient of its PaVaC Award. Mr. Levinson was recently elected to Honorary Membership in Committee D-1 of the American Society for Testing and Materials. He has presented over 50 lectures on paint and coatings and has authored over two dozen articles.

SIDNEY LAUREN

Technical Advisory

has been Executive Director of Coatings Research Group, Inc. since 1972. He is an Honorary Member of the New York Society, and has served on the Educational Committees of the Federation, and the New York and Cleveland Societies. Mr. Lauren received the New York Society's Kienle Award in 1960 and its PaVaC Award in 1966.

GABRIEL MALKIN

Delegate to NPCA And Governmental Agencies

is Chief Engineer for Benjamin Moore & Co., a position which he has held for 25 years. He has been a member of the New York Society's Technical Committee and Chairman of its Environmental Control Committee. Mr. Malkin was a recipient of the Kienle Award from the New York Society in 1962.

Society Meetings

Baltimore May 19

The following slate of officers was elected for the year 1977-78: President—C. Herbert Pund, III, of Conchemco, Inc.; Vice-President—W. Thomas Cochran, of Bruning Paint Co.; Secretary—Harry Schwartz, of Baltimore Paint & Chemical Corp.; and Treasurer—Gordon Allison, of McCormick Paint Works Co.

Robert C. Zeller, of Pfizer, MPM Div., spoke on "ASSESSMENT OF PIGMENT DISPERSION BY A COLORIMETRIC TECHNIQUE."

TOM COCHRAN, *Secretary*

Birmingham May 19

K.J. Harden of Crown Decorative Products Limited, spoke on the "MARKETING OF INDUSTRIAL FINISHES." Statistics were used to illustrate the industrial portion of the U.K. paint market.

Mr. Harden defined marketing as looking at business through the consumers' eyes. Many illustrations were given of the applications of industrial coatings. The marketing function was broken down into its basic elements and each one dealt with in some detail. Topics covered included the company and its functions, the marketing mix, the restrictive environment, marketing objectives, market research, product life cycle, promotion and advertising, and sales forecasting. Presentation is the key to successful marketing, he said.

Q. Does the marketing department direct the company to sell what it can make, or make what it can sell?

A. The marketing department cannot talk from strength, very much like the man in the middle, it can only advise.

Q. You gave the impression that new markets/new products is a high risk area to be avoided?

A. No, would not enter this area without sufficient justification - high failure rate.

Q. When entering new markets/new products should the approach be to one or two customers or across a broad field?

A. One or two customers and then build up slowly.

BRIAN F. GILLIAM *Publicity Officer*

Detroit Apr. 19

The following slate of officers was elected for the year 1977-78: President—Thomas A. White, of Ford Motor Co; Vice-President—Mackenzie K. Endo, of Argo Paint & Chemical Co.; Treasurer—Walter Steucken, of Grow Chemical Co.; and Secretary—G. M. Sastry, of Chrysler Corp.

Leonard Afremow, of DeSoto, Inc., spoke on "PRI—ITS NEW IMAGE."

Mr. Afremow discussed the current changes taking place in the Paint Research Institute to increase the organization's usefulness to the paint industry. Some of the improvements include the use of communication consultants, simplified language in reporting research results, and the active seeking of constructive criticism from the paint industry.

WALTER STEUCKEN, *Secretary*

Detroit Apr. 27

The second annual FOCUS Seminar of the Detroit Society was on the subject of "Automotive Action on Corrosion" and was held at the Michigan Inn. The Seminar attracted 259 attendees who heard the following papers on steel processing, pretreating, primer systems, and pigments.

"*Evaluating the Hidden Aspects of Corrosion*"—Dr. Taki Anagnoustou, of Mortell Co.

"*Processing of Vsteel from Raw Materials to Rolling*"—Lockwood Lyon, of Great Lakes Steel Corp.

"*The Use of Clean Steel to Improve Durability of Automotive Bodies*"—George Grossman, of Q-Panel Co.

"*Zincrometal Precoated Steel for Automotive Use*"—Alexander Kennedy, of Diamond Shamrock Co.

"*Use of Electrocoat in the Auto Industry*"—Dr. Marco Wismer, of PPG Industries, Inc.

"*Adhesion Failure Mechanism of Primers*"—Dr. A.G. Smith, of Ford Motor Co.

"*Formulating and Testing Lead and Chromate Free Corrosion Inhibitive Coatings*"—Robert Van Doren, of N L Industries, Inc.

"*Cyclical Corrosion Test for Zinc Rich Primer*"—R.W. Zurilla, of Ford Motor Co.

WALTER STUECKEN, *Secretary*

Golden Gate June 13

The business meeting followed an all-day conference on the topic, "GOVERNMENT REGULATIONS AND INDUSTRIES' REACTION." A total of 76 members attended the session in which eight speakers presented papers.

The following slate of officers was elected for the year 1977-78: President—Walter Ballinger, of Glidden-Durkee Div., of SCM Corp.; Vice-President—Ken G. Probst, of San Jose Regional Vocational Center; Treasurer—Fred Apfel, of International Paint Co.; and Secretary—John C. Dickman, of Reichhold Chemicals, Inc.

Robert Minucciani, of Glidden-Durkee Div., of SCM Corp., spoke on "BALIA—WHAT IT MEANS TO YOU."

Mr. Minucciani discussed the history and achievements of the (San Francisco) Bay Area League of Industrial Associations. He said that BALIA's work covers 20 years in the areas of air pollution control, water and waste systems, sewage services agencies, and Federal Energy Offices.

A. APFEL, *Secretary*

Joint KC/St. L June 3-4

Honored guests in attendance at this, the 26th annual joint meeting of the two societies, included Federation President Neil S. Estrada, and Federation Executive Vice-President Frank J. Borrelle.

Mr. Estrada reviewed the restructuring procedures currently being taken by the Federation and noted that the proposed changes will probably take effect in 1978. He said that the Federation's Technical, Educational, and Manufacturing Committees have been strengthened through regional and national meetings, and that the recent Society Presidents-Elect meeting held at the Spring Council Meeting in May was a great success.

Mr. Borrelle noted with pleasure the spirit of cooperation between the two societies and said that they would also co-host the 1979 Annual Meeting to be held in St. Louis. He then discussed the upcoming Annual Meeting and Paint Show and said that it will be the largest ever.

The regular meeting presented a series of speakers who addressed the topic, "THE EVOLUTIONARY PAINT INDUSTRY."

James Larson, of Cargill, Inc., spoke on "WHY HIGH SOLIDS?"

Mr. Larson discussed the energy savings and resource conservation attained through the use of high solids coatings systems. He noted several guidelines for high solids coatings: conventional formulating techniques, use of strong solvents, use of the best hiding TiO_2, low PVC's, avoidance of high oil absorption pigments, and use of low surface treated pigments.

Dr. Stig Friberg, of University of Missouri—Rolla, spoke on "FUTURE CHEMISTRY ASPECTS OF FUTURE SURFACE COATINGS."

Dr. Friberg stated that the main problems facing the coatings industry today are the removal of solvents from coatings, and improving performance. He said that two new concepts may bring possible solutions to these problems: microemulsions (which exist now), and liquid crystals (which will come in the future). Producing samples of microemulsions, Dr. Friberg noted its clear appearance and said that it was indefinitely stable. Liquid crystals were described as "sandwiched" microlayers of surfactant-water-surfactant-water, etc., through which organic components could be microdispersed.

Q. How much agitation is required to form microemulsions?

A. Simple agitation.

Lee Raden, of Fabricated Metals, Inc., spoke on "SEMI-BULK HANDLING SYSTEMS—DRY AND WET MATERIALS."

Mr. Raden, in an illustrated talk, pointed out that semi-bulk handling is not new. Government regulations, the high cost of drums and bags, and the reluctance for full bulk installations are among the factors that have increased its popularity. He discussed the shipping, storage and handling of dry materials, such as talc, clays, and TiO_2, and of liquid products, such as paint, latex, varnish and chemicals.

John Montgomery, of National Paint and Coatings Association, spoke on the latest legislative and regulatory developments affecting the coatings industry. He noted the increasing need to communicate with government agencies. Mr. Montgomery reviewed all regulatory agencies and asked for continued involvement of coatings personnel in the regulatory process.

HUGO MANCO, *Secretary*
KANSAS CITY SOCIETY

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Eudowood Gardens, Towson). HARRY SCHWARTZ, Baltimore Paint & Chemical Corp., 2325 Hollins Ferry Rd., Baltimore, Md. 21230.

BIRMINGHAM (First Thursday—Warwickshire County Cricket Ground). P.A. HARRIS, Midland Specialty Powders, Unit 8, Bilston Industrial Estate, Staffs, England.

CHICAGO (First Monday—meeting sites in various suburban locations) WILBERT B. BARTLET, Rust-Oleum Corp., 2301 Oakton St., Evanston, Ill. 60204.

C-D-I-C (Second Monday—Sept., Jan., Mar. in Columbus; Oct., Dec., Apr. in Cincinnati; Nov., Feb., May in Dayton). LLOYD J. REINDL, Inland Div., GMC, P.O. Box 1224, Dayton, Ohio 45401.

CLEVELAND (Second Tuesday—meeting sites vary). CHARLES K. BECK, Addressograph Multigraph Corp., 19701 S. Miles Rd., Warrensville Hts., Ohio 44128.

DALLAS (Thursday following second Tuesday—Vic's Gallery Restaurant). SAMUEL F. BIFFLE, Sherwin-Williams Co., 2802 W. Miller Rd., Garland, Texas 75040.

DETROIT (Fourth Tuesday—Rackham Memorial Bldg.). WALTER STUECKEN, Grow Chemical Co., P.O. Box 45, Pontiac, Mich. 48056.

GOLDEN GATE (Monday before Third Wednesday—Sabella's Restaurant, San Francisco). FRED APFEL, International Paint Co., Inc. 220 S. Linden Ave., S. San Francisco, Calif. 94080.

HOUSTON (Second Tuesday—Sonny Look's Sir-Loin Inn). WILLIAM A. WENTWORTH, Napko Corp., P.O. Box 14509, Houston, Tex. 77021.

KANSAS CITY (Second Thursday—Fireside Inn). HUGO R. MANCO, Farmland Industries, Inc., P.O. Box 7305, N. Kansas City, Mo. 64116.

LOS ANGELES (Second Wednesday—Steven's Steak House). ALBERT SENEKER, Ameron, Research & Development, 4813 Firestone Blvd., South Gate, Calif. 90280.

LOUISVILLE (Third Wednesday—Essex House). J.B. LOCOCO, Reynolds Metals Co., P.O. Box 1800, Plant III, Louisville, Ky. 40201.

MONTREAL (First Wednesday—Bill Wong's Restaurant). R. A. FRASER, Canadian National Railways, 3950 Hickmore Ave., Montreal, Que. H1W 1A3.

NEW ENGLAND (Third Thursday—Fantasia Restaurant, Cambridge). GEORGE MULVEY, Dampney Co., 85 Paris St., Everett, Mass. 02149.

NEW YORK (Second Tuesday—varies between New York and New Jersey locations). SAUL SPINDEL, David Litter Laboratories, Inc., 116 E. 16th St., New York, N.Y. 10003.

NORTHWESTERN (Tuesday after first Monday—Jax Cafe). ROBERT HESKIN, Valspar Corp., 1101 3rd St., S., Minneapolis, Minn. 55415.

PACIFIC NORTHWEST (Portland Section—Tuesday following second Wednesday; Seattle Section—the day after Portland; British Columbia Section—the day after Seattle). MICHAEL GRIFFIN, Reichhold Chemicals Ltd., P.O. Box 130, Port Moody, B.C., Canada.

PHILADELPHIA (Second Thursday—Valle's Steak House, 9495 Roosevelt Blvd., Phila.). LOTHAR S. SANDER, 111 Harris Rd., Princeton, N.J. 08540.

PIEDMONT (Third Wednesday—Howard Johnson's Coliseum, Greensboro, N.C.). CHARLES B. WILSON, Reliance Universal, Inc., P.O. Box 2124, High Point, N.C. 27261.

PITTSBURGH (First Monday—Skibo Hall, Carnegie-Mellon University Campus). J.H. DAHL, J. H. Matthews Co., 1315 W. Liberty Ave., Pittsburgh, Pa. 15226.

ROCKY MOUNTAIN (Monday prior to second Wednesday—Gasthaus Ridgeview, Wheatridge, Colo.). JIM PETERSON, Peterson Paint Co., P.O. Box 311, Pueblo, Colo. 81002.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant). MORRIS D. GILLIAM, Lanson Chemical Co., P.O. Box 128, E. St. Louis, Ill. 62202.

SOUTHERN (Gulf Coast Section—Second Tuesday; Central Florida Section—Thursday after third Monday; Atlanta Section—Third Thursday). ALFRED L. HENDRY. A.L. Hendry & Co., P.O. Box 17099, Tampa, Fla. 33612.

TORONTO (Second Monday—Town and Country Restaurant). H. ZAPFE, Ashland Oil Canada Ltd., 2620 Royal Windsor Dr., Mississauga, Ont., Canada.

WESTERN NEW YORK (Second Tuesday—Cavalier Restaurant, Amherst, N.Y.). LEONARD H. GIELINSKI, Spencer-Kellogg Div., Textron, Inc., P.O. Box 210, Buffalo, N.Y. 14225.

New York May 10

Honored guests in attendance included Frank Borrelle, Federation Executive Vice-President, and Thomas Kocis, Director of Meetings and Communications.

Twenty-five year membership pins were awarded to the following persons: Irving Hyman, of Benjamin Moore & Co.; William Richter, of Mobile Chemical Co.; Paul Katzauer, of Stevens Paint Corp.; David Busker, of Nortman Associates, Inc.; William Naumann, of Shell Chemical Co.; James J. Kennedy, of Essex Chemical Corp.; John Oates, of Troy Chemical Corp.; and William Singer, of Troy Chemical Corp.

The following slate of officers was elected for the year 1977-78: President—George J. Dippold, of Whittaker, Clark and Daniels, Inc.; Vice-President—Saul Spindel, of D/L Laboratories, Inc.; Secretary—Sidney Rubin, of Greenpoint Paint & Varnish Co.; and Treasurer—Marvin Schnall, of Troy Chemical Corp.

Fred Daniel, of Daniel Products Co., was presented the 1977 PaVaC Award for his outstanding contributions to the coatings industry and to the New York Society.

Sidney Levinson, of D/L Laboratories, Inc., spoke on "PAINTS AND COATINGS—PAST, AND PRESENT, AND FUTURE."

Mr. Levinson examined the progress made in various aspects of the coatings industry from the 1930's to the present. He predicted that the future will see an increase in the use of factory finished items; a reduction in the use of heavy metals, toxic solvents, and toxic emissions; safer working conditions; faster production; faster cure at reduced temperatures; higher prices; and a return to increased use of agriculturally based products.

SAUL SPINDEL, *Secretary*

Los Angeles June 8

President Gerald West presented 25-year pins to Walter K. Barber, of PPG Industries, Inc.; Jack Blecher, of Whittaker Coatings & Chemicals; D.G. Cromwell, of Sinclair Paint Co.; Jerome Danin, of Sinclair Paint Co.; E.T. Horn, of E.T. Horn Co.; Knox Price, of Tenneco Chemicals, Inc.; H.C. Ross, of Western Laboratories; and R.G. Trudeau, of McCloskey Varnish Co.

Nicholas J. Iammarino, of Kelco, Inc., spoke on "HYDROPHILIC COLLOIDS FROM NATURE."

Mr. Iammarino discussed the harvesting and processing of seaweed which yields heteropolysaccharide, tradenamed Zanflo.

ALBERT SENEKER, *Secretary*

Piedmont June 15

Honored guest at the meeting was Federation Executive Vice-President Frank J. Borrelle who presented a series of slides depicting the people and activities of the Federation and the Paint Research Institute. He also discussed the 1977 Annual Meeting and Paint Show and said it would be the largest ever held.

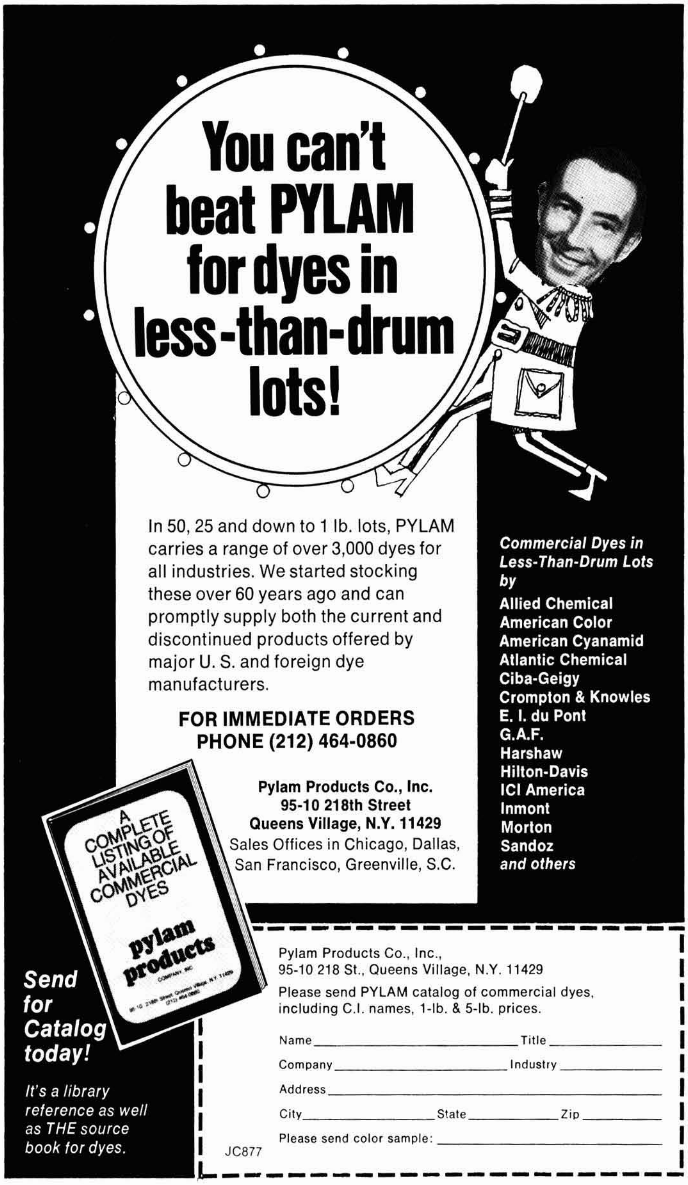
CHARLES B. WILSON, *Secretary*

Pittsburgh June 24

Dennis Astorino, an architect, spoke on "PSYCHOLOGICAL EFFECTS OF COLOR."

Mr. Astorino discussed the use of color by architects, such as blue for a "cooler" effect, the other various colors to induce a variety of psychological effects. He said that, in the future, color would be effectively used to combat certain problems, such as high energy consumption. Mr. Astorino also gave a brief history of the use of color noting that Frank Lloyd Wright utilized color concepts in the 1940's.

ROBERT T. MARCUS, *Secretary*



Elections

CLEVELAND

Active

Konker, Clayton H.—Mobile Chemical Co., Cleveland, Ohio.

Associate

Ellenberger, Robert W.—Hercules Incorporated, Cleveland, Ohio.

DETROIT

Active

Anagnostou, Taki J. — Mortell Co., Warren, Mich.
Johns, Richard L. — Flint Ink Corp., Detroit, Mich.
Turkiewicz, Donald J. — Titan Finishes Corp., Detroit.

GOLDEN GATE

Active

Brill, Bernard M.—Midland Div., Dexter Corp. Hayward Calif.
Specht, Timothy G.—Pacific Vegatable Oil, Richmond, Calif.

Associate

Shea, Dan—V.I.P., Palo Alto, Calif.

NEW ENGLAND

Active

Asgeirsson, Asgeir—Key Polymer Corp., Lawrence, Mass.
Crane, Robert A.—Cabot Corp., Billerica, Mass.
Cronin, Arthur F., Jr.—Weber & Smith, Inc., Reading, Mass.
Giuffrida, John J.—Cabot Corp., Billerica.
Schnake, Paul F.—Roymal Coatings & Chem. Co., Newport, N.H.

NEW YORK

Active

Boardman, Martin—Columbia Paint, Inc., Jersey City, N.J.
Breindel, Kenneth—Diamond Shamrock Corp., Process Chem. Div., Morristown, N.J.
Goldstein, Alvin W.—Proctor Paint Co., Yonkers, N.Y.
Greenberg, Harry—Norton & Son, Inc., Bayonne, N.J.
Lazaro, Mario, Jr.—Sapolin Paints, Inc., Brooklyn, N.Y.
Lieberman, Harvey—Cardinal Color & Chemical, Inc., Paterson, N.J.
Masciulli, Leo—Cardinal Color & Chemical, Inc., Paterson.
Morales, Elenita S.—Norton & Son, Inc., Bayonne.
Patel, Shashi P.—Norton & Son, Inc., Bayonne.
Patrick, John V.—Norton & Son, Inc., Bayonne.
Tracton, Arthur A.—Allied Chemical Co., Cheshire, Conn.
Salerno, Vincent J.—N L Industries, Inc., Hightstown, N.J.
Seiden, Leon—Kirker Chemical Co., Paterson.
Vasquez, Fermin I.—M. Grumbacher, Inc., New York, N.Y.
Weiner, Louis—Podell Industries, Inc., Clifton, N.J.

Associate

Butchyk, Roger J.—Tenneco Chemicals, Inc., Fords, N.J.
Calo, Donald A.—Calo Industries, Inc., Floral Park, N.Y.
Canty, William H.—R.T.Vanderbilt Co., Inc., Norwalk, Conn.
Davis, David S.—Cellomer Corp., Newark, N.J.
Goldberger, Peter—Air Products & Chemicals, Inc., Bayside, N.Y.
Goldstein, Gabriel F.—Inmont Corp., Bound Brook, N.J.
Jachts, Martin C.—Seegott & Assoc. of N.J., Inc., Parsippany, N.J.
Jubanowsky, Louis J.—York Castor Oil Co., Westfield, N.J.
King, Gary S.—Exxon Chemical Co. USA, Florham Park, N.J.
Merwin, John A.—Tenneco Chemicals, Inc. Fords.
Mitzak, John V.—Inmont Corp., Bound Brook.
O'Brien, George J.—R.T.Vanderbilt Co., Inc., Norwalk.
Rawes, Arthur M.—PFD Penn Color, Doylestown, Pa.
Retkwa, John S.—PVO International, Boonton, N.J.
Rhodes, Andrew W.—Hercules Incorporated, New York.
Schafer, Ira M.—Reichhold Chemicals, Inc., Teaneck, N.J.

PACIFIC NORTHWEST

Associate

Doan, Garry C.—Kingsley & Keith Canada Ltd., Vancouver, B.C.
Gaskill, Frank L.—Coatings Equip. Co., Kirkland, Wash.

PHILADELPHIA

Active

Patel, Natu—Best Bros. Paint Mfg. Co., Sinking Spring, Pa.
Plunkett, John B.—Del Val Ink & Color Co., Riverton, N.J.
Saggese, Edward J.—U.S. Dept. of Agriculture, Philadelphia, Pa.
Tobia, Albert M.—Del Val Ink & Color, Inc., Riverton.

Associate

Chinoy, Noshir F.—Air Products and Chemicals, Inc., Allentown, Pa.
Hilbert, Theodore A.—Ashland Chemical Co., Englewood Cliffs, N.J.
Parell, James V.—Quaker City Chems. Inc., Philadelphia, Pa.

SOUTHERN

Associate

Aultman, Phillip M.—McCullough & Benton, Atlanta, Ga.
Frye, Greg H.—Podell Industry, Atlanta.
Rainwater, Howard E.—McKesson Chemical Co., Atlanta.
Smith, Hugh G.—McKesson Chemical Co., Tampa, Fla.
Williamson, Richard D.—Byk-Mallinckrodt, Marietta, Ga.

WESTERN NEW YORK

Active

Mecca, Sebastian V.—Ameron Protective Coatings Div. Buffalo, N.Y.

Astrohall
Houston, Texas
October 26-28

Technical Articles in Other Publications

Compiled by the Technical Information Systems Committee—H. Skowronska, Chairman

Defazet
Deutsche Farben-Zeitschrift
(In German)

Published by Lack- und Chemie-Verlag Elvira Moeller GmbH,
Karl-Benz-Strasse 11, Postfach 11 68, 7024 Filderstadt 1, Germany

Vol. 31 No. 2 February 1977

Haselmayer, F.—"Additives;" 52-55.

Wagner, K., and Brettner, P.—"Preservation and Fungicidal Content of Coatings. Function and Test Methods;" 56-60.

Harke, H.P.—"Are Mercury-Containing Preservatives Still Up-to-Date?;" 61-62.

Scheifer, J.—"Application of Additives (Rheology);" 62-65.

Vol. 31 No. 3 March 1977

Survey of Equipment and Apparatus (announcements of 20 suppliers); 94-114.

Demmler, K., Müller, E., and Schwarz, M.—"Physical Processes Taking Place during the Curing of Unsaturated Polyester Resin Coatings;" 115-128.

Farbe und Lack
(In German)

Published by Curt R. Vincentz Verlag, 3 Hannover, Postfach 6247,
Schiffgraben 43, Germany

Vol. 83 No. 6 June 1977

Gaul, W.—"The Verband der Lackindustrie (Association of the Coatings Industry) Gives Account;" 487-489.

Koth, D., Bode, R., and Schumaker, W.—"A New Scale for Grading Pigment Blacks Based on Spectroscopy;" 490-495.

Czepluch, W.—"Luminance Density Indicatrices and Binocular Gloss Impression;" 495-499.

Rehacek, K.—"Precipitate (Sediment) Formation in Pigmented Coating Materials. (2) Fast Evaluation;" 500-506.

Rautenberg, H.J.—"Novaculite—Platelike Hard Fillers for the Paint Industry;" 506-508.

Brushwell, W.—"Technology of Alkyd and Acrylic Resins" (literature review); 509-513.

Schwegmann, B.—"Cleaning Problems in the Paint Industry" (paint factory maintenance); 513-515.

Anon.—"25th Anniversary Celebration and Change of Directorship of the Forschungsinstitut fur Pigmente und Lacke e.V. (Research Institute for Pigments and Lacquers), Stuttgart;" 533-537.

Industrie-Lackier-Betrieb
(In German)

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Hannover 1, Schiffgraben 43, Germany

Vol. 45 No. 3 March 1977

Haagen, H.—"Electrostatic Charging of Paints in Airless Spraying;" 89-95.

Lückert, O.—"Optimal Metal Pretreatment, with Regard to Energy, Environmental Protection, and Recycling;" 95-100.

Wittich, G.—"Role of Paints/Coatings in Fire Protection;" 101-104.

Experts's Forum—"Thick Film Iron Phosphate Coatings;" 104-106.

Vol. 45 No. 4 April 1977

Fest, M.—"Lacquering/Coating—Various Ways to Form Resin-Based Surface Coatings;" 129-132.

Hess, H., and Liere, H.—"Safety Precautions during Electrostatic Powder Spraying;" 133-136.

Kunze, S., Merten, E., and Schmidt, H.R.—"Coating Systems with Different Gloss Ranges for Nuclear Power Plants;" 141-143.

Pigment and Resin Technology

Published by Sawell Publications Ltd., 127 Stanstead Road,
London SE23 1JE England

Vol. 6 No. 2 February 1977

Anon.—"Influence of Outdoor Weathering on the Mechanical Properties of Products Made from Polyester Mortar;" 4-5.

Americus—"Coatings Update: A Review of New Raw Materials;" 6-13.

Vol. 6 No. 3 March 1977

Browes, A.—"Resin Plant Safety: The Designer's Contribution and Conscience;" 19-21.

Americus—"Coatings Update: Trends and Economic Progress in the Coatings Industry;" 22-25.

Vol. 6 No. 4 April 1977

Smith, G.C.—"Photochemical Degradation of Alkyd Paints;" 4-8.

Anon.—"Liquid Polybutadiene Resins;" 11-15.

Plaste und Kautschuk mit Fachteil Anstrichstoffe
(In German)

Published by VED Deutscher Verlag für Grundstoffindustrie, 27
Karl-Heine-Strasse, 7031 Leipzig, E. Germany DDR

Vol. 24 No. 3 March 1977

Peters, H.G.—"A New Method for Determining the Use-Value of Paints for the Protection against Corrosion;" 209-211.

Vol. 24 No. 4 April 1977

Ernst, H., and Mushack, J.—"New Thermosetting Coating Materials for Extreme Thermal and Chemical Stress;" 284-286.

La Rivista del Colore - Verniciature Industriale
(In Italian)

Published by La Rivista del Colore, S.R.I., Via Imbriani 10, 20158
Milan, Italy

Vol. 10 No. 106 February 1977

Borri, F.—"The Structure of Sandblasted Surfaces;" 41-46.

Zerboni, P.—"Techniques of Electrostatic Powder Coating;" 47-49.

Vol. 10 No. 107 March 1977

Borri, F.—"The Structure of Sandblasted Surfaces;" 77-84.

Anon.—"Guidelines for Construction of Pretreatment and Coating Lines—Part VII;" 85-89.

Skandinavisk Tidsskrift för Färg och Lack

Published by Dansk Bladforlag K/S, Holbersgade 20,
1057 Copenhagen, Denmark

Vol. 23 No. 4 April 1977

Johnsen, S.—"Drag Reducing Systems for Ships's Hulls;" 101-122 (in Danish).

Verfkroniek
(In Dutch)

Published by Groot Haesebroekseweg 1, Postbus 71,
Wassenaar, Netherlands

Vol. 50 No. 3 March 1977

Jacobi, G.M.—"Binders/Vehicles Suitable for Radiation Curing;" 75-81.

Rolla Paint Short Courses to be Held in Sept. - Oct.; New Topic of Microemulsions Included in Schedule

The Fall series of Paint Short Courses sponsored by the University of Missouri — Rolla has been scheduled from September 7 to October 14.

The Fall series has expanded to include the subject of Emulsions and Microemulsions to be held Sept. 7-9.

This new course will provide instruction from the fundamentals to the latest developments in the science of emulsions and microemulsions and their application in such areas as the chemical, petroleum, food, pharmaceutical, and cosmetic fields. Workshop and laboratory participation is included.

Dr. Stig Friberg, Professor and Chairman of the Dept. of Chemistry at the Rolla campus will be Director and course lecturer.

The course fee of $300 includes all classroom and laboratory materials, reception, and banquet. Lodging is not included.

All other courses will again be under the direction of Lewis P. Larson, of the University of Missouri—Rolla, who has 47 years of experience in the paint industry. Also, for the first time, John A. Gordon, Jr., of AMSCO Div. of Union Oil Co., will serve as Co-Director of the series.

The other scheduled courses are:

(Sept. 12-16) 35th Introductory Short Course on Composition of Paint—The course will offer basic information on the ingredients used in paint, the machinery and procedures used in the formulation of paint, and the various quality control tests currently in use. Cost of the course is $175.

(Sept. 19-23) 7th Paint Inspectors and Quality Controllers Short Course—Procedures and equipment used in conducting paint inspections and tests will be examined. Students will gain laboratory experience in running tests in viscosity, fineness, hardness, gloss, etc. Cost of the course is $200.

(Sept. 26-30) 3rd Introductory Short Course on Tinting, Shading and Matching of Colored Paints—Basic information on color pigments and tinting systems used in the paint industry will be presented. Laboratory experiments will be conducted on color match standards. Cost of the course is $200.

(Oct. 3-7) 29th Advanced Chemical Coatings Workshop—The workshop is designed to provide solutions to coatings problems being encountered in industrial and trade sales. Discussion sessions with a panel of industry experts will examine topics, such as titanium dioxides, zinc oxides, extenders, colors and colorants, pigments, thinners and solvents, and resins. Cost of the workshop is $175.

(Oct. 10-14) 26th Paint Short Course for Painting Contractors, Paint Inspectors and Maintenance Engineers—Guest lectures will discuss spray application, maintenance of painted surfaces, preparation and painting of metal substrates and wood surfaces. Also examined will be the deterioration of surfaces due to weathering. Cost of the course is $175.

For additional information, or to register, contact Norma Fleming, Education Coordinator, Extension Div., University of Missouri — Rolla, Rolla, Mo. 65401; or, Lewis P. Larson, Director, Box 3073, Columbus, Ohio 43210.

ASTM Invites Assistance in Developing Lead Analysis Procedures

Procedures for the analysis of lead and chromium in air particulates and paints containing lead chromate pigments are being developed by Committee D-1 on Paint and Related Coatings and Materials of the American Society for Testing and Materials (ASTM).

The D-1 subcommittee (D01.21.03B) developing the procedures also plans to extend this work to include silica-coated lead chromate pigments.

All interested persons who wish to participate should contact J.A. Devlin, Jr., E.I. du Pont de Nemours & Co., Inc., Marshall R&D Laboratory, P.O. Box 3886, Philadelphia, Pa. 19146.

Tech. Advisory Committee Meets with Society Technical Committee Chairmen

The second annual meeting of Constituent Society Technical Committee Chairmen, sponsored by the Federation, was held June 9 and 10 in Cleveland.

A get-acquainted reception was held on the evening of June 9 for the Chairmen and members of the Federation's Technical Advisory Committee. The two groups then met June 10 in an all-day session, chaired by Sid Lauren (Cleveland), Chairman of the Technical Advisory Committee.

Major topics of discussion were reports on each Society's technical activities, both current and planned, cultivating more member involvement and management support, and developing meaningful technical projects for Committee work.

16 Societies Represented

Sixteen Societies were represented: Ed Countryman (Baltimore); Layton Kinney (Chicago); Bob Montague (C-D-I-C); Ashwin Parikh (Dallas); John Dickman (Golden Gate); Jim Vick (Houston); Greg Muselman (Kansas City); Jim Fryman (Los Angeles); Horace Philipp (Montreal); Bob Warren (New England); Tom Ginsberg (New York); Bob Rodenberg (Pacific Northwest); Stan LeSota (Philadelphia); Jim Peterson (Rocky Mountain); Dan Adrien (Southern); and Jan Grodzinski (Toronto).

In addition to Chairman Lauren, other Technical Advisory Committee members attending were: Thad Broome (Southern); Moe Coffino (New York); Bernie Krantz (Los Angeles); Leon Kutik (Chicago); and Kurt Weitz (Toronto).

Also attending was Harold Werner (Cleveland), Chairman of the Joint Federation/ASTM Committee, who requested the cooperation of the Society Committee Chairmen insofar as their technical projects could be related to new standards and methods of tests for consideration by ASTM Committee D-1.

FSCT staff members attending the meeting were Executive Vice-President Frank J. Borrelle and Thomas Kocis, Director of Meetings and Communications.

New York Society Co-sponsoring Coatings Fundamentals Course

A two-semester course on the Fundamentals of Coatings Technology is again being offered at New York City Community College by the Joint Education Committee of the New York Society for Coatings Technology and the New York Paint and Coatings Association.

The first semester, consisting of 15 evening sessions beginning on October 5, is designed to meet the needs of coatings technologists who wish to gain a broader background in coatings fundamentals. A basic understanding of chemistry is desirable, although not mandatory, inasmuch as the chemistry principles required for the course will be presented in clear, concise and simplified terms. Topics to be covered include basic raw materials, for example, pigments, oils, solvents, and resins.

In the second semester, to be offered in February 1978, emphasis will be on paint formulation, application techniques, and test methods.

The courses will be given at Voorhees Campus of New York City Community College, 450 West 41st St., on Wednesday evenings from 6:45 to 8:45.

Registration fee is $120 per semester, and includes the course text book and other course-related materials.

To register, write Saul Spindel, D/L Laboratories, 116 East 16th Street, New York, N.Y. 10003 (by September 19). Checks should be made payable to the New York Society for Coatings Technology.

SPE Technical Conference To Focus on Lead in Plastic

The Society of Plastics Engineers' Delaware Valley Section will hold its Fall Retec (Regional Technical Conference), "The Law and You," October 4 and 5 at the Copley Plaza, Boston, Mass.

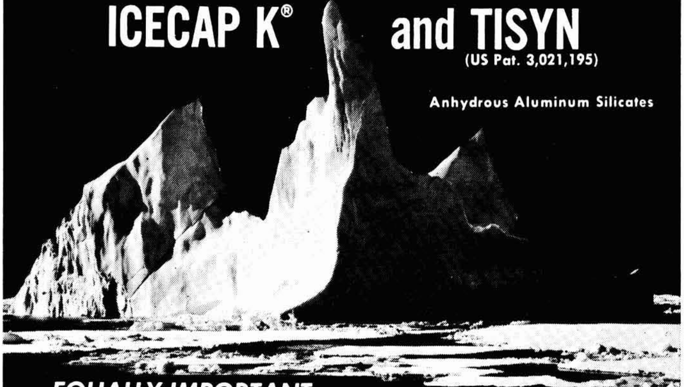
The program will cover industry concerns in the use of lead chromates and other lead-bearing colorants for pigmentation of plastic and/or rubber.

Robert Alexander, of Nortech Co., will serve as Program Chairman, representing the Eastern New England Section of the Appearance Div. of SPE.

Advance registration is $60 for SPE members, and $70 for non-members. To register, contact Donald Aikman, % D.H. Litter Co., Inc., P.O. Box 247, Ballardvale, Mass. 01810.

Hotel reservations should be made directly with Copley Plaza, Copley Square, Boston, Mass. 02116.

President Neil S. Estrada (far right), accompanied by his wife Lily, represented the Federation at the recent Biennial Conference of the OCCA, held in Eastbourne, England. Also attending (left to right): President Designate of SLF, A. McLean and Mrs. McLean; Hans Raaschou Nielsen, Past-President of SLF; and President of OCCA, A.T.S. Rudram and Mrs. Rudram



Additional Contributions Boost PRI Research Funds

A Constituent Society, 14 firms, and eight individuals contributed funds recently in support of the research programs of the Paint Research Institute.

PPG Industries, Inc., Troy Chemical Corp., Rohm and Haas Co., and Mobil Chemical Canada Ltd. were corporate donors, while individual contributions were made by Mr. & Mrs. Flemming Kress, Mr. & Mrs. Lionel Sharpe, and A. S. Davidson.

Additionally, the Cleveland Society made its second contribution of the year as part of a program to match funds donated by its members (see accompanying story). This program generated 10 company contributions (Kalcor Coatings Co., Seegott & Associates, Inc., Tremco Corp., Body Bros., Inc., Mameco International, Palmer Supplies Co., Ohio Solvents & Chemicals Co., Jamestown Paint & Varnish Co., Donald McKay Smith, Inc., and Q-Panel Co.) and five individual contributions (Ross Galati, Sidney Lauren, Fred Schwab, Helen Skowronska, and Dr. & Mrs. Raymond R. Myers).

These bring to 54 the number of contributors to PRI for the 1977 research programs, and supplement the funds committed by the Federation.

1977 Contributors to PRI

SOCIETIES
Baltimore
C-D-I-C
Cleveland
Detroit
Golden Gate
Kansas City
Montreal
New York
Pacific Northwest
Southern
Toronto

ASSOCIATIONS
Baltimore PCA

INDIVIDUALS
A. S. Davidson
Ross Galati
Mr. & Mrs. Flemming Kress
Sidney Lauren
Louisville Anonymous
Dr. & Mrs. Raymond R. Myers
Fred Schwab
Mr. & Mrs. Lionel Sharpe
Helen Skowronska

CORPORATIONS
Agents of Daniel Products Co.
Bate Chemical Company Ltd.
Body Bros. Inc.
Canada Colors & Chemicals Ltd.
Canadian General Electric Co. Ltd.
Celanese Canada Ltd.
Daniel Products Co.
DeSoto, Inc.
Dow Chemical, U. S. A.
Dumar Paints & Chemicals Ltd.
Inmont Canada Ltd.
Kalcor Coatings Co.
Jamestown Paint & Varnish Co.
L. V. Lomas Chemical Co. Ltd.
MacLean-Hunter Ltd.
Mameco International
Mobil Chemical Canada Ltd.
Benjamin Moore & Co. Ltd.
Nacan Products Ltd.
Ohio Solvents & Chemicals Co.
Palmer Supplies Co.
PPG Industires, Inc.
Q-Panel Co.
Reed—Pigments Div.
Reichhold Chemicals Ltd.
Rohm and Haas Co.
Seegott & Associates, Inc.
Selectone Paints Ltd.
Shell Chemical Co.
Donald McKay Smith, Inc.
Tioxide of Canada Ltd.
Tremco Corp.
Troy Chemical Corp.

Cleveland Society Matching Fund Program Yields $1050 for PRI

A unique solicitation program initiated by the Cleveland Society for funds in support of the Paint Research Institute has resulted in an additional $1050 in contributions for research projects.

The Society announced to its members that it would match individual and company contributions (up to a total of $500) during the program period, ending September 30. Begun in May, the program has been so successful that by mid-June contributions totalled $550. Checks for these contributions were sent to Federation headquarters, along with the Society's check for $500 to match the donations.

The matching funds are in addition to an earlier society contribution.

CALL FOR PAPERS

First International Conference On Durability of Building Materials and Components

August 21 — 23, 1978
Ottawa, Canada

The Conference, sponsored by the National Research Council of Canada, American Society for Testing and Materials, U.S. National Bureau of Standards, and Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM), will consider the topics:

- Economic and energy conservation aspects of durability.
- General aspects of durability of various materials, i.e., inorganic, organic, porous materials, and natural products.
- Environmental factors affecting durability and their measurement.
- Testing.

Prospective authors are asked to submit a preliminary title as soon as possible. "Instructions for Authors" will be sent in return. An abstract is required before September 30, 1977, and the manuscript before March 20, 1978.

All inquiries should be addressed to K. Charbonneau, Executive Secretary, National Research Council of Canada, Ottawa, Ontario K1A 0R6.

People

Dr. John C. Weaver, Consultant, Coatings Group, The Sherwin-Williams Co., Cleveland, Ohio, and retired Director of Research of the company, was elected a Director of the American Society for Testing and Materials (ASTM) for a three-year term beginning July 1.

Dr. Weaver received his B.S. Degree in chemistry from Denison University in Granville, Ohio. He later attended the University of Cincinnati where he received his M.A. and Ph.D. Degrees.

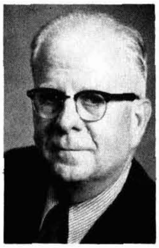
He joined Sherwin-Williams Co. in 1936, and his work involved resins, varnishes, driers, and dehydrated castor oil. In the following years his responsibilities included research and development management and coordination at various levels and interfaces of research and development manufacturing, quality control, international corporate and government agencies and departments. From 1968 until he retired in 1974, Dr. Weaver was director of research for the Coatings Group. He continues as a consultant in coatings to Sherwin-Williams.

Dr. Weaver was elected by the ASTM Board of Directors in 1976 an Honorary Member of ASTM and is also a member of the Federation of Societies for Coatings Technology and its Cleveland Society, American Chemical Society, and the Cleveland Association of Research Directors of which he is a past-president.

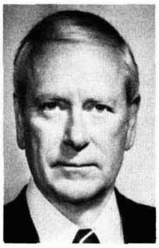
His honors and awards include membership in the honorary scientific research society of Sigma Xi, the ASTM Award of Merit for distinguished service to voluntary standardization, and he was the 1969 recipient of the Federation's George Baugh Heckel Award for his "outstanding contribution to the advancement of the Federation's interest and prestige."

Frank J. Doyle has been elected President of PPG Industries Canada Ltd., Toronto. He has been with the company since it was created in 1952 and served most recently as Chairman of the Board and President of the Canadian Pittsburgh Industries Div.

In a series of managerial appointments, Southern Coatings & Chemical Co. has named: **Austin E. Floyd**—Assistant General Manager, Sumter and Slidell facilities; **W.S. Shuler**—Plant Manager, Sumter facility; and **H.E. Owens**—Corporate Purchasing Manager. **R.S. McKenzie, Jr.** will continue as Plant Manager at Slidell.



J.C. Weaver



J.A. McKinney

Johns-Manville Corp. has appointed **John A. McKinney** Chief Executive Officer. In this capacity, Mr. McKinney will be responsible for overall administration of the company's worldwide network of manufacturing, mining and marketing.

Rudolf W. Graf has been named Senior Vice-President in charge of international operations and administration for the Minerals & Chemicals Div. of Engelhard Corp. Mr. Graf's responsibilities include direction of worldwide exploration and coordination of environmental control programs.

J.A. Lofthouse has been elected Chairman of the Board of Directors of ICI Americas. He succeeds **William B. Duncan** who is now Deputy Chairman with Imperial Chemical Industries Ltd., the London based parent company of ICI Americas. **Edward J. Goett** will continue as President and Chief Executive Officer.

The Hilton-Davis Co., Pigments Div., has named **Richard G. Batezell** Sales Representative for the Pacific northwest area.

Francis X. McDermott will assume the position of Senior Vice-President of Kelco. To his current responsibilities for marketing and sales he will add the areas of research and development.

For the fourth time in 10 years, the Coatings & Resins Div. of PPG Industries has received the paint manufacturers award of the Painting and Decorating Contractors of America (PDCA). The award, presented at the PDCA annual meeting in Houston, Tex., was accepted by Elmer C. Larsen, Vice-President and General Manager of the division. The award plaque cites PPG for outstanding service to the painting and decorating industry during 1976.

Paul S. Litzsinger has been appointed Manager—Technical Service Dept. of Carboline Co. He will be responsible for all activities of the department including engineering, field service and application.

Body Bros., Inc. has named **R.G. Landis** as Manufacturing Superintendent. Mr. Landis has been with the company since 1966 and most recently served as Assistant Technical Director. He is a member of the Philadelphia Society for Coatings Technology.

United Coatings, Inc. has promoted **Richard M. Hille** to Manufacturing Vice-President. He will be responsible for the Chicago and Los Angeles plants. Mr. Hille is Treasurer of the Chicago Society for Coatings Technology.

Donald A. Kaessen has been named Vice-President of Engineering for The Warren Rupp Co. at its Mansfield, Ohio headquarters.

Dr. George Roberts has been appointed Director of Corporate Research for Air Products and Chemicals, Inc.; Allentown, Pa. Also, the company has named **Michael Scigliano** Manager of Process Design. He was formerly section manager in the Industrial Chemicals Div. of Air Products.

Robert Walsh, of Walsh & Associates, Inc., St. Louis, Mo., has been elected President of Materials Marketing Associates, Inc. **Ken Ridolfi,** of Matteson-Ridolfi, Inc., Detroit, Mich., and **Chris Brandt,** of George C. Brandt, Inc., Kansas City, Mo. were elected Vice-Presidents. Elected to the Board of Directors were **Jack Shelton,** of J.F. Shelton Co., Portland, Ore., and **Douglas Everett,** of Van Horn, Metz & Co., Inc., Philadelphia, Pa.

Henrietta Sears, formerly Purchasing Manager of Baltimore Paint & Chemical Co., has been named Director of Purchases for that company.

William L. Huettel, President of Pratt & Lambert's United Paint Co., Memphis, Tenn., has been elected a Director of Pratt & Lambert. Elected as Vice-President was **Michael M. Galbraith** succeeding **Richard F. Brewster,** who is retiring after 40 years of service with the company.

Andrew D. Palmer, Advertising Manager of trade paint sales, has retired after 25 years of service with PPG Industries' Coatings & Resins Div. Mr. Palmer devoted a major portion of his career to the development of PPG's retail stores program. He will be succeeded by **C. Joseph Bauer.**

Ted S. Trzos has been appointed Technical Sales Manager of Illinois Minerals Co. Mr. Trzos served as Secretary for the Pittsburgh Society for Coatings Technology in 1974.

Valspar Corp. has appointed **Thomas H. Brehm** Central Regional Manager for the company's Minnesota Paints line. Also, **Francis J. Baudhuin,** Vice-President of Special Products, will retire at year's end. He has been associated with the paint industry since 1940.

Eastman Chemical Products, Inc. has appointed **G.S. (Pete) Teague, Jr.** and **Jack W. Lowe, Jr.** to the newly created positions of Senior Marketing Representatives in the Coatings Chemicals Div.

In a series of managerial appointments, BASF Wyandotte Corp. promoted **James G. Brown** to Vice-President, Chemicals Specialties Business; **Guenter Koenen** was named General Manager, Colors and Auxiliaries Div.; **Dr. Robert D. Vaughn** was appointed Director of the newly-established department of Scientific and Technical Affairs; and **Dr. Francis J. Hohn** was named Director of Corporate Planning and Market Research.

Dr. G.M. Sastry has been appointed Manager—Research and Product Development Laboratories for the Chemical Div. of the Chrysler Corp.

In a series of five managerial appointments, the Chemical Coatings Div. of DeSoto, Inc. has named **Carol Plass** Marketing Services Manager; **Al Henning** and **Leonard Laskin** Industrial Research Managers; and **Ray Parenti** and **James Gauchel** were appointed Technical Managers.

Richard G. Bull has been elected Vice-Chairman of the Board of Directors of the Sherwin-Williams Co. He has been associated with the concern for 39 years and served most recently as Senior Vice-President—Marketing. The Board of Directors also named **Bernard E. Rassat** Assistant Treasurer and Assistant Secretary. He has been with the company 26 years, most recently as Assistant to the Treasurer.

Jerry W. McCandless has been promoted to Vice-President of Sales for Kurfees Coatings, Inc., Louisville, Ky.

Obituary

John Millar, Technical Manager of powder coatings for the Farboil Paint Co., died June 1, 1977. A native of Scotland, he came to Farboil ten years ago. He was a member of the Baltimore Society for Coatings Technology. Mr. Millar is survived by his wife, Margaret Joan, and three children, Margaret, Stephen and Peter.

Robert I. Thompson, Marketing Representative for the Pigments Dept. of E.I. du Pont de Nemours & Co., Inc., died June 26 near Chardon, Ohio. He had served du Pont since 1947, and was a member of the Cleveland Society for Coatings Technology, Cleveland Chemical Association, and the Cleveland Paint and Coatings Association.

Literature

Calcium Carbonate

The properties and uses of a quality-controlled calcium carbonate filler and reinforcing agent are discussed in a recently published bulletin. The product, Winnofil® S, is a precipitated calcium carbonate of ultra-fine particle size (about 72 mμ), surface treated with calcium stearate to prevent agglomeration and to increase water repellency. To obtain a copy of bulletin 761-42, write ICI United States, Inc., Specialty Chemicals Div., Wilmington, Del. 19897.

Air Pollution Control

A new and unique concept in particulate removal and gas absorption is described and illustrated in detail in a bulletin entitled, "Centripetal Vortex Contractor." The bulletin describes several applications and illustrates them schematically. Performance curves are given and typical applications are illustrated. Dimensional data are included on several different models of the CentriField contractor. For literature write Public Relations Dept. Entoleter, Inc., 251 Welton St., Hamden, Conn. 06511.

Textile Coatings

An 18-page bulletin examines a line of thermoplastic polyurethanes which are used to make industrial and consumer erties of the material is described. Processing techniques, including solution coatings and melt coating, are detailed. coatings and melt coating, are detailed. For a copy of bulletin G-58, "Textile Coatings with Estane Thermoplastic Polyurethane," write Public Relations Dept., B.F. Goodrich Chemical Div., 6100 Oak Tree Blvd., Cleveland, Ohio 44131.

Liquid Polymer

A non-ionic high activity polymer that can be used in both nonpotable water clarification and pollution control applications is discussed in recent literature. Advantages of Nalcolyte® 7181, a single component, liquid emulsion flocculant, include immediate dissolution, decrease in carryover to the filters, faster sludge dewatering, and improved finished water quality. Further information can be obtained from Nalco Chemical Co., 2901 Butterfield Rd., Oak Brook, Ill. 60521.

Foreign Buyers' Guides/ Raw Material Suppliers' Guides

GREAT BRITAIN: "Paint Trade Manual of Raw Materials and Plant," (1975-76 edition). This volume lists, in alphabetical arrangement, the suppliers of raw materials, chemicals, laboratory apparatus, and manufacturing plant equipment. In addition to suppliers' names and addresses, the U.K. agents for non-British suppliers are given. (Published by Sawell Publications Ltd., 127 Stanstead Rd., London, SE23 1JE England. Cost is £ 5).

GERMANY: "Lackrohstoff - Tabellen," (Paint Raw Materials Tables, 6th edition). This is a useful compendium of information about drying oils, resins—both natural and synthetic, solvents and plasticizers, as well as driers and various additives excluding pigments. The primary classification is by raw material type, and secondary, by supplier. The information, which includes physical and chemical data, is arranged in tables. Also given are suppliers' names and addresses. (Published by Curt R. Vincentz Verlag, Postfach 6247, 300 Hannover 1, Germany. Cost is 78 DM).

SWITZERLAND: "Internationales Coating Lexicon und Bezugsquellenregister," (Coatings International Dictionary and Suppliers' Directory. Two volumes). The Dictionary defines names of raw materials, finished products, processes, test instruments, etc., and includes suppliers in many instances. The scope of this publication appears similar to that of "Hawley's Condensed Chemical Dictionary."

The new edition of the Suppliers' Directory will appear this fall and will be an alphabetical arrangement of suppliers under the raw material, chemical, equipment, etc., to be ordered. (Published by Verlag Coating, Bankgasse 8, CH-9001 St. Gallen, Switzerland. Cost is 85 SwF).

Lab Mixer

An efficient laboratory mixer which operates at speeds from 600 to 5800 rpm is discussed in a newly released brochure. The mixer disperses, emulsifies, homogenizes, suspends, or stirs quantities from 0.5 to 5 liters. For more information on the Chemcol Type MS 1 CAA-R Mixer write Ahiba-Mathis, Inc., P.O. Box 3185, Charlotte, N.C. 28203.

Handling Systems

A comprehensive, 24-page brochure has been published which relates four storage and retrieval systems for industry, which include: the Automove® Unitload, a high-rise storage and retrieval system for pallet-sized loads; the Mole® ,a high-density system designed for deep lane storage and adaptable to high-rise cranes; the Automove® Miniload, a stacker crane system for automatic inventory control for small parts storage and retrieval; and the Man-Rider®, a high-rise, pallet-sized storage system without the cost of computer controls. For the booklet, "Storage and Retrieval Systems," write Litton UHS, Marketing Dept., 7100 Industrial Rd., Florence, Ky. 41042.

Solvent Selection

An eight-page foldout booklet providing detailed information on the selection of solvents for coatings is now available. Data on solvents, co-solvents, couplers, diluents, and plasticizers are presented in a series of charts. Copies of the guide, "Solvent Selector for Coatings," is available from Union Carbide Corp., Coatings Materials, Dept. RAM, 19th Floor, 270 Park Ave., New York, N.Y. 10017.

IR Spectrophotometers

Literature describing a new series of spectrophotometers is now available. These medium-priced devices have integrated scan control Providing a resolution of 0.5 cm^{-1}, these models have built-in service diagonistics. For further information on the X-99 series write Perkin-Elmer Corp., Instrument Div., Main Ave., Mail Station 12, Norwalk, Conn. 06856.

Grinding Mill

The advantages of a new, three-dimensional grinding mill are related in a brochure now made available. The mill is specifically designed for the preparation of chemical, petrological, mineral, and dye samples. It is reported to have very fast grinding qualities, low abrasion of grinding vessels, and a wide variety of grinding vessel size and materials. For more information, write Albert Monasebian, Marketing Manager, Micro Materials Corp., 100 Grand St., Westbury, N.Y. 11590.

Photocuring Agents

A new 8-page booklet is available which compares the performance of various commercial photocuring agents with Irgacure® 651. Several acrylate and polyester-styrene formulations are described in thicknesses from 0.5 to 6 mils. Cure rates, resultant hardness, color resistance and shelf life are compared. The brochure, "Photocuring Agent for Inks and Coatings," may be obtained from CIBA-GEIGY Corp., Additives Dept., Plastics & Additives Div., Ardsley, N.Y. 10502.

Primer Systems

A 12-page brochure which describes rust resisting, water-soluble primer systems is now available. Two resin systems are used in a variety of baking type, air drying, and surfacing primers yielding excellent physical properties and weatherability. Copies of bulletin TMA-121 are available from Amoco Chemicals Corp., Dept. ADV-JPAT, Mail Code 4102, 200 East Randolph Dr., Chicago, Ill. 60601.

Fabricators Directory

A 12-page directory has been published which lists over 200 fabricators in the U.S.A. and Canada who have worked with Hetron® and Aropol® resins. A fabricator can choose from a wide selection of these chemical resistant resins to produce equipment such as tanks and duct, linings, coatings and accessories for the industries corrosive environments. To obtain a copy of this directory, write Ashland Chemical Co., Resins & Plastics Div., Dept. HFAB, P.O. Box 2219, Columbus, Ohio 43216.

CLASSIFIED ADVERTISING

COATINGS ENGINEER—The National Coatings Center utilizes first principles in fundamental investigations and applied research common to the needs of the Composite Coatings Industry. The objectives are related to raw materials, paint manufacture and application pf polymeric membranes to common substrates. Staff additions are contemplated at the level of project management and Laboratory Director. For indications of qualification expectations see Mattiello Lecture—Journal of Coatings Technology, issue of January 1977, pp. 37-48. Your statement of experience will be considered in confidence. Send resume to: H.L. Gerhart, Director, National Coatings Center, Carnegie-Mellon Institute of Research, 4400 Fifth Ave., Pittsburgh, Pa. 15213. An Equal Opportunity Employer.

Pigment Dispersants

Technical literature describing a new series of low molecular weight polymeric dispersants, Natrol 42 and Natrol 72, is now available. Natrol 42, supplied as a 50% aqueous solution, is a low molecular weight acrylate copolymer. It offers the possibility of eliminating phosphates or polyphosphates from many suspensions. Natrol 72, supplied as a 100% active powder, is a low molecular weight polymeric dispersant with a unique combination of sulfonate and carboxylate groups. For further information and samples, contact Chemical Products Dept., National Starch and Chemical Corp., 10 Finderne Ave., Bridgewater, N.J. 08807.

Particle Size Analyzer

A practical, field-proven method for continuous monitoring of particle size for process control, as well as a precise tool for rapid analysis of the size and distribution of particles, is discussed in a newly released brochure. The Microtrac analyzer provides the capability to: monitor particulate material production in industrial processes where size distribution of particles is time-dependent, characterize the size distribution of dry powders as well as particulate material in water or other liquids, and determine when the processed product reaches target "spec" or detect "out-of spec" products and take immediate corrective action. For further information write Advanced Business Development Dept., Mail Drop 102, Leeds & Northrup Co., North Wales, Pa. 19454.

Chemical Additives

Newly released technical bulletins detailing the performance advantages of three new chemical additives are now available. Two of the additives, Dabco® DC-1 and Dabco® DC-2, are delayed action catalysts designed for use in the production of rigid and microcellular polyurethane foam. In tandem, the catalysts can provide an extended initiation time without an extended cure time. In other combined proportions the catalysts offer a normal initiation time with a significant decrease in cure time. The third new additive, VS-135 polyvinyl chloride foam stabilizer, is a liquid for chemically-blown vinyl foams which can be applied directly to the PVC resin by the manufacturer. To obtain these bulletins, contact Air Products and Chemicals, Inc., Chemical Additives Div., Box 538, Allentown, Pa. 18105.

Low Cure Enamel

A low cure enamel with 50% solids by volume, for better coverage, is described in literature now available. The off-white enamel provides thickness in fewer passes and requires a minimum of low temperature baking time, 20 min at 250° F. Applied by air, airless, hot airless or hot airless electrostatic spray, the desired film thickness of 1.2 to 1.5 mil can be obtained in one pass. More information can be obtained by contacting Richard Fricker, Manager of Technical Projects, The Valspar Corp., 1101 Third St. South, Minneapolis, Minn. 55415.

Book Review

ENGLISH/FRENCH PAINTS AND COATINGS VOCABULARY

L'Association Quebecoise des
Industries de la Peinture
Montreal, Quebec, Canada
1977 (272 pages)
$12.00

Reviewed by
Helen Skowronska
Sherwin-Williams Corp.
Cleveland, Ohio

This handy pocket-size (approximately 4″ × 7″) extremely legible volume is a result of the efforts of a committee of professional chemists and translators from member companies of the Quebec Paint Industries Association.

The text, which includes about 4000 commonly used terms in the coatings industry, is convenient to use—for the English/French portion is printed right side up from one end of the book while the French/English portion is printed upside down from the other end of the book.

Although the words and terms have been collected from various reliable sources, this vocabulary is by no means all-inclusive. The committee plans future updates.

This book should appeal not only to those doing business in Quebec, but also to anyone in need of a basic English/French and French/English coatings vocabulary.

Coming Events

FEDERATION MEETINGS

(Oct. 25)—Fall Council Meeting, Shamrock Hilton Hotel, Houston, Tex.

(Oct. 26-28)—55th Annual Meeting and 42nd Paint Industries' Show. Astrohall, Houston, Texas. (FSCT, Suite 830, 1315 Walnut St., Philadelphia, Pa. 19107).

SPECIAL SOCIETY MEETINGS

(Sept. 14-15)—Montreal and Toronto Societies Symposium on "Energy Today—Energy Tomorrow." In Toronto on the 14th. In Montreal on the 15th.

(Mar. 8-10)—Southern Society Annual Meeting. Omni International Hotel, Atlanta, Ga. (A. Roy Neal, Rico Chemicals, Inc., P.O. Box 1003, Toccoa, Ga. 30577).

(Mar. 9-10)—Cleveland Society Symposium on "Advances in Coatings Technology." (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, Ohio 44242).

(Apr. 13-15)—Dallas and Houston Societies. Southwestern Paint Convention. The Hilton Inn, Dallas, Texas. (J. Donald Webb, Jones-Blair Co., P.O. Box 35286, Dallas, Texas 75235).

(May 4-6)—Pacific Northwest Society Spring Symposium. Washington Plaza Hotel, Seattle, Wash. (Curtis P. Bailey, Parker Paint Mfg. Co., 3302 S. Junett St., Tacoma, Wash. 98409).

OTHER ORGANIZATIONS

(Sept. 7-9)—Microemulsions and Emulsions Short Course. University of Missouri—Rolla, Rolla, Mo. (Norma Fleming, Extension Div., University of Missouri—Rolla, Rolla, Mo. 65401).

(Sept. 8)—"Managing Health and Safety in the Chemical Industry." Workshop. New Orleans Marriott Hotel, New Orleans, La. (Milton Freifeld, Manufacturing Chemists' Association, 1825 Connecticut Ave., N.W., Washington, D.C. 20009).

(Sept. 12-Oct. 14)—Paint Short Courses at University of Missouri—Rolla. Composition of Paints and Chemical Coatings—Sept. 12-16; For Paint Inspectors and Quality Controllers—Sept. 19-23; Tinting, Shading, and Matching Color Paints—Sept. 26-30; Advanced Chemical Coatings Workshop—Oct. 3-7; For Maintenance Engineers, Architects, Painting Contractors—Oct. 10-14. (Norma Fleming, Extension Div., University of Missouri—Rolla, 501 W. 11th St., Rolla, Mo. 65401).

(Sept. 14-15)—Symposium on "UV Polymerization and the Coatings Industry," sponsored by Newcastle-upon-Tyne Section of Oil and Colour Chemists' Association. (H. Fuller, Tioxide International Ltd., Carlton Weathering Station, Yarm Back Lane, Stockton-on-Tees, Cleveland TS21 1AX, England).

(Sept. 25-28)—First International Convention of Oil & Colour Chemists' Association of Australia. Canberra, Australia. (Oil & Colour Chemists' Association of Australia, P.O. Box 93 Punchbowl, 2196, Australia).

(Oct. 4-5)—"The Law and You," Fall RETEC of Society of Plastics Engineers. Copley Plaza, Boston, Mass. (Don Aikman, ℅ D. H. Litter Co., Inc., Box 247, Ballardvale, Mass. 01810).

(Oct. 5-7)—National Coil Coaters Association Fall Technical Meeting. Hyatt Regency O'Hare, Chicago, Ill. (Jere Lawrence, NCCA, 1900 Arch St., Philadelphia, Pa. 19103).

(Oct. 11-15)—Intercolor 77, "Colour Technology—Today and Tomorrow." Schweizer Mustermesse Halls 22 and 24, Basel, Switzerland. (John Fletcher, Mack-Brooks Exhibitions Ltd., 62-64 Victoria St., St. Albans, Herts, England AL1 3XT).

(Oct. 18-20)—"Finishing '77" Conference and Exposition. Cobo Hall, Detroit, Mich. (Jon Grove, Association for Finishing Processes of SME, 20501 Ford Rd., Dearborn, Mich. 48128).

Coming Events (Continued)

(Oct. 24-26)—National Paint and Coatings Association Annual Meeting. Hyatt Regency Hotel, Houston, Tex. (Georgene Savickas, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005).

(Oct. 31-Nov. 2)—Conference on "Fundamentals of Adhesion—Theory, Practice, and Applications." State University of New York, New Paltz, N.Y. (Dr. A.V. Patsis, Fall Conference in Science and Technology, State University of New York, Coykendall Science Building, New Paltz, N.Y. 12561).

(Nov. 1-3)—International Pollution Engineering Congress. Georgia World Congress Center, Atlanta, Ga. (Clapp & Poliak, Inc., 245 Park Ave., New York, N.Y. 10017).

(Nov. 7-10)—Society of Plastics Engineers National Technical Conference on "Safety and Health with Plastics." Regency Inn, Denver, Colo. (Eugene E. Wilson, SPE, 656 W. Putnam Ave., Greenwich, Ct. 06830).

(Nov. 7-10)—International Symposium on Chromatographic Analysis of Polymers and Related Materials. Chicago, Ill. (Jack Cazes, Chairman, Waters Associates, Inc., Maple St., Milford, Mass. 01757).

(Nov. 14-16)—14th Annual Meeting of the Society of Engineering Science, Inc. Lehigh University, Bethlehem, Pa. (Dr. George C. Sih, Director, Institute of Fracture and Solid Mechanics, Lehigh University, Bethlehem, Pa. 18015).

(Nov. 18-20)—Annual National Decorating Products Show. McCormick Place, Chicago, Ill. (National Decorating Products Association, 9334 Dielman Industrial Drive, St. Louis, Mo. 63132).

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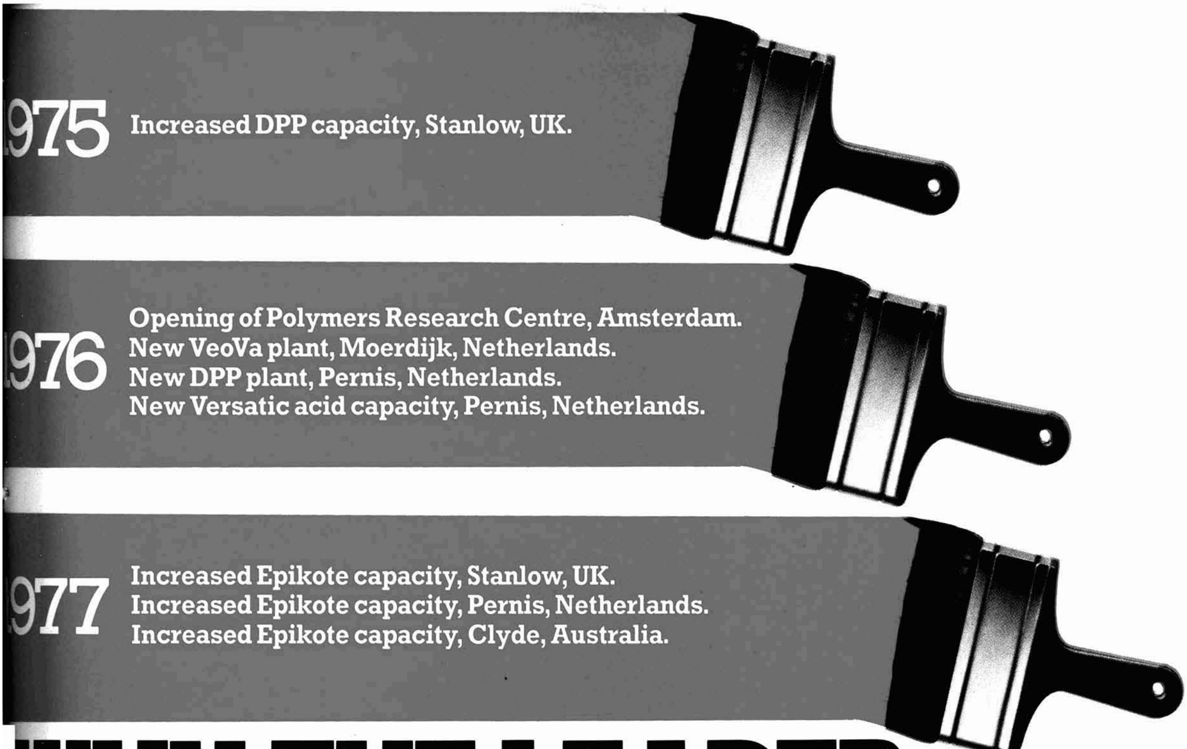

975 Increased DPP capacity, Stanlow, UK.

976 Opening of Polymers Research Centre, Amsterdam.
New VeoVa plant, Moerdijk, Netherlands.
New DPP plant, Pernis, Netherlands.
New Versatic acid capacity, Pernis, Netherlands.

977 Increased Epikote capacity, Stanlow, UK.
Increased Epikote capacity, Pernis, Netherlands.
Increased Epikote capacity, Clyde, Australia.

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