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JOURNAL OF COATINGS TECHNOLOGY

July 1985

1985 50 Fiftieth Anniversary of the Paint Industries Show

and Sixty-Third Annual Meeting

CERVANTES CONVENTION CENTER
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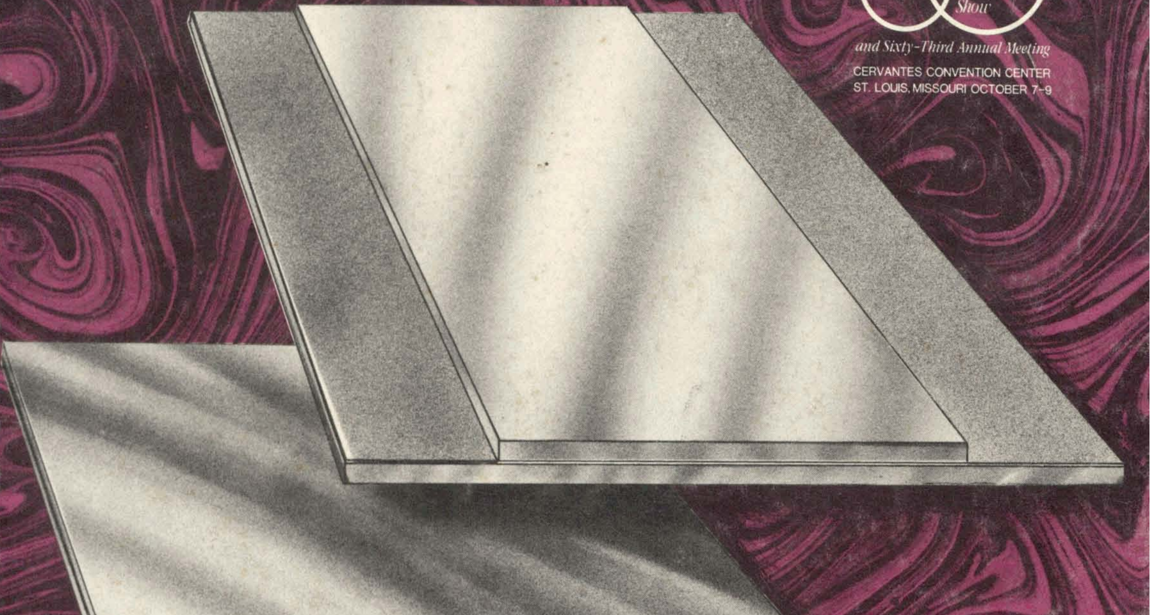

Physico-Chemical Factors in the Performance of Polymer-Metal Bonds

Mantel

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They can be used as components in applications ranging from durable coatings for rigid and flexible substrates on cars to superior coatings for urethane foam roofing.

TONE Polymeric Intermediates consist of a broad spectrum of multi-functional polyols for producing high-quality polyurethanes, or for flexibilizing and upgrading the properties of thermoset coatings; low viscosity reactive diluents for increasing the solids content of thermoset coatings while improving key properties; and a hydroxyfunctional acrylic monomer for improving the flexibility, impact resistance and durability of higher solids acrylic or vinyl copolymer coatings.

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"CREATIVE COLORSHIP FOR OVER A CENTURY"

JULY 1985

jct JOURNAL OF COATINGS TECHNOLOGY

VOLUME 57 NUMBER 726

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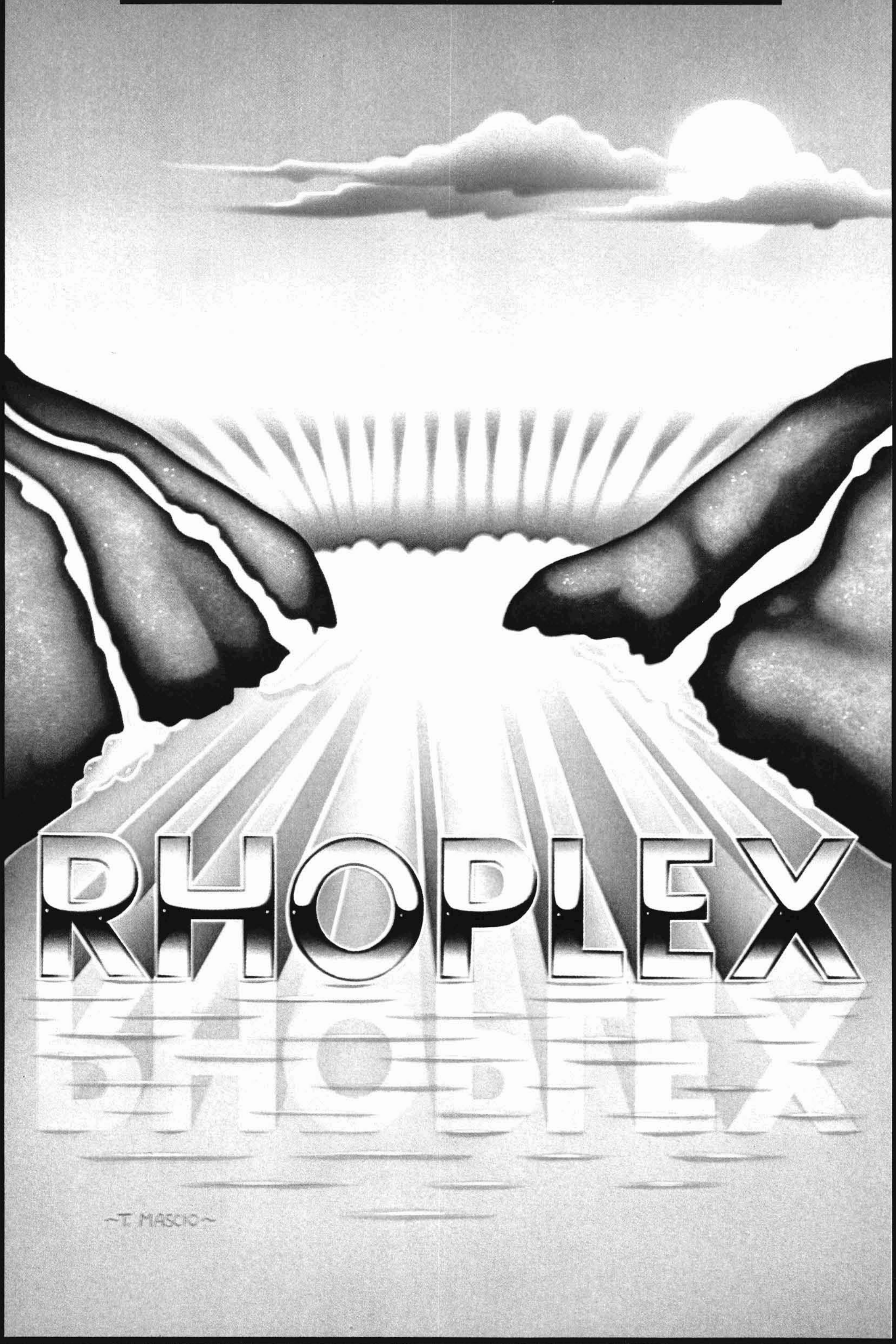
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~T. MASCIO~

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2 Years	$51.00	$ 97.00	$ 71.00
3 Years	$73.00	$142.00	$103.00

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Comment

The Need for Review Articles

One of the most universally held truths in the world of science—a maxim, if you will—is that those who would progress must stand on the shoulders of those who went before. True *insight*, then, is a rather rare commodity; the products and creations of technology are the pinnacles resting upon mountains of research.

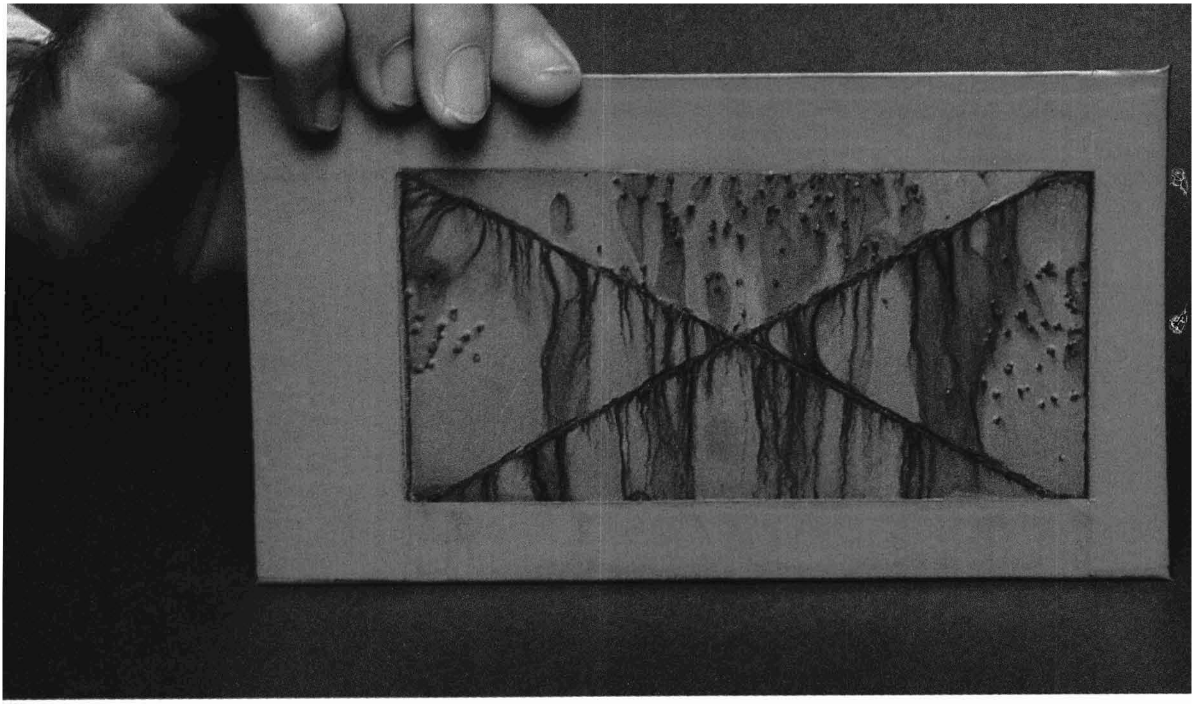
Recognizing this, the Federation's Publications Committee, at its recent meeting, has authorized the Journal of Coatings Technology to accept for submission review articles summarizing the essence of an article or group of articles in one or more publications. Topics selected should, of course, serve the broad interests of the readers of JCT, bringing together references and citations and leading to a cohesive overview of developments in the area discussed.

The limitations placed on the writer are those found in the JCT "Guide for Authors" (see pages 33–34, January 1985, or request from JCT office).

By condensing the mountains of published research into easily digestible morsels, review articles serve a real purpose in the scientific community.

Robert F. Ziegler

Robert F. Ziegler,
Editor



CIBA-GEIGY epoxy hardeners and the VOC solution

With new 100% solids Hardener XU 283, you can formulate an EPA-acceptable coating with improved performance.

Nobody has to tell you about EPA-mandated restrictions on the volatile organic content (VOC) of industrial coatings. Or about the fact that these restrictions are being adopted state by state.

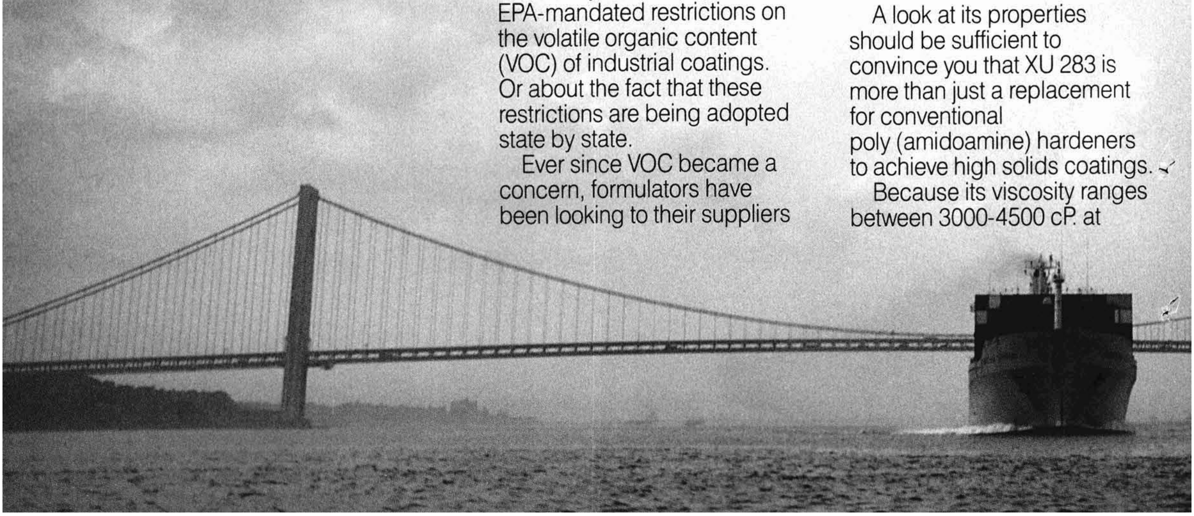
Ever since VOC became a concern, formulators have been looking to their suppliers to develop high solids substitutes for existing standard epoxy resin/poly (amidoamine) hardener formulations—substitutes that could provide the high performance characteristics necessary in coatings for bridges, containers and tanks, pipes, ships, and railroad cars.

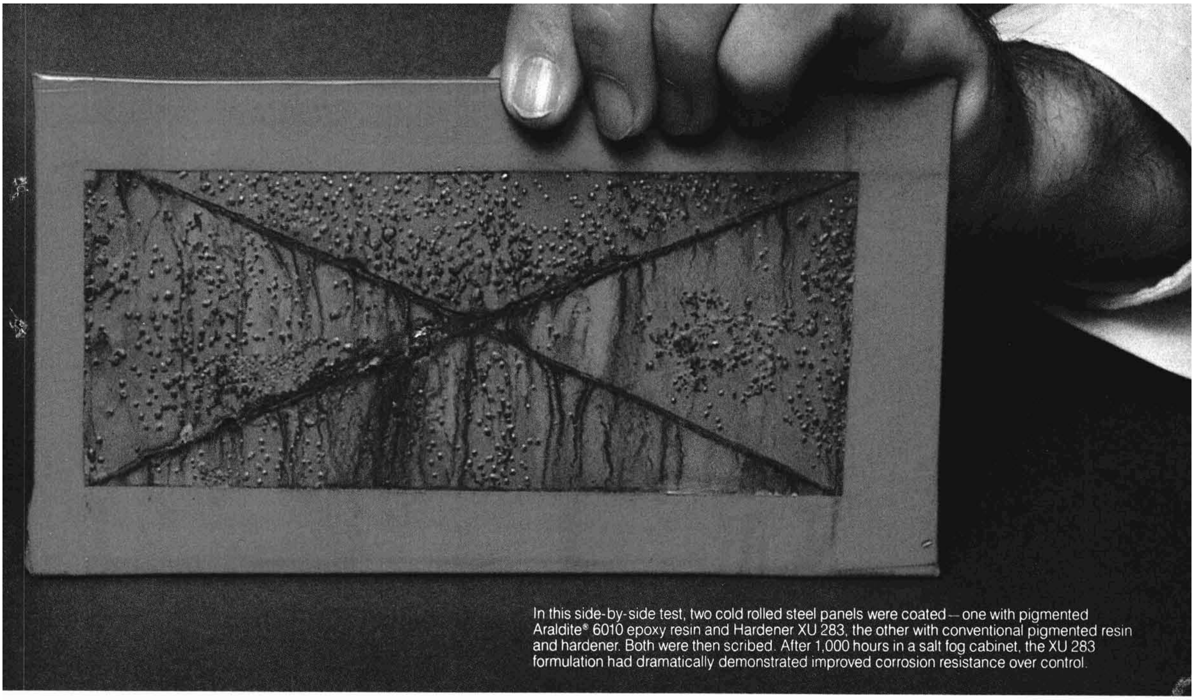
That's why we challenged our chemists to work on a solution. And why that solution is available today as a 100% solids, modified poly (amidoamine) hardener known as XU 283.

More than just a replacement.

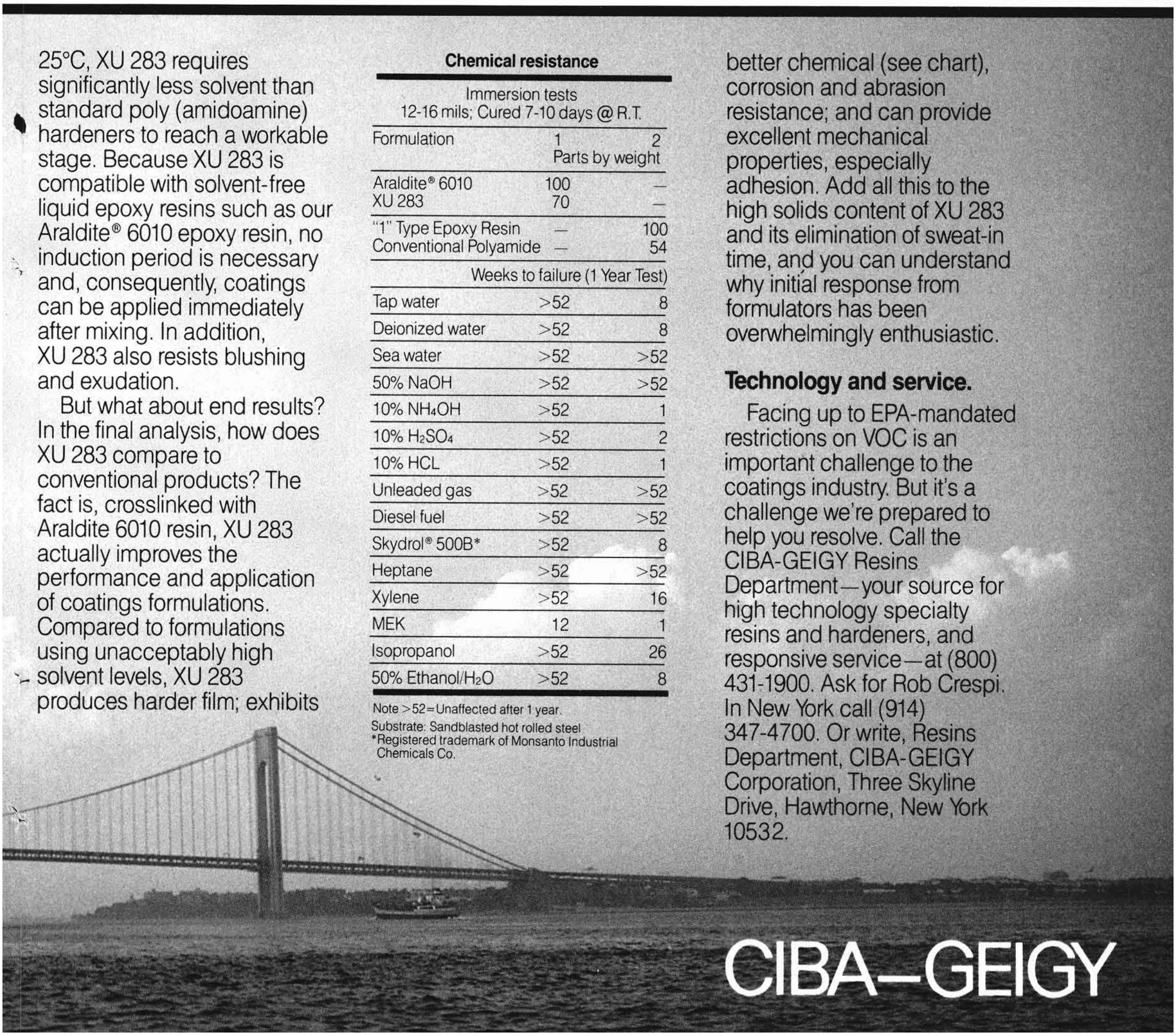
A look at its properties should be sufficient to convince you that XU 283 is more than just a replacement for conventional poly (amidoamine) hardeners to achieve high solids coatings.

Because its viscosity ranges between 3000-4500 cP. at





In this side-by-side test, two cold rolled steel panels were coated—one with pigmented Araldite® 6010 epoxy resin and Hardener XU 283, the other with conventional pigmented resin and hardener. Both were then scribed. After 1,000 hours in a salt fog cabinet, the XU 283 formulation had dramatically demonstrated improved corrosion resistance over control.



25°C, XU 283 requires significantly less solvent than standard poly (amidoamine) hardeners to reach a workable stage. Because XU 283 is compatible with solvent-free liquid epoxy resins such as our Araldite® 6010 epoxy resin, no induction period is necessary and, consequently, coatings can be applied immediately after mixing. In addition, XU 283 also resists blushing and exudation.

But what about end results? In the final analysis, how does XU 283 compare to conventional products? The fact is, crosslinked with Araldite 6010 resin, XU 283 actually improves the performance and application of coatings formulations. Compared to formulations using unacceptably high solvent levels, XU 283 produces harder film; exhibits better chemical (see chart), corrosion and abrasion resistance; and can provide excellent mechanical properties, especially adhesion. Add all this to the high solids content of XU 283 and its elimination of sweat-in time, and you can understand why initial response from formulators has been overwhelmingly enthusiastic.

Chemical resistance

Immersion tests
12-16 mils; Cured 7-10 days @ R.T.

Formulation	1	2
	Parts by weight	
Araldite® 6010	100	—
XU 283	70	—
"1" Type Epoxy Resin	—	100
Conventional Polyamide	—	54
	Weeks to failure (1 Year Test)	
Tap water	>52	8
Deionized water	>52	8
Sea water	>52	>52
50% NaOH	>52	>52
10% NH_4OH	>52	1
10% H_2SO_4	>52	2
10% HCL	>52	1
Unleaded gas	>52	>52
Diesel fuel	>52	>52
Skydrol® 500B*	>52	8
Heptane	>52	>52
Xylene	>52	16
MEK	12	1
Isopropanol	>52	26
50% Ethanol/H_2O	>52	8

Note >52=Unaffected after 1 year.
Substrate: Sandblasted hot rolled steel
*Registered trademark of Monsanto Industrial Chemicals Co.

Technology and service.

Facing up to EPA-mandated restrictions on VOC is an important challenge to the coatings industry. But it's a challenge we're prepared to help you resolve. Call the CIBA-GEIGY Resins Department—your source for high technology specialty resins and hardeners, and responsive service—at (800) 431-1900. Ask for Rob Crespi. In New York call (914) 347-4700. Or write, Resins Department, CIBA-GEIGY Corporation, Three Skyline Drive, Hawthorne, New York 10532.

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Abstracts of Papers in This Issue

PHYSICO-CHEMICAL FACTORS IN THE PERFORMANCE OF POLYMER-METAL BONDS—S. Ponce, D. Gamet, and H.P. Schreiber

Journal of Coatings Technology, 57, No. 726, 37 (July 1985)

The conformation at surfaces and interfaces of polar-group-containing polymers used in coatings has been shown to vary with the surface energy of the substrate against which the film is formed. A dependence on the solvent and on the initial concentration of polymer in solutions from which the film is solidified is also apparent. These factors are strongly implicated in the strength of bonds formed between substrate and coating polymer, as demonstrated by the performance of aluminum joints using PMMA as the adhesive layer. When the polymer is fully encased by aluminum surfaces, uniform chain conformation can be attained, leading to strong, durable bonds. However, when the polymer surface is partly in contact with metal and partly with air, a surface conformation non-uniformity is created. This must be eliminated for thermodynamic reasons, thus providing a physico-chemical driving force for the rapid aging and failure of the polymer-metal joints. It is shown that this factor is equally important for aging both in dry and in humid environments. The performance of joints using non-polar polymer adhesives is simpler since such polymers cannot attain a similar range of surface conformations.

SELECTION OF A SPATIAL SAMPLING PROCEDURE FOR EVALUATING THE DEFECT AREA OF A COATED STEEL PANEL—D.P. Bentz and J.W Martin

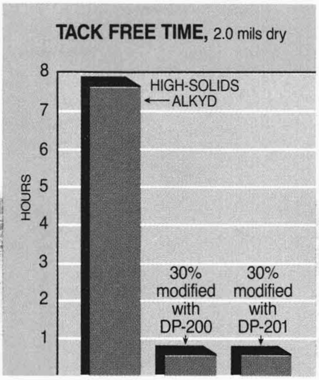
Journal of Coatings Technology, 57, No. 726, 43 (July 1985)

Various spatial sampling procedures for determining the defect area of a coated panel are assessed using Monte Carlo techniques. Spatial sampling procedures have many advantages over the comparative visual standards currently used in evaluating defect area. In a previous report, a full grid sampling procedure was employed; the primary disadvantage of this procedure was its long evaluation time. This procedure can be replaced by other sampling procedures with shorter sampling times as long as these other procedures are both accurate and easy to implement into actual practice. From the Monte Carlo simulations, systematic point sampling is found to be superior to both random point and stratified random point sampling in quickly estimating defect area proportion. Two other spatial sampling procedures may also find applications in coatings evaluation, linear sampling which effectively quantifies the corrosion area around a scribe mark and systematic area sampling which provides valuable information on the defect size distribution as well as the total defect area.

REACTION OF N-(2-HYDROXYETHYL) AMIDO COMPOUNDS—Z.W. Wicks, Jr., M.R. Appelt, and J.C. Soleim

Journal of Coatings Technology, 57, No. 726, 51 (July 1985)

N-(2-hydroxyethyl)-N-methyl octanamide esterifies more rapidly than the corresponding acetamide and benzamide derivatives in that order and much more rapidly than octanol. Contrary to simple alcohols, amide alcohols esterify more rapidly with benzoic acid than with octanoic acid. However, the benzoate ester of the amide alcohol saponifies more slowly than the octanoate ester. Tertiary amide alcohols esterify more rapidly than secondary amide alcohols. Cyclic N-(2-hydroxyethyl) amido compounds do not show this enhanced reactivity. It was demonstrated that a factor in the lack of acid catalysis is the base strength of the amide group. The reaction rate of acyclic amide alcohols with phenyl isocyanate is slower than that of octanol. On the other hand, ethers can be obtained by reaction of amide alcohols with octanol in the presence of a weak acid catalyst. The results are not consistent with the mechanism previously proposed to explain the enhanced esterification rate. A new mechanism involving formation of an oxazolinium ion intermediate is proposed. The amide alcohols undergo self alcoholysis of the amide by the alcohol to form amide esters. N-(2-hydroxyethyl)-N,N′,N′-trimethylurea was shown to cyclize thermally to yield dimethyl amine and 3-methyl-2-oxazolidinone.


TACK FREE TIME, 2.0 mils dry
HOURS
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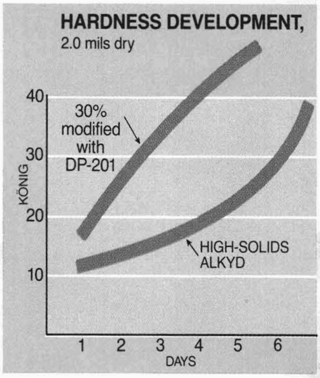
HIGH-SOLIDS ALKYD
30% modified with DP-200
30% modified with DP-201


HARDNESS DEVELOPMENT, 2.0 mils dry
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30
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HIGH-SOLIDS ALKYD
1
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6
DAYS

Abstracts of Papers in This Issue (Continued)

EFFECT OF SOLVENT CHOICE ON WATER-BASED COATING/WOOD INTERACTIONS—P. Lucas and L. Smith

Journal of Coatings Technology, 57, No. 726, 65 (July 1985)

A clear water-borne alkyd resin solution was shown to swell cell walls of Eastern white pine and leave them in a partially swollen condition upon oven-drying. Cosolvent rather than resin was principally responsible for this phenomenon. Force-drying at an elevated temperature did not remove the cosolvent. However, immersion in water did remove it, showing that no permanent dimensional stabilization had occurred. Accelerated weathering of brush-coated panels appears to confirm these results because this resin performed better than the same resin dissolved in xylene, but only for a limited time. Since cosolvents are usually present in water-borne solution coatings, the technique of measuring cell wall bulking by treating and then drying the wood without exposing it to water may be an invalid measure of resin penetration into cell walls.

WATER-BORNE CORROSION INHIBITIVE PRIMERS EVOLVE TO BE COMPETITIVE—Golden Gate Society for Coatings Technology

Journal of Coatings Technology, 57, No. 726, 71 (July 1985)

In previous reports, corrosion inhibitive primers were seldom found to perform as well as solvent-borne systems. In this report, two water-borne primers, a latex-based system with an inorganic corrosion inhibitive pigment and a water-borne alkyd pigmented with a corrosion inhibitive non-toxic complex inorganic oxide, were chosen for further study. In outdoor exposures, even in extremely corrosive conditions, the experimental water-borne primers performed at least as well as a red lead solvent-based standard primer. The efficacy of surface preparation by sandblasting, so often shown by the Steel Structures Painting Council, was confirmed in comparison to wire brushing or solvent washing. Two aluminum pigment-based topcoats were also beneficial in outdoor exposures. The correlation between the outdoor exposures and the popular laboratory exposures test systems was poor at best.

BARRIERS TO INNOVATION IN THE ORGANIC COATINGS INDUSTRY—M.A. Glaser

Journal of Coatings Technology, 57, No. 726, 79 (July 1985)

The organic coatings industry must organize to innovate more effectively during the next decade in order to prosper or perhaps even to survive as a discrete industry. Studies have identified both organizational and personal barriers to this objective. Such barriers may be imposed by internal or external factors. A list of these barriers is presented. Typical case histories are reported. A method for monitoring the progress of R&D projects is suggested. In addition to more and better technological innovations, better overall management practices are needed to optimize R&D effectiveness.

Papers to Be Featured In the August Issue

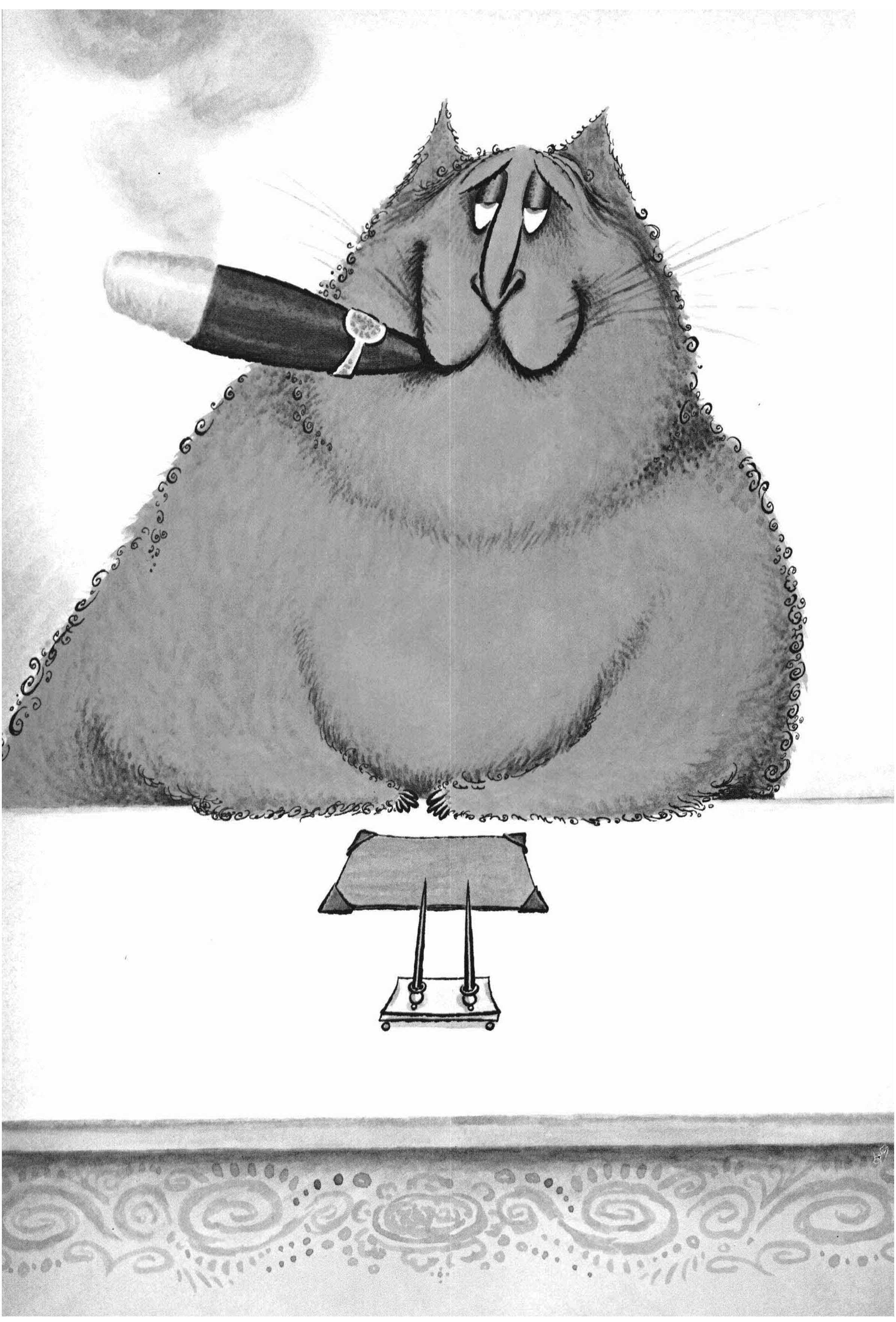
"Dispersion of (Magnetic) Pigment Powders in Organic Liquids"—H.F. Huisman, PD Magnetics B.V.

"A New Computational Method for Determining the Shear Rate Dependent Viscosity of Coatings"—H-H. Kuo, General Motors Research Laboratories.

"Dispersion and Classification Effects in a Three-Roll Mill"—Y. Murakami, et al., Kyushu University.

"New Cellulosic Polymers for Rheology Control of Latex Paints"—K.G. Shaw and D.P. Leipold, Hercules Incorporated.

"Study of Interactions Between Wood and Water-Soluble Organic Solvents"—W.B. Smith, et al., University of Massachusetts—Amherst.



FSCT 'Spring Week' Major Success in Baltimore

The Federation's second "Spring Week" was just as successful and active as the first in 1984. There were three major events: (1) Seminar; (2) Society Officers Meeting; and (3) Board of Directors Meeting. And for the 30 spouses who registered for the Federation's meetings, there was a tour of Baltimore's famous aquarium and lunch on Friday.

Seminar

The Seminar on "Recent Developments in Home Painting," programmed by Technical Advisor Roy Brown, attracted an attendance of 119, of which 99 were paid (five were from Canada, one from England, and two from Bermuda). Among the speakers were an architect, a home builder, a painting contractor, a paint dealer, and nine from the coatings industry who covered subjects ranging from painting various substrates to common paint problems. And with the two lively Q&A sessions, it was a most interesting and informative seminar for the attendees.

Society Officers Meeting

This full-day orientation session on May 16 was attended by 30, representing 24 Societies (26 Society Officers, three Society Representatives, and the Executive Secretary of the New York Society). It was the ninth annual meeting of this group and like all previous ones, was an enlightening experience for all present, including Federation Officers and Staff.

Board of Directors Meeting

Major business from this meeting at the Omni International Hotel on May 17 was:

Attendance (58): Thirty-six members of the Board and 22 guests (among them 12 Society Officers who stayed over from the previous day's meeting).

FSCT Financial Report: First quarter statement indicated that income and expenses are in keeping with the budget of $1,700,000.

Federation Membership: Federation membership growing steadily and nearing 7,000 mark. Biggest gains in 1985 were made by Detroit, Toronto, and Mexico Societies. Their Membership Chairmen will receive tokens of appreciation from Federation.

Annual Meeting and Paint Show: "Big 50" Paint Show in St. Louis (October 7–9) will be a real "whopper" with 240 exhibitors in 56,200 net sf. Forty of the exhibitors are new. Hotel reservations already made indicate a good attendance. Exciting program—with theme of "Coatings R&D: Today's Investment in Tomorrow"—will get underway on Monday, October 7, with the Keynote Address by John P. McAndrews, Group Vice-President, F&FP Products, DuPont Co. Jim Valvano, basketball coach at North Carolina State, will speak at Wednesday luncheon. Marriott will serve as Federation's headquarters hotel.

Technical Advisor: Roy Brown reported that 70 labs are enrolled in the Federation's Proficiency Testing Program, administered by Collaborative Testing Services. Will be continued next year. . . . Eight Society Technical Committees still engaged in exterior exposure of test panels using paints containing a mildewcide chemically attached to the latex polymer. Too early to draw any conclusions. . . . Fifteen video tapes demonstrating the performance of quality control tests have been donated to the Federation by McWhorter, Inc. Federation will combine them into two tapes for use in training lab technicians. . . . Roy welcomes suggestions for topic of 1986 Seminar—May 13–14 in Pittsburgh.

Paint Research Institute: PRI Trustees met on May 15 and reported to Board that it is their intent to change name of PRI to "Coatings Industry Education Fund" later this year. . . . Southern Society contributed $750 to PRI in late March.

Southern Society's Generous Contribution: Another contribution by the Southern Society—and a very generous one—was $25,000 to the Federation, for use in refurbishing the new staff offices. Many thanks, Southern Society!!

Nomination: The slate for 1985–86 presented by the Nominating Committee is:

President-Elect—Carlos Dorris, of Dallas
Treasurer—Deryk Pawsey, of Pacific Northwest
Executive Committee—Dan Toombs, of New England (3 years)
Kurt Weitz, of Toronto (1 year)
Board (At-Large)—Rick Hille, of Chicago (2 years)
John Lanning, of Louisville (2 years)
Board (Past-President)—J.C. Leslie, of Kansas City (2 years)

There were no nominations from the floor.

By-Laws: No report at this meeting. Committee will have four proposals for the fall meeting: (1) Two new Standing Committees; (2) Guidelines for groups wishing to affiliate with Federation; (3) Revised procedures for Federation Honorary Membership; and (4) The lowering of Society Honorary Member dues from $20 to $10.

Actions of Executive Committee: Committee actions of October 27, 1984 and January 18, 1985, were approved by the Board.

The following from the May 15th meeting of the committee were also okayed by the Board:

(1) Appropriated an additional $12,000 to Technical Advisory Committee in 1985, so that committee can change time of annual meeting of Society Technical Committee Chairmen to fall (beginning November 1985) and in the fall thereafter. (The group met in March this year).

(2) Extended hold on applications for Federation Honorary Membership until October 10—date of next Executive Committee meeting and four days after By-Laws Committee report to Board.

(3) Auhorized expenditure of about $75,000 to purchase hardware and software to computerize staff operations (JCT subscriptions, accounting, advertising, Paint Show, word processing, JCT papers, etc.)

(4) Appropriated $1,000 to continue Federation's supporting member affiliation with Steel Structures Painting Council.

(5) Instructed By-Laws Committee to prepare enabling resolutions to amend By-Laws VIII so that Society Honorary Member dues will be lowered from $20 to $10.

(6) Referred Southern Society's finished draft of "Exterior Flat Latex Paints" to Technical Advisory Committee. Report due in fall.

(Continued on page 21)

Federation of Societies for Coatings Technology

1315 Walnut St., Phila., PA 19107

John P. McAndrews, Group V.P. of DuPont Co., To Present Keynote Address at Annual Meeting

The Federation is pleased to announce that John P. McAndrews, Group Vice-President—Finishes and Fabricated Products, E.I. DuPont de Nemours & Co., Inc., Wilmington, DE, will present the Keynote Address at Monday's Opening Session at its 63rd Annual Meeting in St. Louis, October 7–9.

Mr. McAndrews joined the DuPont Co. in 1947 as a Chemical Engineer at the Marshall Laboratory in Philadelphia. Over the next 10 years he rose through technical and supervisory roles to the position of Manager of the laboratory in 1957.

In 1960 he was appointed Manager of the Flint, MI, sales development laboratory and in 1962 became Assistant Sales Manager for automotive fabrics and finishes in Detroit. Later that year, Mr. McAndrews was named Director of the Fabric Sales Div. and the following year was made Assistant Director of Marketing of the Automotive and Industrial Products Div.

In 1964 he was named General Sales Manager of the Consumer Products Div. of the Fabrics and Finishes Dept.

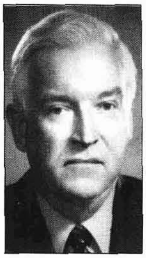
Mr. McAndrews was named Director of Marketing for Remington Arms in 1966 following a transfer and attained the positions of Vice-President, Director, Executive Vice-President, and President.

He was named Vice-President, Finishes and Fabricated Products Dept. in 1982, and assumed his present position in 1983.

The Annual Meeting will open on Monday morning, October 7, at the Cervantes Convention Center, and Program Chairman Joseph A. Vasta, of E.I. DuPont de Nemours & Co., Inc., has announced the theme, "Coatings R&D: Today's Investment in Tomorrow." He and his Program Steering Committee are developing a schedule of presentations around this topic.

Program Highlights

- Mattiello Lecture by Ruth Johnston-Feller, Color Scientist, "Reflections on the Phenomenon of Fading." (See May 1985 JCT, p. 14)
- Manufacturing Committee-sponsored Seminar, "Manufacturing the Next Generation of Coatings"
- Session on Use of Computers for Coatings Technologists
- Panel Session on Coatings R&D Management
- Roon Awards Competition papers
- Constituent Society papers
- Papers by affiliated overseas organizations



J. P. McAndrews

J. Valvano

Paint Industries' Show

The 50th Anniversary Paint Industries' Show will be held in conjunction with the Annual Meeting. The 1985 Paint Show is the largest, by far, in Federation history with 240 companies occupying over 56,000 sq. ft. of exhibit space at Cervantes Convention Center.

The Show is the only national exhibit of raw materials and equipment used in the manufacture of paints and related coatings, and participating firms will have their top technical personnel on hand to discuss the latest developments in coatings manufacturing technology.

Exhibit hours will be 12:00 to 5:30 pm on Monday, October 7; 9:30 am to 5:30 pm on Tuesday, October 8; and 9:30 am to 3:00 pm on Wednesday, October 9.

Co-Headquarters Hotels

Co-headquarters for the Annual Meeting will be the Sheraton St. Louis Hotel and the Marriott Pavilion Hotel. Other hotels with blocks of rooms set aside for the Annual Meeting are: Bel Air Hilton, Best Western, Clarion, Embassy Suites, Holiday Inn Market St., Holiday Inn Riverfront, Mayfair, Omni-Union Station, Radisson St. Louis, Rodeway Inn, and University Plaza.

Room Reservations

All requests for rooms and suites must be sent to the Federation office on the official housing form which has been mailed to all members and is included in this issue (see pages 27–33.) Additional housing forms are available from the Federation headquarters office.

Registration Fees

Advance registration is available for $50 for members and $65 for non-members. Fee for spouses' activities is $35 in advance.

There will be a special registration fee of $25 each for retired members and their spouses. This applies to advance registration only.

On-site registration will be $60 for full time and $40 for one day for members. Non-member fees will be $75 for full time and $50 one day. Spouses registration will be $45 on-site.

Registration forms were mailed to all members in April and are included in this issue (see pages 27–33).

Spouses Program

Included in the spouses registration fee will be a get-acquainted wine and cheese social on Monday afternoon and continental breakfast on Tuesday and Wednesday at the Convention Center. A tour of St. Louis and of the spectacular St. Louis Cathedral will also be featured.

Federation Annual Awards Luncheon

The Federation Awards Luncheon will be held Wednesday at the Sheraton St. Louis Hotel.

Presentations will be made to the recipients of the George Baugh Heckel Award (outstanding individual who has contributed to the advancement of the Federation), the Flynn Awards (firms judged to have the best exhibit booths in the 1985 Paint Industries' Show), the Roon Awards Competition awards, and other Annual Meeting awards.

Featured speaker at the Luncheon will be Jim Valvano, Head Coach of the North Carolina State University basketball team.

Program Steering Committee

Assisting Chairman Vasta in development of the Annual Meeting program are: Percy Pierce (Vice-Chairman), PPG Industries, Inc., Allison Park, PA; Taki Anagnostou, Akzo Coatings America, Inc., Troy, MI; Richard Eley, Glidden Coatings & Resins Div., SCM Corp., Strongsville, OH; William H. Ellis, Chevron Research Co., El Segundo, CA; James Lee, Lanchem Corp., E. St. Louis, IL; Stanley LeSota, Rohm and Haas Co., Spring House, PA; John S. Ostrowski, Valspar Corp., Minneapolis, MN; and David Richie, Midland Div. of Dexter Corp., Waukegan, IL.

The economy of excellence.

In rheological additives for paints, too, there is still no substitute.

Using the best additives you can buy goes a long way toward problem-free manufacturing. The savings are proven.

That's why so many of you use rheological additives from NL Chemicals. You're confident of consistent performance. High purity. Excellent gel strength. And it's a confidence that comes with the economy of excellence across our entire spectrum.

It comes with our products. With the new BENTONE SD*-1 and BENTONE SD-2 plus the standards of the industry, BENTONE* 27, 34, and 38 rheological additives. With our THIXATROL* family. With our M-P-A* antisettling additives.

Long recognized as your most reliable source of supply, NL Chemicals is the world's largest producer of rheological additives for solvent based systems.

Innovation, technical field support, world-wide capabilities are also part of our economy of excellence.

Add it all up. You simply cannot afford a substitute. Come to the originator.

Contact **NL Chemicals/NL Industries, Inc.,** Box 700, Hightstown, New Jersey 08520. Telephone 609/443-2500. In Canada, contact **NL Chem Canada, Inc.,** 4 Place Ville-Marie, Suite 500, Montreal, PQ, Canada H3B 4M5. Telephone 514/397-3501.

NL Chemicals

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FSCT Hosts Successful Spring Seminar on 'Home Painting' in Baltimore

The third Federation Spring Seminar was held on May 14 and 15, at Baltimore's Omni International Hotel, in conjunction with the Incoming Society Officers Meeting and the Board of Directors Meeting, during Federation "Spring Week."

This successful 1-½ day event was designed to bring together the various groups involved in the manufacture, sale, specification, and application of paints and coatings, for a cooperative dialogue on all areas of original and maintenance painting.

The program featured paper presentations by an architect, home builder, paint dealer, painting contractor, and paint manufacturers.

An attendance of 119 included architects, home builders, hardboard manufacturers, contractors, paint dealers, and paint manufacturers. Attendees came from all parts of the U.S., as well as Bermuda, Canada, and England.

President Joe Bauer delivered welcoming remarks on behalf of the Federation, and FSCT Technical Advisor Roy Brown, who developed the programming, served as Moderator.

The program included the following presentations:

"The Future of the Home Market to the Year 2000"—Edward Bourguignon, Glidden Coatings & Resins Div., SCM Corp., Cleveland, OH.

"What's New in Home Building?"—Hugh Winstead, AIA, The Ryland Group, Inc., Columbia, MD.

"Painting Metal and Masonry Surfaces"—Robert L. Collins, The O'Brien Corp., South Bend, IN.

"Painting Wood and Wood Composition Substrates"—Roger E. Haines, Tnemec Co., Inc., Kansas City, MO.

"Architectural Wood Stains"—Emil Iraola, Olympic Stain, Seattle, WA.

"The Exterior Latex or Oil Paint Dilemma"—James Edwards, Valspar Corp., Minneapolis, MN.

"How the Architect Views Paint and Painting"—Stuart Liss, AIA, Stuart Liss & Associates, Architects, Arlington, VA.

"Drywall—Construction, Taping, and Painting"—A. Clarke Boyce, Nacan Products Ltd., Toronto, Ont., Canada.

"Selecting and Using Caulks and Sealants"—Robert M. Evans, Case-Western Reserve University, Cleveland, OH.

"Common Paint Problems and How to Treat Them"—Ron Raley, Devoe and Raynolds Co., Louisville, KY.

"The Importance of Paint Quality"—Thomas Hill, Pratt & Lambert, Inc., Buffalo, NY.

"The Role of the Painting Contractor"—Wayne Jolly, W.W. Jolly Painting Contractors, Randallstown, MD.

"How the Paint Dealer Can Help"—Woody Cornetta, Elmont Paint & Wallpaper, Inc., Elmont, NY.

Special Discount Fares Available from TWA To Annual Meeting

Special arrangements have been made with TWA to offer discounted fares within the U.S. to/from St. Louis, MO, for the October 7-9 Annual Meeting and Paint Show at the Cervantes Convention Center. These special fares are available only when you call the unlisted toll-free number (800-325-4933); in Missouri only, call (800-392-1673). Be sure to ask for lowest fare available! You must give the FSCT Convention number which is:

#9911077

'Spring Week' Held in Baltimore

(Continued from page 16)

(7) Referred two proposed awards—"Southern Society Memorial Award" and "Mathematics and Statistical Methods Award" (by Joe Prane and Earl Hill)—to Future Planning Committee.

(8) Thanked Southern Society for its $25,000 contribution to the refurbishing of the Federation's staff offices.

(9) Deferred decision—pending further study—on request from Prof. Irv Krieger, of Case Western Reserve, for $7,500 to support 1986 Gordon Research Conference on Coatings and Films.

(10) Approved Federation co-sponsorship of SCAI-type symposium with MCCA and Detroit Color Council in spring of 1986—*provided* details, dates, and other arrangements can be worked out satisfactorily.

(11) Approved holding 1987 Spring Week in Seattle, provided details, arrangements, and schedule can be worked out satisfactorily with Pacific Northwest Society. Spring Week would be tied in with the annual PNW Symposium and the Federation's Seminar would serve as the technical program of the PNW event. Society Officers would meet on Tuesday, April 28; Board on Wednesday, the 29th; and the Seminar on Thursday and Friday, April 30 and May 1.

Three New Committees: Three of the new committees appointed by President Joe Bauer—Professional Development, Federation Chairs (or Professorships), and Future Planning—have met and further reports will be coming later this year.

Sale of Federation Year Book: Los Angeles Society asked that Federation not sell its *Year Book* to non-members, because of LA's own problems with employment search organizations. Federation does not knowingly sell *Year Book* to "head hunters."

Federation Board approved a motion which stipulated that Federation continue its present practice.

Boston Stone: New England Society reported that $4,664 (of $5,084 in contributions) was expended in study by Society for Preservation of New England Antiquities to determine the condition of the Stone and alternatives to conserve it. SPNEA recommended six options. No decision yet.

Next Meeting of Board: Sunday, October 6, 1985; Marriott Hotel; St. Louis; 9:00 a.m.

FRANK J. BORRELLE,
Executive Vice-President

Plan Now to Attend
1985 Annual Meeting & Paint Show
Cervantes Convention Center, St. Louis, MO
October 7-9

Corrosion Inhibitors on Seal Materials Is Topic of Battelle Research

Researchers at the Battelle Petroleum Technology Center in Houston, TX, are conducting a study to assist in the selection of improved combinations of seal materials and corrosion inhibitors for oil and gas production systems.

In addition to filling an information gap on how corrosion inhibitors affect commonly used seal materials, the study results are expected to lead to improved reliability, safety, and decreased downtime and costs.

"Although inhibitors are successfully used to protect metallic tubing, casing, and other components from corrosion," said Michael J. Watkins, who heads the study team, "they can severely damage certain elastomeric seal materials. Because corrosion inhibitor technology is highly proprietary, seal and equipment manufacturers often recommend seals not knowing the effects inhibitors may have on their performance."

As an example, Mr. Watkins stated that amine-based corrosion inhibitors are widely used to protect metallic parts in deep sour wells. These amines often degrade fluoroelastomers, materials often recommended for seals and packers in these same environments. Such degradation can lead to premature seal failure, possibly resulting in increasing workover frequency, operating costs, and compromising operational safety.

The Battelle study team will establish guidelines that can be used to select compatible combinations of corrosion inhibitors and seal materials. To do so, researchers are now characterizing the effects of commonly used water- and oil-based inhibitors on elastomeric materials. This includes evaluating both physical and mechanical properties of elastomers that have been exposed at varying temperatures and lengths of time to a series of inhibitor environments.

Elastomers being examined include: fluoroelastomers—vinylidene fluoride copolymers, perfluoroelastomers, and propylenes; nitrile rubbers—sulfur cured and peroxide cured; saturated nitrile rubber; and ethylene-propylene rubber.

Battelle also plans to evaluate how corrosion inhibitors affect seal integrity. This will be determined by functional seal testing, in which seal failure is related to changes in physical and mechanical properties.

In addition to establishing guidelines, Battelle will develop rapid screening tests for establishing the relative performance of a particular elastomer in various corrosion inhibitors. These tests will be especially helpful in evaluating new combinations of inhibitors and seal materials.

Additional information can be obtained from Michael J. Watkins, Battelle's Petroleum Technology Center, 1100 Rankin Road, Houston, Texas 77073.

Dexter Corporation Forms Joint Venture with Sico

The Midland Div. of the Dexter Corporation, Waukegan, IL, and Sico, Inc., Longueuil, Quebec, have announced the formation of SIDEX, a joint venture between the two companies in order to combine the technology of Midland with the manufacturing expertise of Sico.

Headquartered in Toronto, SIDEX will manufacture and sell packaging products to the Canadian food and beverage container industry. Midland's entire line of packaging coatings and compounds will be produced in Canada and Sico's packaging coatings will be sold by SIDEX.

Midland is a major international supplier of high technology coatings materials and related products, with manufacturing sites located in four U.S. cities and six foreign countries.

Sico, a manufacturer of consumer and industrial paint products, is the largest Canadian-owned paint manufacturer with four plants in Canada.

Chemische Werke Huls To Acquire Nuodex Inc.

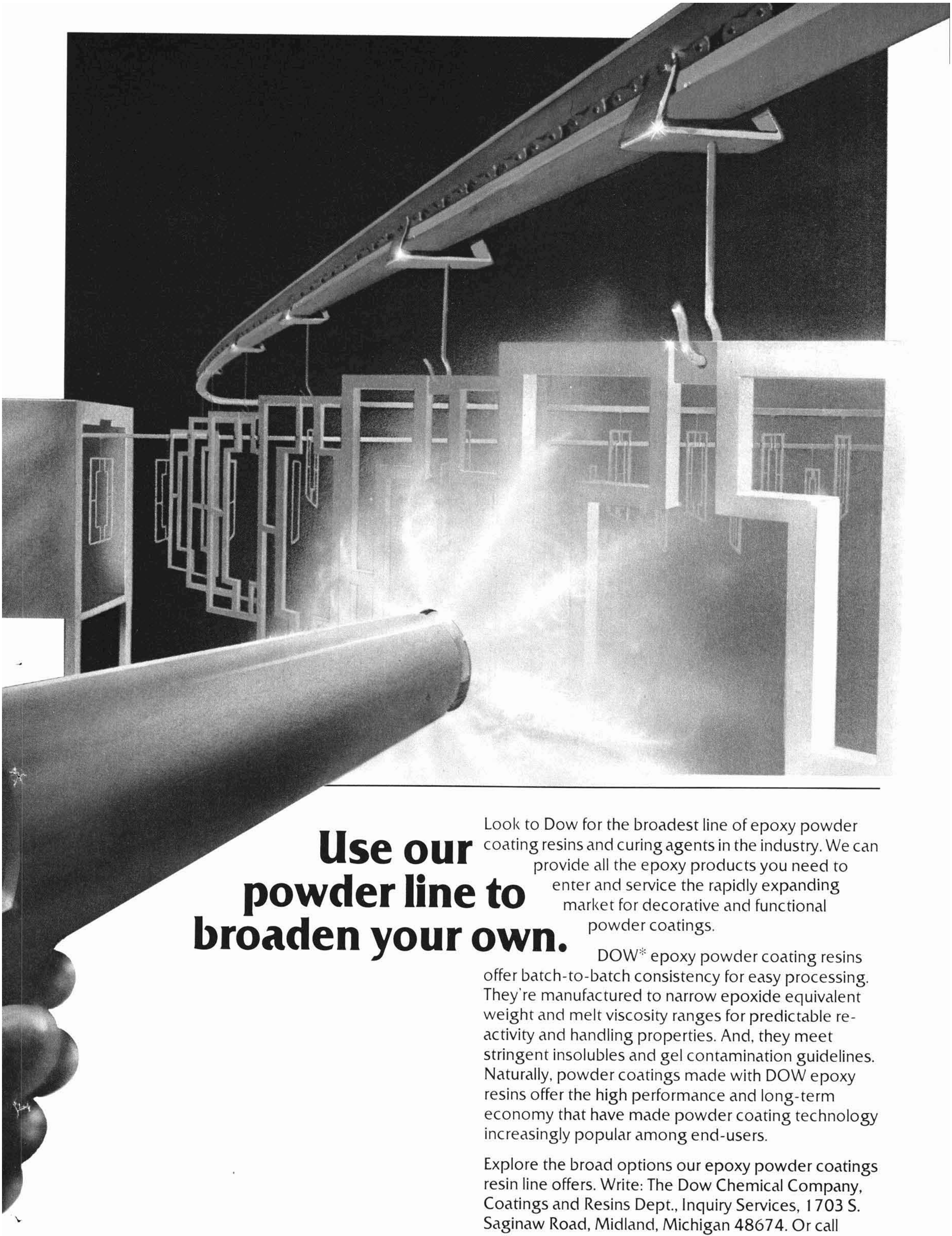
Nuodex Inc., Piscataway, NJ, has been acquired by Chemische Werke Huls AG (Huels) of Marl, West Germany. According to Nuodex President and Chief Executive Officer, Frank X. Dwyer, the firm will retain its corporate identity and continue as an independent entity, with all current operations and management. Nuodex Inc., a manufacturer of coatings chemicals, colorants, specialty chemicals, synthetic lubricants, and rigid vinyl film, employs more than 700 people at 11 plants in the U.S., Canada, and The Netherlands.

Sartomer Company Integrates With ARCO Specialty Chemicals Group

Sartomer Co., West Chester, PA, a subsidiary of Atlantic Richfield Co., and leading producer of functional monomers and oligomers, has been integrated with the Philadelphia-based Specialty Chemicals Group of ARCO Chemical Co., a division of Atlantic Richfield.

The consolidated organization, with sales of over $100 million worldwide, will be under the direction of Kenneth J. Siegfried, Vice-President, Specialty Chemicals. Research, sales, and technical service staffs of each group are being integrated to provide increased customer service coverage and support as well as an expanded R&D capability. As part of the integration, a business development department has been established to investigate new products and application areas.

The ARCO Specialty Chemicals Group also includes Advanced Materials, headquartered in South Carolina, and ARCOGraph, Inc., which produces chemicals for the printing ink industry.



Battelle Seeks to Evaluate Physical Coating Processes

A study to evaluate technical and economic opportunities for new physical coating processes is being proposed by analysts at Battelle Institut e.V. in Frankfurt, Germany.

The study is expected to provide comprehensive information on the technical state of the art of many processes available for treatment of surface areas as well as conditions for the manufacture, use, and economic benefits derived from the process. It will be supported on a multiclient basis and should be of particular interest to manufacturers and users of coatings and coating equipment and products. Also benefiting will be users and manufacturers of materials-intensive equipment prone to wear and corrosion.

According to Battelle's H. Ronald Hamilton, manufacturers and users continually face problems with wear and tear on drills, cutters, presses, bearings, valves, and pistons, as well as problems with corrosion on steel, sheet metals, containers, and vehicle parts. "Physical processes for surface treatment could lead to important advances," Mr. Hamilton said. "But the great number of processes, combined with the large number of substrate materials that can be treated, makes it difficult for the specialist to choose the most suitable process and to evaluate its limitations and scope."

"Very little information is available for the potential user to estimate how much would be saved in an individual case by protecting critical parts against corrosion and wear. Nor is much known about how much purchasers would be willing to pay for surface-finished critical parts," added Mr. Hamilton. To address the information problem, Battelle specialists will provide technical descriptions—including a summary, analysis, and evaluation—of processes being applied in industry, those ready for market introduction, and those at the research stage.

On the economic side, they will project the total number of units of surface-coating equipment in use through 1990. They also will anticipate sales per year, amount of material to be coated, and the potential value added. In addition, cost-benefit analyses will be prepared. The study will assess current markets in Japan and the United States, and present the most probable lines of development in Europe, based on the experiences of the leading nations in the field.

The study is still open for membership. More information may be obtained from H. Ronald Hamilton, Battelle Memorial Institute, 505 King Ave., Columbus, OH 43201.

Safety Initiatives Introduced by CMA

The Chemical Manufacturers Association, Washington, D.C., has announced a series of initiatives to increase public access to hazard information about chemicals and improve emergency response planning and training at the local level. The initiatives will also expand the industry's capability to provide direct assistance to fire, police, and medical personnel responding to chemical emergencies.

According to Edwin C. Homer, Chairman of the Board of the CMA, the initiatives are grouped under two new programs: the Community Awareness and Emergency Response program (CAER); and the National Chemical Response and Information Center.

The CAER program is centered around the concept that "the public should have access to information on hazardous chemicals," stated Mr. Homer. Working with community emergency response officials, other local industries, and interested citizens, the chemical plant managers will serve as the catalyst in developing the CAER program. Under this plan, material safety data sheets (MSDS), lists of workplace hazardous substances and written hazardous communications programs developed by companies under the federal Occupational Safety and Health Act should be made available to the public.

The second industry initiative, the Chemical Response and Information Center, will coordinate responses to requests for emergency and non-emergency information on chemicals and training for emergency service personnel at the local level.

The center will be built around the Chemical Transportation Emergency Center, the industry's 14-year-old transportation emergency hotline service. CHEMTREC provides information on chemicals to emergency service personnel—such as fire, police, and rescue squads—during transportation accidents involving chemicals. It is recognized by the U.S. Department of Transportation as the source of emergency information on hazardous materials involved in transportation accidents.

Four new programs will be added to this existing service:

(1) CHEMTREC will be expanded to provide 24-hour-a-day information to emergency service and medical personnel for non-transportation incidents.

(2) A major new service—CHEMNET—will provide expert on-site assistance to deal with transportation and non-transportation emergencies through a "mutual-aid" network of chemical industry and "for-hire" emergency response teams.

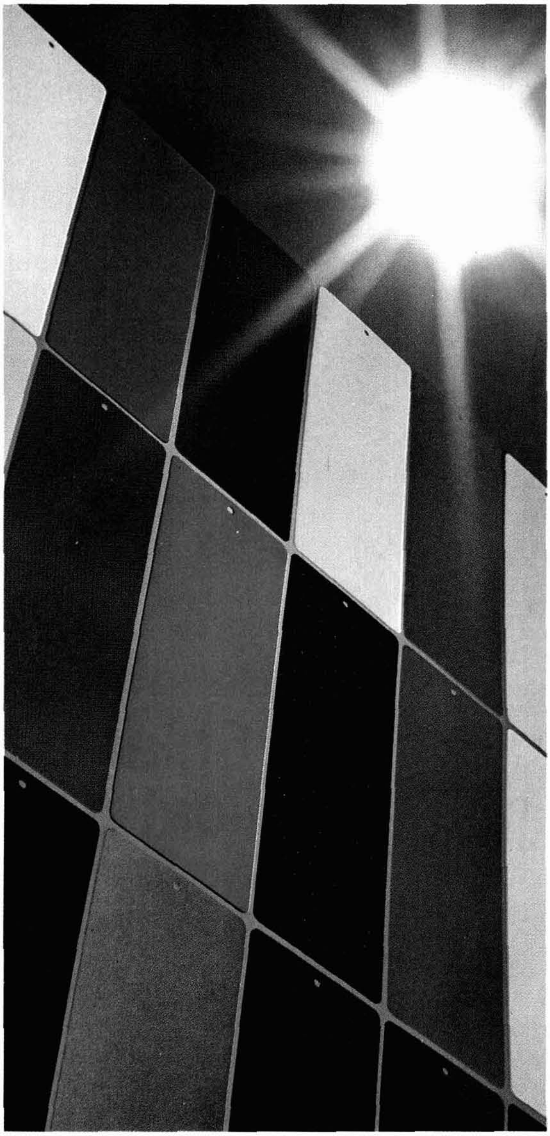
(3) The Chemical Referral Center will provide the public with a central contact point, using an "800" toll-free telephone number, for information on chemical hazards in non-emergency situations. This service will begin in the fall.

(4) Long-standing training programs for industry personnel will be expanded to include development of training materials for emergency service personnel outside the industry at the local level.

At its recent Awards Night, Finnaren & Haley, of Philadelphia, honored its record-setting sales force for 1984. Carl Johnson, Vice-President of Trade Sales (center), is shown with his top team (left to right): Carl Johnson III, Chip Scherer, Morris Nagle, Richard Burton, Jr., and Paul Schweiger

In sunlight, coatings can die in months

With CIBA-GEIGY light stabilizers, they can live for years



Cracking, delamination and catastrophic failure often occur in coatings exposed to the sun. Consequently, the service life of both coating and substrate is shortened, and the cost of maintenance goes up.

Commercial use has shown that most types of coatings can be protected against photodegradation by two classes of CIBA-GEIGY light stabilizers.

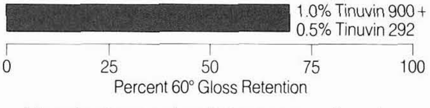
The first class is the hindered amine light stabilizers (HALS), such as Tinuvin® 292, Tinuvin 144 and Tinuvin 079L. They protect gloss and help prevent loss of physical properties that may result in chalking, erosion, water permeability and checking.

Ultraviolet light absorbers (UVA) such as Tinuvin 328, Tinuvin 900 and CGL-1130 are the other class. UVAs prevent UV light from degrading light-sensitive materials, especially primers, mildewcides and pigments. Thus, they protect performance characteristics, such as adhesion between primer and top coats. Depending on the pigment used, a UVA and HALS combination will improve color retention.

While a CIBA-GEIGY UVA or HALS by itself provides good protection for coatings, usage has shown that combinations of the two may give better results. This development is so important that CIBA-GEIGY has four patents* covering the use of HALS and combinations of HALS and UVAs in acrylic, polyester, alkyd and polyurethane coatings.

Percent 60° Gloss Retention After Two Years of Exposure

Sample: Two-Component Solid White Acrylic
Aliphatic Polyurethane Coating
Exposure: 5° South Florida Black Box



Manufacturers of maintenance, coil and powder coatings can now formulate their products to yield substantially longer service life.

For more information on light stabilization of coatings, call 800 431-1900 (in New York, 914 347-4700). Or write to: Additives Department, CIBA-GEIGY Corporation, Three Skyline Drive, Hawthorne, NY 10532.

CIBA–GEIGY

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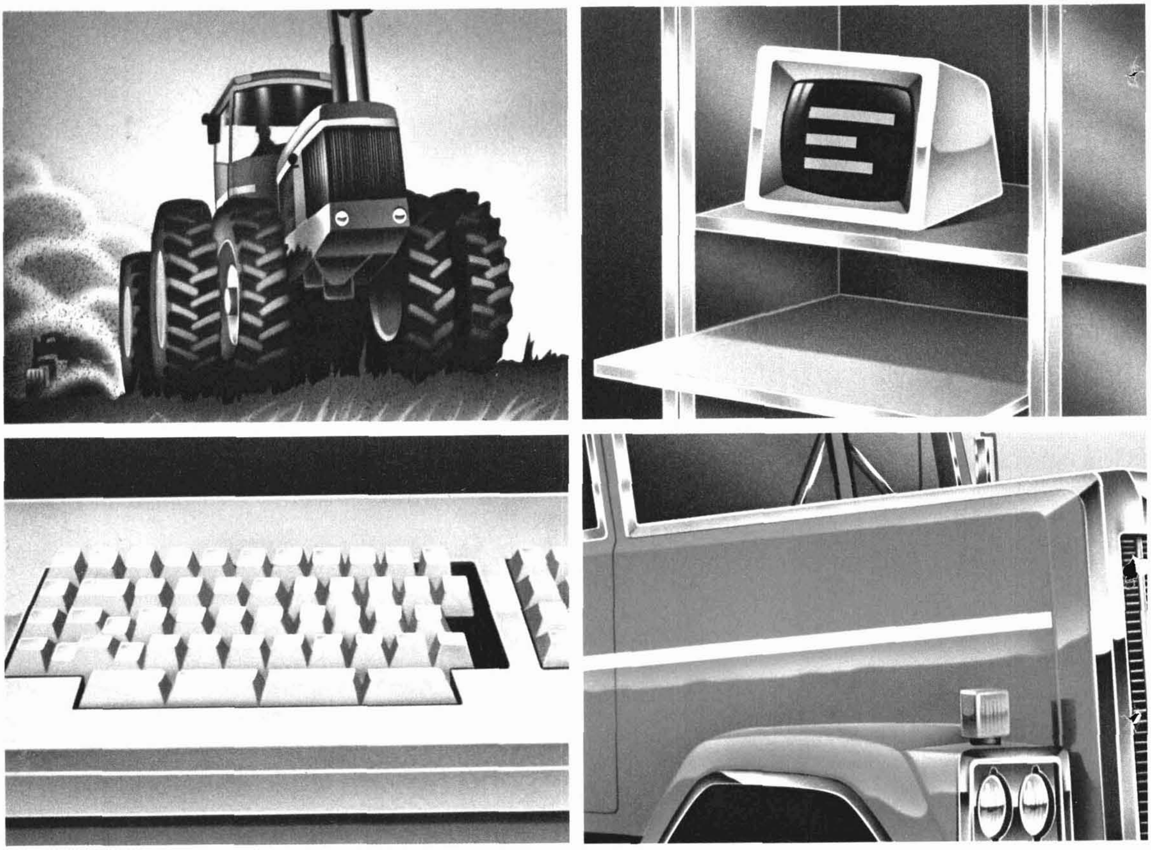
*U.S. Patent Nos. 4,314,933; 4,426,471; 4,426,472; and 4,344,876 assigned to CIBA-GEIGY Corporation.

Are Your Urethane Finishes TOUGH ENOUGH?



ACRYLOID® Polyols Come Shining Through The Toughest Applications.

Today's urethane finishes have to handle a lot of different jobs and hold up to heavy use under less-than-ideal conditions. That's why Rohm and Haas offers an extensive selection of high performance acrylic polyols for urethane coatings—all backed by extensive testing and technical support. ACRYLOID polyols can help you meet your specifications —*durability . . . high gloss with excellent retention . . . solvent resistance . . . fast tape times, good pot life . . . low VOC and more.*

Our current product line includes: ACRYLOID AU-608X, ACRYLOID AU-608S, and RESIN QR-999—the new generation of our most well known polymer; new RESINS QR-1003 and QR-1004—for improved chemical and solvent resistance; new RESINS QR-1033 and QR-1034—for fast lacquer dry and reduced isocyanate demand; RESIN QR-946 and REACTIVE MODIFIER QM-1007—for high solids coatings.

So get tough. Go with Rohm and Haas for acrylic polyols that come shining through. For samples and technical literature, contact your local Rohm and Haas representative today, or write our Marketing Services Dept., Independence Mall West, Philadelphia, PA 19105.

ROHM AND HAAS
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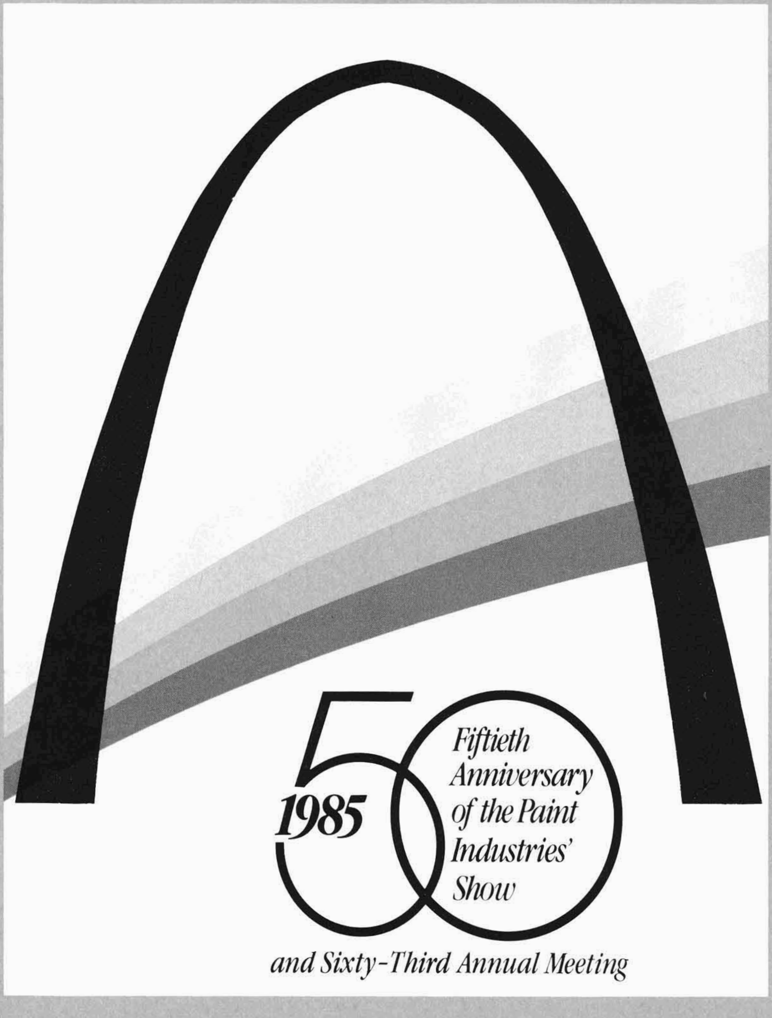
FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

Housing and Advance Registration Forms



CERVANTES CONVENTION CENTER
ST. LOUIS, MISSOURI OCTOBER 7-9

1985 ADVANCE REGISTRATION

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

1315 Walnut St., Philadelphia, PA 19107

C
U
V

Office Use Only

Date received ________

Amount $ ________

Check No. ________

Please fill out this form and mail with a check in the correct amount (made payable to the FSCT) to the Federation address shown above. All checks must be payable in U.S. Funds. Any that are not will be returned. DEADLINE DATE FOR ADVANCE REGISTRATION IS SEPTEMBER 6. NONE WILL BE ACCEPTED AFTER THAT DATE.

A $10.00 charge will be made for cancellations received prior to September 6. No refunds will be made after that date.

INDUSTRY REGISTRATION FEES:

A ☐ MEMBER $50.00

Please name the Federation Society in which you are a paid-up member:

____

Federation Constituent Society

B ☐ NON-MEMBER $65.00

G ☐ SPECIAL FEE FOR RETIRED MEMBERS $25.00

____

Federation Constituent Society

INFORMATION FOR REGISTRATION BADGE:

NICKNAME

FIRST NAME

LAST NAME

BUSINESS AFFILIATION

STREET

CITY

STATE *(U.S. only)*

MAILING ZONE

COUNTRY (OTHER THAN U.S.)

BUSINESS CLASSIFICATION DATA FOR THE ABOVE REGISTRANT:

YOUR COMPANY (CHECK ONE BLOCK ONLY)

- AA ☐ Manufacturers of Paints, Varnishes, Lacquers, Printing Inks, Sealants
- BB ☐ Manufacturers of Raw Materials
- CC ☐ Manufacturers of Equipment and Containers
- DD ☐ Sales Agent for Raw Materials and Equipment
- EE ☐ Government Agency
- FF ☐ Research/Testing/Consulting
- GG ☐ Educational Institution Library
- HH ☐ Paint Consumer
- JJ ☐ Other

YOUR POSITION (CHECK ONE BLOCK ONLY)

- KK ☐ Management/ Administration
- LL ☐ Manufacturing and Engineering
- MM ☐ Quality Control
- NN ☐ Research and Development
- PP ☐ Technical Sales Service
- QQ ☐ Sales and Marketing
- RR ☐ Consultant
- SS ☐ Educator/Student/ Librarian
- TT ☐ Other

SPOUSES REGISTRATION AND INFORMATION FOR REGISTRATION BADGE:

D ☐ SPOUSE $35.00

SPECIAL FEE FOR THE SPOUSES OF RETIRED MEMBERS ONLY:
H ☐ $25.00

NICKNAME

NAME

ADDRESS

CITY

STATE

MAILING ZONE

COUNTRY (OTHER THAN U.S.)

TICKETS FOR FEDERATION LUNCHEON, WEDNESDAY, OCTOBER 9 (@ $20.00)

Z ☐ NUMBER REQUIRED: ________
$20.00 EACH.

A CHECK IN THE AMOUNT OF:

$ ________

IS ENCLOSED

Federation of Societies for Coatings Technology

YE OLDE PAINT STONE 1737

1985 Annual Meeting
Paint Industries' Show
October 7, 8, 9
Cervantes Convention Center
St. Louis, Missouri

TO OUR MEMBERS AND FRIENDS:

With much pleasure, I invite all those associated with the coatings manufacturing industry to attend the Federation's 63rd Annual Meeting and 50th Paint Industries' Show in St. Louis, October 7–9.

In 1972, the Federation marked the 50th Anniversary of its founding. In 1985, we reach another milestone with the Golden Jubilee of the Paint Show, the largest and finest exhibit of materials, equipment, and services for paint and coatings manufacturers.

The "Big 50" Paint Show will indeed be that—and another record-breaker.

Matching the Show in quality of content will be the Program Sessions under the chairmanship of Joseph A. Vasta. And how significant and timely is the theme: "Coatings R&D: Today's Investment in Tomorrow."

I am pleased that our 1985 convention will get underway on a high note with the Monday morning Keynote Address by John P. McAndrews, Group Vice-President, F&F Products Dept., DuPont Co.

Come join us in St. Louis for the Big Show, the Big Program, and a Learning Experience well worth your time.

Joseph A Bauer

Joseph A. Bauer
President, FSCT

FSCT 1985 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
CERVANTES CONVENTION CENTER, ST. LOUIS, MISSOURI
OCTOBER 7, 8, 9 (Monday, Tuesday, Wednesday)

THE BIG 50
1985
Fiftieth Anniversary of the Paint Industries' Show
and Sixty-Third Annual Meeting
CERVANTES CONVENTION CENTER
ST. LOUIS, MISSOURI OCTOBER 7-9

APPLICATION FOR HOTEL ACCOMMODATIONS

MAIL TO:
Fed. Socs. Coatings Tech.
1315 Walnut St.—Dept. H
Philadelphia, PA 19107

Please indicate below the type of accommodations requested and choice of hotels. All reservations will be processed by the Housing Bureau of the St. Louis Convention & Visitors Bureau. Hotel assignments will be made in accordance with prevailing availability. The Housing Bureau will send you an acknowledgment, noting the hotel to which you have been assigned. (Bureau telephone # 314-421-1166). The confirmation of your reservation will come to you directly from the hotel, to whom you must direct all inquiries (phone numbers in this brochure).

All reservations will be held until 6:00 p.m. and none can be guaranteed after September 6.

TYPE OF ACCOMMODATION	NUMBER	RATE REQUESTED
Single (1 person)		
Double (2 persons)		
Twin (2 persons)		
Suite (parlor and 1 bedroom)		
Suite (parlor and 2 bedrooms)		

CHOICE OF HOTELS:
1st
2nd
3rd
4th

NAMES OF ROOM OCCUPANTS AND DATES OF ARRIVAL DEPARTURE

Type of Room	Name	Dates Arrive	Depart

Please Type Additional Reservations on a Separate Sheet and Attach to This Form

SEND CONFIRMATION FOR ALL RESERVATIONS TO:

Name ______________________________

Company ______________________________

Address ______________________________

City ______________________ State or Province ______________________

Country ______________________ Mailing Code ______________________

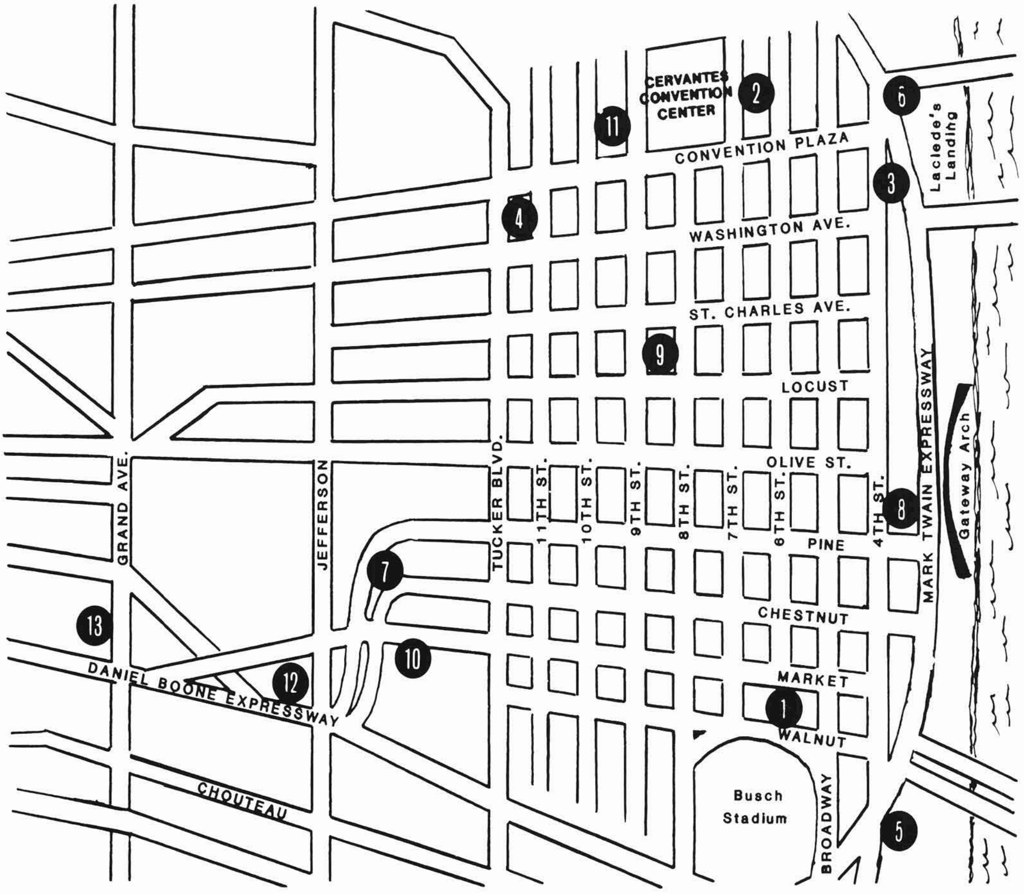
Telephone ______________________

Note: Requests for accommodations at the Marriott or Sheraton will be limited to five rooms per company. A parlor counts as one room.

No. on Map	Hotel	Singles	Doubles/ Twins	Parlor & 1 Bedroom	Parlor & 2 Bedrooms
(1)	**†Marriott Pavilion**	$74	$86	$185–$295	$225–$375
(2)	**†Sheraton St. Louis**	74	86	275	
(3)	**Bel Air Hilton**	72	84	175	350
(4)	**Best Western St. Louisian**	46	54		
(5)	**Clarion**	72	84	195–315	325–405
(6)	**Embassy Suites**	80	90		
(7)	**Holiday Inn Market St.**	54	61		
(8)	**Holiday Inn Riverfront**	70	80		
(9)	**Mayfair**	59	69		
(10)	**Omni—Union Station**	83	96	250 & up	375 & up
(11)	**Radisson St. Louis**	65	81	110	380–450
(12)	**Rodeway Inn**	48	54		
(13)	**University Plaza**	49	55		

* All room rates are subject to a City and State Tax of 9.75%.

† Requests for accommodations at the Marriott Pavilion or the Sheraton St. Louis will be limited to five rooms per company. A parlor counts as one room. Additional reservations will be assigned to other cooperating hotels.



FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
1985 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
CERVANTES CONVENTION CENTER, ST. LOUIS, MISSOURI
MONDAY THROUGH WEDNESDAY, OCTOBER 7, 8, 9

The Combined Annual Meeting and Paint Industries' Show Is a Major Educational Activity of the Federation. This Significant Coatings Industry Event Consists of Three Days of Technical Program Sessions and Exhibits, Running Concurrently.

"COATINGS RESEARCH AND DEVELOPMENT: TODAY'S INVESTMENT IN TOMORROW"

The outstanding program presentations being arranged for the Annual Meeting Program will be centered about the theme—"Coatings R&D: Today's Investment in Tomorrow." The theme emphasizes the need to shape, guide, and protect the future through innovative coatings science and technology. Investments in coatings R&D will ensure continued ability to provide quality products to meet today's requirements and anticipate tomorrow's challenges.

"BIG 50" PAINT SHOW WILL FEATURE PRODUCTS/SERVICES OF 220 EXHIBITORS

The Paint Industries' Show—best known and largest exhibit of products and services used in the formulation, testing, and manufacture of paints and related coatings—will be another record-breaker in both size and number of exhibitors.

Exhibiting in the Show will be more than 220 companies which manufacture and supply a wide variety of raw materials, production equipment, laboratory apparatus & testing devices, containers, and a variety of services for the coatings manufacturing industry. The list of current exhibitors is included in this brochure.

Key personnel from coatings manufacturers in the U.S., Canada, and several other countries attend each year. The Paint Show gives them the opportunity to learn of the latest developments in the industry and to discuss them with the top technical/sales staffs of the exhibitors.

Show hours will be: Monday—12:00-5:30; Tuesday—9:30-5:30; Wednesday—9:30-3:00.

FEDERATION BOARD TO MEET ON SUNDAY

The Federation's Board of Directors meeting will be held on Sunday, October 6, in the Marriott Hotel.

HOTELS AND RESERVATIONS

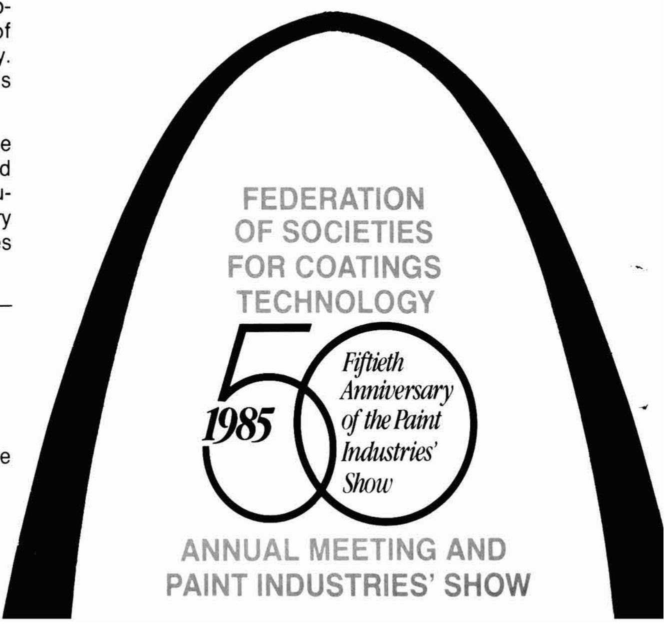
Thirteen hotels have reserved blocks of rooms for the Federation. A map showing the location of the hotels and a schedule of rates are included in this brochure.

All reservations will be processed by the St. Louis Convention and Visitors Bureau. The Bureau will send you an acknowledgment, noting the hotel to which you have been assigned. (Bureau telephone # 314-421-1166). The confirmation of your reservation will come directly from the hotel, to whom you must direct all inquiries.

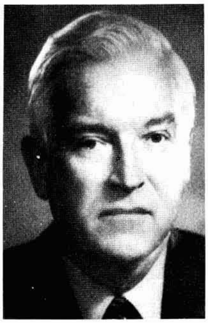
Phone numbers of the hotels (Area Code 314) are:

Marriott Pavilion	421-1776	Holiday Inn Riverfront	621-8200
Sheraton St. Louis	231-5100	Mayfair	231-1500
Bel Air Hilton	621-7900	Omni-Union Station	241-6664
Best Western	421-4727	Radisson St. Louis	421-4000
Clarion	241-9500	Rodeway Inn	534-4700
Embassy Suites	241-4200	University Plaza	534-8300
Holiday Inn Market St.	231-3232		

Requests for accommodations at the Marriott Pavilion or the Sheraton St. Louis will be limited to five rooms per company. A parlor counts as one room.



JOHN P. McANDREWS, OF DUPONT, WILL GIVE KEYNOTE ADDRESS



The Federation is pleased and honored to announce that John P. McAndrews, Group Vice-President—Finishes & Fabricated Products, DuPont Co., will present the Keynote Address at the Monday morning opening session. Mr. McAndrews joined the DuPont Co. in 1947 as a chemical engineer at the Marshall Lab. in Philadelphia. In succeeding years he advanced through several posts within the F & FP Dept. He was transferred to Remington Arms in 1966 and elected President in 1979. He was named Vice-President of the F & FP Dept. in 1982 and assumed his present position in 1983.

ANNUAL FEDERATION LUNCHEON TO BE HELD ON WEDNESDAY

The Annual Federation Luncheon will be held on Wednesday in the Sheraton. It will feature a guest speaker and the presentation of the Paint Show, Heckel, Roon, and other awards.

SPOUSES ACTIVITIES TO BEGIN WITH MONDAY AFTERNOON SOCIAL

A get acquainted wine and cheese social in the Convention Center will open the Spouses Program on Monday afternoon. There will be continental breakfasts on Tuesday and Wednesday morning and a special tour with lunch on Tuesday.

TWA NAMED OFFICIAL AIRLINE FOR ANNUAL MEETING AND PAINT SHOW

The Federation has appointed TWA as the official airline for the convention in St. Louis. For flights within the United States, phone the toll-free number: 800-325-4933 (in Missouri 800-392-1673). You must give the Federation's account number: 9911077. Be sure to ask for the lowest fare available. Applicable dates of travel for the special fare are October 4–12, 1985.

HOST COMMITTEE

The Federation's two Societies in Missouri (St. Louis and Kansas City) will serve as the official hosts for the Annual Meeting and Paint Show. The General Chairman is Howard Jerome, of Spatz Paint Industries, Inc. Subcommittee Chairmen are: Spouses—Mrs. Howard (Gene) Jerome; Program Operations—John Folkerts, of Future Coatings; Registration Area—Joseph W. Wrobel, Jr., of Ciba-Geigy Corp.; Information Services—William Reckel, of Amteco, Inc.; and Liaison—Nick Dispensa, of Davis Paint Co.

PROGRAM COMMITTEE

Joseph A. Vasta, of the DuPont Co., F&FP Dept., Wilmington, DE, is the Chairman of the Federation's Program Committee. The Vice-Chairman is Percy E. Pierce, of PPG Industries, Inc., Allison Park, PA. Other members of the committee are: Taki Anagnostou, of AKZO (Wyandotte) Paint Products, Inc., Troy, MI; William H. Ellis, of Chevron Research Co., El Segundo, CA; Richard Eley, of Glidden Coatings & Resins Div., Strongsville, OH; Stanley LeSota, of Rohm and Haas Co., Spring House, PA; John S. Ostrowski, of Valspar Corp., Minneapolis, MN; David Richie, of Midland Div., Dexter Corp., Waukegan, IL; and James Lee, of Lanchem Corp., E. St. Louis, IL.

Shown above is the famous Gateway Arch. In the background is Busch Stadium.

1985 Paint Industries' Show

Current List of Exhibitors

Aceto Chemical Co., Inc.
Advanced Coating Technologies, Inc.
Air Products and Chemicals, Inc.
Akzo Chemie America/Interstab Chemicals, Inc.
Alcan Powders & Chemicals
Allied Industrial Tank
C.M. Ambrose Co.
American Chemical Society
AMF Cuno, Gen. Filter Prod. Div.
Angus Chemical Co.
Anker Labelers Corp.
Applied Color Systems, Inc.
Arco Chemical Co.
Aries Software Corp.
Ashland Chemical Co., IC&S Div.
Atlas Electric Devices Co.

B.A.G. Corp.
BASF Wyandotte Corp.
Battelle Memorial Institute
Bausch & Lomb, Inc.
Beltron Corp.
Berol Chemicals, Inc.
BIP-Brain Power, Inc.
Blackmer Pump Div., Dover Corp.
Bonar Industries, Inc.
Bowers Process Equipment, Inc.
Brockway Standard, Inc.
Brookfield Engineering Laboratories, Inc.
Buckman Laboratories, Inc.
Buhler-Miag, Inc.
Bulk Lift International, Inc.
Burgess Pigment Co.
Byk-Chemie USA

Cabot - Cab-O-Sil Div.
Calgon Corp., Div. of Merck & Co., Inc.
Cargill, Inc.
CasChem, Inc.
Celanese Chemical Co.
Celanese Specialty Resins
Cellomer Corp.
CEM Corp.
Certified Equipment & Mfg. Co.
Chemical Week
ChemTech Industries, Inc.
Chevron-American Gilsonite
Chicago Boiler Co.
Clawson Tank Co.
Color Corp. of America
Columbian Chemicals Co.
Commercial Filters
Consolidated Packaging Machinery/Pfaudler
Continental Fibre Drum Co.
Cook Paint & Varnish Co.
Cordova Chemical Co.
Cosan Chemical Corp.
Cray Valley Products, Inc.
Cyprus Industrial Minerals Co.

Daniel Products Co.
DataLogix Formula Systems, Inc.
DeFelsko Corp.
Degussa Corp.
University of Detroit
Diagraph Corp.
Diamond Shamrock Chemical
Disti, Incorporated
D/L Laboratories
Dominion Colour Co.
Dow Chemical USA
Dow Corning Corp.
Draiswerke, Inc.
Drew Industrial Div.
DSET Laboratories, Inc.
DuPont DBE Solvent

Eastman Chemical Products, Inc.
Eastern Michigan University
Ebonex Corp.
Eiger Machinery, Inc.
Elcometer, Inc.
Elektro-Physik, Inc.
EM Chemicals
Engelhard Corp.
Epworth Mfg. Co., Inc.
Erwin Software Co.
Exxon Chemical Americas

Fawcett Co., Inc.
FSCT
Fillite USA, Inc.
Filterite, Brunswick Technetics Filtration Systems
Filter Specialists, Inc.
Fricke Enterprises
Fryma, Inc.

GAF Corp.
Paul N. Gardner Co.
Georgia Kaolin Co.
Globe Trading Co.
Goodyear Tire & Rubber Co.
Gorman-Rupp, Inc.
W.R. Grace & Co., Davison Chemical Div.
Grefco, Inc., Dicaperl & Dicalite Depts.

Haake Buchler Instruments, Inc.
Halox Pigments, Div. Hammond Lead Products, Inc.
Harshaw/Filtrol Partnership
Helios Container Systems
Henkel Corp., Polymers Div.
Hercules Incorporated
Heubach, Inc.
Hilton-Davis Chemical Co.
Hitox Corp. of America
Hockmeyer Equipment Corp.
Hotpack Corp.
J.M. Huber Corp.
Hunter Associates Laboratory, Inc.

ICI Americas, Inc.
Ideal Manufacturing & Sales Corp.
Industrial Finishing, Hitchcock Publishing Co.
Inolex Chemical Co.
International Minerals & Chemicals Corp.
ISC Alloys Ltd.
Itasco Industries Div., I.W.I., Inc.

S.C. Johnson & Son, Inc. (Johnson Wax)

Kay Publishing Co. Ltd.
Kenrich Petrochemicals, Inc.
Kent State University
Kinetic Dispersion Corp.
King Industries, Inc.
KTA-Tator, Inc.

Labelette Co.
Letica Corp.
Liquid Controls Corp.
LogiCom, Inc.
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Lubrizol Corp.

3M, Commercial Chemicals Div.
Macbeth
Machinefabriek Klieverik B.V.
Magnesium Elektron, Inc.
Manchem, Inc.
Manville
Marco Scientific, Inc.
McWhorter, Inc.
Mearl Corp.
Mettler Instrument Corp.
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Micro Powders, Inc.
Miller Paint Equipment, Inc.
Milwhite Co., Inc.
Mineral Pigments Corp.
MiniFibers, Inc.
Minolta Corp.
University of Missouri-Rolla
Mitech Corp.
Mobay Chemical Corp.
Modern Paint and Coatings
Morehouse Industries, Inc.
Mozel Chemical Products Co.
MSD Systems
Myers Engineering

Nalco Chemical Co.
NACE
National Paint and Coatings Association
Netzsch Incorporated
Neville Chemical Co.
NJZ Colors, Inc.
NL Chemicals/NL Industries
Neupak, Inc.
North Dakota State University
Nuodex, Inc.
NYCO

O'Brien Industrial
Ottawa Silica Co.

P.A. Industries
Pacific Anchor Chemical Corp.
Pacific Micro Software Engineering
Pacific Scientific, Gardner/Neotec Div.
Paint & Coatings Industry Magazine
Parallax Computer Corp.
Penn Color, Inc.
Pennsylvania Glass Sand Corp.
Pfizer, Inc., MPM Div.
Phillips Chemical Co. & Catalyst Resources, Inc.
Pigment Dispersions, Inc.
Plastican, Inc.
Poly-Resyn, Inc.
Polyvinyl Chemical Industries
PPG Industries, Inc.
P.R.A. Laboratories, Inc.
Premier Mill Corp.
Progressive Recovery, Inc.
Purnell International

Q-Panel Co.
Quintel Corp.

Recovery Filtration Products
Red Devil, Inc.
Reeco
Reichard-Coulston, Inc.
Reichhold Chemicals, Inc.
Rheometrics, Inc.
Rohm and Haas Co.
Roper Pump Co.
Russell Finex, Inc.

Semi-Bulk Systems, Inc.
Serac, Inc.
Shamrock Chemicals Corp.
Shell Chemical Co.
Sherwin-Williams Chemicals
Silberline Manufacturing Co., Inc.
Southern Clay Products, an ECCA Co.
University of Southern Mississippi
South Florida Test Service
Spencer Kellogg Div. of Textron, Inc.
Spartan Color Corp.
A.E. Staley Mfg. Co.
Steel Structures Painting Council
Sun Chemical Corp., Colors Group
Sylvachem Corp.
Synray Corp.

Tammsco, Inc.
Technology Marketing Corp.
Tego Chemie Service Gmbh
Thiele Engineering Co.
Toyo Aluminium K.K.
Troy Chemical Corp.

Union Camp. Corp.
Union Carbide Corp.
Union Carbide Corp., Spec. Polymers & Comp. Div.
Union Chemicals Div., Union Oil Co. of CA
Union Process, Inc.
United Catalysts, Inc.
Universal Color Dispersions
Universal Filters, Inc.
U.S. Polymers, Inc.

R.T. Vanderbilt Co.
Verlan Ltd.
Viking Pump-Houdaille, Inc.
Vorti-Siv, Div. of M&M Machine, Inc.

Wacker Chemical Co.
Warren Rupp-Houdaille, Inc.
Wilden Pump & Engineering Co.
Witco Chemical Co., Organics Div.

Zeelan Industries, Inc.

The newest fact in the Case for ARCOSOLV solvents: DPM Acetate

THE FACT IS ARCO Chemical Company is introducing the latest addition to our line of propylene-based glycol ethers and acetates, ARCOSOLV® DPM acetate. It is specially designed for those applications requiring a slow evaporating non-hydroxylic solvent.

THE FACT IS research on propylene glycol ethers and acetates shows no evidence of reproductive organ toxicity even at high exposure levels.

THE FACT IS a growing number of manufacturers have already moved from E-Series to P-Series solvents. They found ARCOSOLV solvents often could directly replace ethylene solvents in both performance and cost.

THE
CASE
FOR ARCOSOLV®
PROPYLENE GLYCOL ETHERS AND ACETATES

The CASE for ARCOSOLV Solvents

In view of these facts, ARCO Chemical presents a strong CASE for switching from E-Series products to ARCOSOLV propylene glycol products:

Cost

Similarity to the E-Series makes ARCOSOLV solvents a straightforward, economical reformulation choice.

Availability

Our strong raw materials position in propylene oxide and methanol, our dedicated production capacity, nationwide terminal network, and the addition of DPM acetate, make us ready to meet the needs of the marketplace.

Safety

Tests in the U.S., Japan and Europe have demonstrated that P-Series products have dramatically safer toxicological profiles than E-Series products.

Effectiveness

ARCOSOLV propylene glycol ethers and acetates offer solvency power for a wide range of substances, a good range of evaporation rates and excellent coupling and coalescing ability. Use the chart at left to compare properties.

Facts Make the CASE for ARCOSOLV Solvents

In Cost, Availability, Safety and Effectiveness, the CASE for ARCOSOLV ethers and acetates is a strong one. For more information—and details on our new DPM acetate—call ARCO Chemical Company today, toll-free, at 1-800-354-1500. In Pennsylvania, call 1-800-292-1500.

Typical Physical Properties

ARCO Chemical Nomenclature	Chemical Name	Molecular Weight	Evaporation Rate BuAc = 100	Solubility Parameter	Solubility % Wt. in water/ water in
Glycol Ethers					
ARCOSOLV® PM	Propylene Glycol Methyl Ether (PGME)	90.1	66	10.4	∞
ARCOSOLV® DPM	Dipropylene Glycol Methyl Ether (DPGME)	148.2	2	9.6	∞
—	Ethylene Glycol Ethyl Ether (EGEE)	90.1	32	9.9	∞
—	Ethylene Glycol Butyl Ether (EGBE)	118.2	6	8.9	∞
Glycol Ether Acetates					
ARCOSOLV® PMAC	Propylene Glycol Methyl Ether Acetate (PGMEA)	132.2	34	9.2	18.5/5.6
—	Ethylene Glycol Ethyl Ether Acetate (EGEEA)	132.2	20	9.4	23.8/6.5
ARCOSOLV® DPMAC	Dipropylene Glycol Methyl Ether Acetate (DPGMEA)	190.2	<1	8.3	12.3/3.5
—	Ethylene Glycol Butyl Ether Acetate (EGBEA)	160.2	3	8.6	1.1/1.6

ARCO Chemical Company ARCO
Division of AtlanticRichfieldCompany

Physico-Chemical Factors In the Performance Of Polymer-Metal Bonds

S. Ponce, D. Gamet, and H.P. Schreiber
Ecole Polytechnique*

The conformation at surfaces and interfaces of polar-group-containing polymers used in coatings has been shown to vary with the surface energy of the substrate against which the film is formed. A dependence on the solvent and on the initial concentration of polymer in solutions from which the film is solidified is also apparent. These factors are strongly implicated in the strength of bonds formed between substrate and coating polymer, as demonstrated by the performance of aluminum joints using PMMA as the adhesive layer. When the polymer is fully encased by aluminum surfaces, uniform chain conformation can be attained, leading to strong, durable bonds. However, when the polymer surface is partly in contact with metal and partly with air, a surface conformation non-uniformity is created. This must be eliminated for thermodynamic reasons, thus providing a physico-chemical driving force for the rapid aging and failure of the polymer-metal joints. It is shown that this factor is equally important for aging both in dry and in humid environments. The performance of joints using non-polar polymer adhesives is simpler since such polymers cannot attain a similar range of surface conformations.

INTRODUCTION

Study of the surface and interfacial properties of polymers continues to arouse considerable interest. Like bulk properties, these features of polymer behavior are complicated by the high molecular weight and the broad molecular weight distribution in polymers and the capability of polymer chains to form deformable entanglement networks. These polymer characteristics produce long relaxation times and, consequently, properties are often measured with the polymers in non-equilibrium states.[1]

An important example of complex surface properties was given by Schonhorn and coworkers,[2] who showed that the critical surface tension, γ_c, of polyethylenes could vary significantly depending on the substrate against which the polymer was solidified. The concept that hydrophobic polymers can attain different values of surface energy by orienting in specific ways to the bulk materials, has been developed more generally by Fowkes.[3] In the case of polar-group-containing polymers (PGCP), additional complexities arise. Some aspects of these are noted in current theoretical extensions of lattice model concepts,[4,5] intended to account for differences existing between the conformation of chain molecules at interfaces and in the isotropic bulk polymer. Experimental aspects of surface and interfacial properties in PGCP have been elaborated in recent work from this source. Inverse gas chromatography has shown[6,7] that the conformation of polymethyl methacrylate (PMMA) chains in thin films formed from polymer solutions depends strongly on the thermodynamic quality of the solvent. Further, the conformational degree of freedom in some PGCP leads to thin films in which the air and substrate interfacial energies differ considerably,[7,8] the resulting non-isotropy contributing to the barrier properties of these films and to their durability. Similarly, recent studies have shown[8,9] that rheological features, including the apparent persistence of chain entanglements in solutions, carry over into the solid state of polymer films formed from those solutions, thus helping to determine the cohesive strength and the adhesion properties of such films.

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*Dept. of Chemical Engineering, P.O. Box 6079, Succ. A, Montreal, Que. H3C 3A7, Canada.

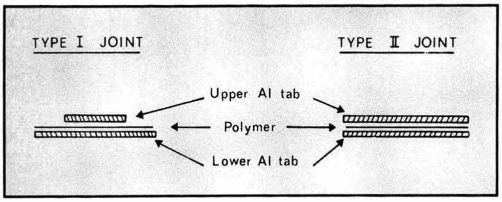

Figure 1—Schematic view of Type I and Type II A1/polymer structure

Table 1—Summary of Intrinsic Viscosities at 30°C

Solvent	[η] in dl.g^{-1}: PMMA	PS
Chloroform	0.570	—
Cyclohexane	—	0.466
Toluene	0.303	0.372
Toluene/butanol	0.352	0.225
Toluene/heptane	0.185	0.308

The present article further documents the effects of proposed conformational degrees of freedom in PGCP films on their performance as adhesives in metal/polymer/metal joints, and makes comparisons with the performance of simpler, hydrophobic polymer films.

EXPERIMENTAL

The polymers used as adhesives in this work were a commercial sample of PMMA (Dow Chemical Co., M_v = 80,000, T_g = 103° C[6]) and a commercial polystyrene, PS, with $M_w = 1.02 \times 10^5$ and a T_g = 96° C. The metal substrate in the formation of joints was freshly degreased, washed and dried aluminum, 0.15 cm thick, cut to give test specimens as described below. The majority of test samples were made by coating the metal with polymer from solution. PMMA was used in solutions with chloroform (ch), toluene (t), toluene/butanol (t/b) 50/50 (vol.) ratio, and toluene/heptane (t/h) 90/10 (vol.) ratio as solvents. PS was cast from cyclohexane (cx), in addition to t, t/h, and t/b. Initial concentrations, c_i, of the polymers were in the range 5–20 g dL^{-1}. Intrinsic viscosities in these solvents were measured with Ubbelohde viscometers.

Control Al/polymer/Al joints were prepared by compression molding at 180° C for two minutes using 0.10 – 0.11 g of polymer as adhesive. In these joints the polymer/metal contact was over a 5 cm × 5 cm area, the polymer being fully encased in joints referred to as Type II (described below). Molded joints were cooled to room temperature at about 10° C/min, ensuring uniform thermal history[9] for all specimens. Other joints were made using polymers cast from solution. Cleaned Al was cut to 15 cm × 5 cm strips and a uniform wet film of polymer solution was applied to a 5 cm × 5 cm area of a strip. The polymer was dried for 72 hr in a vacuum oven at 50° C and at a pressure less than 0.1 mm Hg. As reported earlier,[7,8] infrared and scanning calorimetric data had shown that these conditions were adequate for quantitative removal of solvent from the polymers. The coated Al strips were then used to form two types of test specimens, as shown schematically in *Figure* 1. To form Type I, 0.5 cm PTFE shims were placed on the coated Al strip so as to expose a 5 cm × 3 cm strip of polymer, but covering a 1 cm polymer layer at either end of the strip. This configuration represented the bottom layer in a compression molding sequence in which an uncoated Al strip was overlaid on the coated specimen to form a joint. During the molding sequence the polymer was partly in contact with Al and partly in contact with the low surface energy PTFE shim. To form Type II joints no shims were used, which created a full 5 cm × 5 cm polymer-metal contact area. Gravimetric analyses showed that between 0.08–0.12 g of polymer was used in these structures, consistent with the polymer weights used in compression-molded control joints (Type II only).

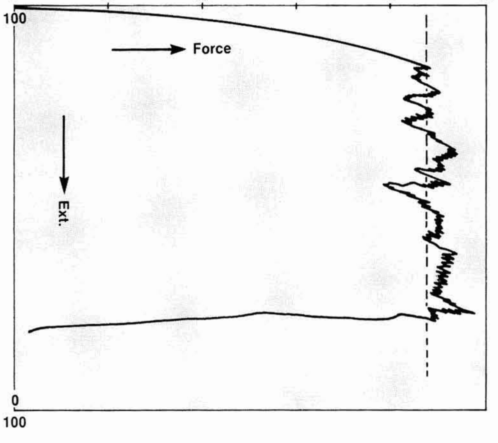

Figure 2—Typical force-extension trace: Type II joint, with PMMA adhesive extension rate = 2 cm.min^{-1}. Broken line is mean force value

Table 2—Initial Bond Strength of Reference Joints and Joints Using Polymers Cast from Solution

Initial ci = 10 g/dL^{-1}
Joints tested within 24 hr of preparation

Polymer		PMMA	PS
Solvent	Joint Type	Bond Strength N. cm^{-2}	Bond Strength N. cm^{-2}
ch	I	11.8	—
	II	13.7	—
t	I	5.9	9.9
	II	6.3	11.2
t/b	I	8.7	9.5
	II	9.8	10.3
t/h	I	5.6	9.2
	II	5.3	9.6
cx	I	—	14.3
	II	—	15.7
comp. molded		15.2	17.7

Type I, II, and control joints were tested for bond strength with an Instron Table Model apparatus. Molded rubber clamp covers were fitted to the jaws of the instrument to provide a satisfactory grip on the test pieces. Only the metal ends of joints were clamped and in a bond strength determination one Al face of the sandwich was peeled away from the polymer at an angle of 180°, and a jaw separation speed of 2 cm/min^{-1}. Since both PMMA and PS are brittle polymers at room temperatures, sporadic fracture occurred during testing, leading to jagged force vs extension traces, as shown in *Figure* 2. At least four determinations for each system led to the reported bond strength data; these are averages of the mean values obtained in individual cases by the averaging convention illustrated in *Figure* 2. To study property retention, a number of joints was placed in air ovens at 60° C and 70% relative humidity. A second series was aged at 60° C under dry N_2. Bond strength analyses were made periodically over an overall period of ~ 4 weeks.

RESULTS

Intrinsic Viscosities

The intrinsic viscosities of PMMA and PS in solution used for film casting are reported in *Table* 1. All determinations were at 30° C, and the $[\eta]$ values were extrapolated from good linear plots of η_{sp}/c vs c, with data points in $0.04 < c < 0.25$ g/dL^{-1}.

Initial Scan of Bond Strength

In an initial sequence, the bond strengths of Type I, Type II, and molded control joints were compared using as adhesive polymers cast from solutions with $c_i = 10$ g/dL^{-1}. In this series, joints were tested within 24 hr of preparation, having been placed in the controlled environment of the Instron apparatus for at least four hours. The data are entered in *Table* 2.

In all results given in *Table* 2, the experimental error of determination was about ± 8%; thus significant variations in joint strength due to the choice of solvent are clearly in evidence for PMMA. In the case of PS, the variation is considerably smaller; results for polymer recovered from t, t/b, and t/h were essentially equal. The bond strength of compression molded PS joints and of joints using polymer from cx are also roughly equal, but higher than those of the other samples. The data in *Table* 2 do not appear to differentiate strongly between the performance of Type I and Type II joints. Roughly equal bond strengths are obtained in compression molded controls, independent of the polymer involved. In principle, stronger joints might be expected with PMMA as adhesive, due to possible contributions from specific interactions between this PGCP and the metal substrate. To realize this, however, an optimization of molding conditions would be required. The molding sequence adopted in this work was a convenient reference but did not necessarily produce optimum bond characteristics.

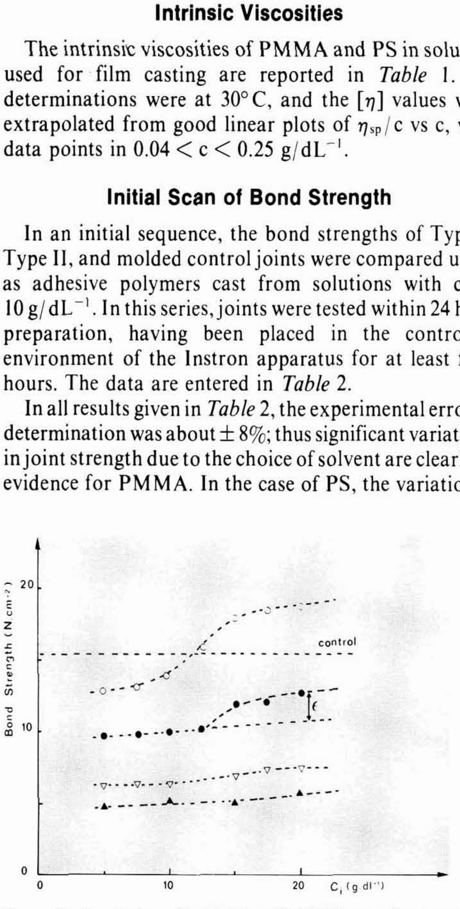

Figure 3—Bond strength of joints with PMMA as adhesive: effect of initial concentration in solution. Legend: O = ch; ▼ = t; ● = t/b; △ = t/h

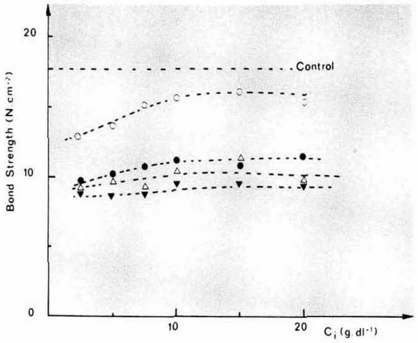

Figure 4—Bond strength of joints with PS as adhesive: Effect of initial concentration in solution. Legend: O = cx; △ = t/b; ● = t; ▼ = t/h

Subtleties in Bond Strength Behavior

Additional accounts of barrier and mechanical properties of solvent-cast polymer films[8] have indicated a significant dependence on initial polymer concentration in solutions. A similar study was therefore performed in this case, with results shown in *Figures* 3 and 4. Films of PMMA and PS used as adhesives were prepared from the various solvent media and initial concentrations as indicated. In this part of the study only joints of Type II (fully encased polymer) were involved.

The complex behavior of joints with PMMA as adhesive (*Figure* 3) shows, again, that the solvent medium and initial polymer concentration exert an appreciable influence on bond properties. Solvent quality is an appreciable variable over the investigated range of c_i. The effect of initial polymer concentration, however, is much greater in the thermodynamically stronger solvents, ch and t/b. This can be established numerically at an arbitrary reference value of $c_i = 20$ g/dL^{-1}, by comparing the experimental value of bond strength with that extrapolated from the initial linear portion of the relationship, as shown in *Figure* 3 for the t/b case. The bond strength increment, ϵ, is then about 25% for ch, ≈ 13% for t/b, ≈ 6% for t, and less than 2% for t/h. The combined effects of concentration and solvent quality can elevate the bond strength of joints above that of

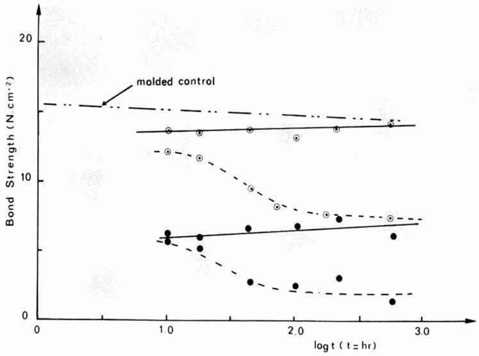

Figure 5—Bond strength retention of Type I and Type II joints with PMMA adhesive; aging at 60° C/70% RH. Legend: ---- Type I joints; —— Type II joints; ○ = ch; ● = t

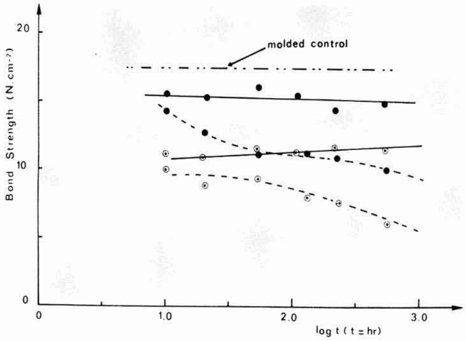

Figure 6—Bond strength retention of Type I and Type II joints with PS adhesive; aging at 60° C/70% RH. Legend: ---- Type I joints; —— Type II joints; ○ = cx; ● = t

compression-molded controls, as demonstrated in *Figure* 3.

The behavior of joints with PS, shown in *Figure* 4, is simpler, with the effect of initial polymer concentration being much reduced. Furthermore, only joints using PS cast from the strongest of the solvents used, cx, are appreciably superior to those with other solvent-cast polymers. The bond strength of compression-molded joints in this case is not exceeded by joints with solvent-cast polymer, although in the case of cx, the difference is very slight when $c_i \geq 10$ g/dL^{-1}.

Time Effects

The time-dependent adhesion changes in humid and dry environments of metal/polymer/metal structures were measured for Type I and Type II joints, with typical results illustrated in *Figures* 5 and 6, respectively, for PMMA and PS, with all systems aged at 60° C/70% RH. In this sequence, polymers were cast from toluene with $c_i = 10$ and 20 g/dL^{-1} (t_{10} and t_{20}); for all other solvents only solutions with $c_i = 10$ g/dL^{-1} were used. *Figures* 5 and 6 also show the aging behavior of molded control specimens. Notable features of the behavior patterns shown include the following:

(1) The compression-molded PS sample is stable under test conditions for periods exceeding ≈ 1000 hr. A slight decrease in bond strength is noted in the corresponding PMMA sample.

(2) The slope of relationships in *Figures* 5 and 6 for Type II joints, where polymers are fully covered by metal,

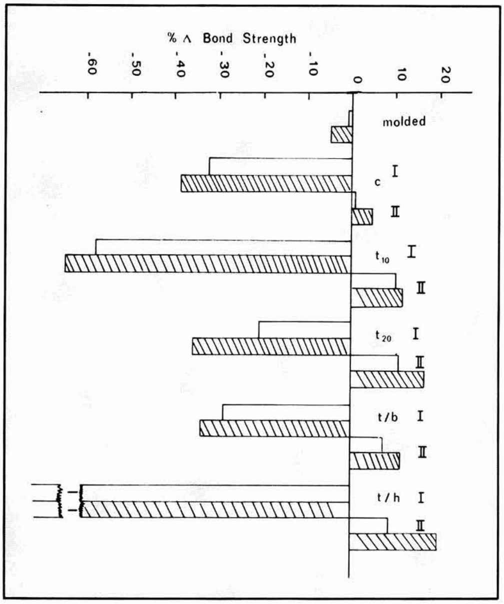

Figure 7—View of % bond strength changes after 100 and 1000 hr accelerated aging: PMMA adhesive. Legend: open bars = 100 hr aging; hatched bars = 1000 hr aging

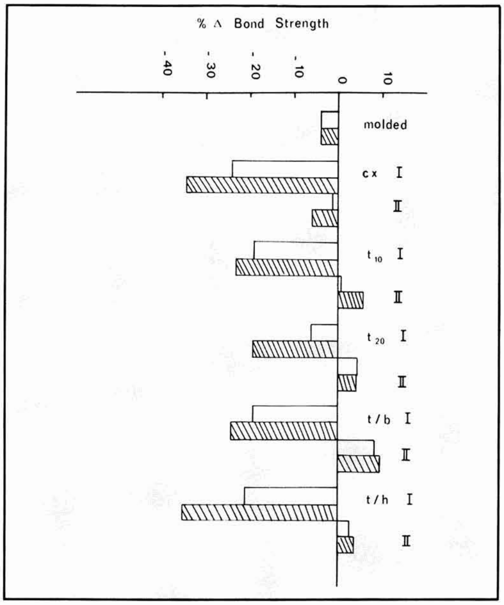

Figure 8—View of % bond strength change after 100 and 1000 hr accelerated aging; PS adhesive. Legend: open bars = 100 hr aging; hatched bars = 1000 hr aging

is positive. The performance of these joints thus improves slightly or remains stable on aging.

(3) The slope of relationships for Type I joints, on the other hand, is strongly negative. Bond strength deterioration tends to take place rapidly in the first week of exposure, then continues at a slowed pace.

(4) The PMMA systems are distinctly more sensitive to aging at elevated T and humidity than are PS systems.

The trends seen in *Figures* 5 and 6 are followed to varying degrees by other systems tested in this sequence. For convenience, pertinent information is summarized in *Figures* 7 and 8 showing the percent change in bond strength following 100 hr and 1000 hr exposure (60° C/70% RH). The latter datum was extrapolated from results as given in *Figures* 5 and 6. The general tendency for Type I joints to deteriorate more rapidly is clearly seen, as is the greater time-dependent variation of PMMA joints (*Figure* 7).

The aging characteristics of PMMA and PS-containing joints subjected to aging at 60°C/dry N_2 are shown in *Figures* 9 and 10. The analogy between the patterns shown here and in *Figures* 5 and 6 is evident. The aging properties in the two cases are similar, but, for PMMA-containing joints, the rate of property loss is attenuated, so that equivalent (lower) performance levels are attained in the humid environment about 15–20% more rapidly than in the dry aging sequence.

The sum of data indicates that bond properties in metal/polymer/metal joints depend on at least the following:

- Polar or non-polar nature of the polymer adhesive;
- Thermodynamic quality of the solvent and initial polymer concentration in solutions from which the film is cast;
- Geometry of the polymer/metal interface;
- The presence of water.

DISCUSSION

Generally speaking, the complex variations in bond strength result from the long relaxation times characteristic of the polymers used in this work. It is unlikely, for example, that any of the bond properties reported here are, in fact, equilibrium values. As noted earlier, the compression molding sequence, adopted here for convenience, did not necessarily produce steady-states either at polymer-substrate contacts, or at the level of intersegmental contacts in the bulk polymers. In the polymers cast from solutions onto the metal, additional considerations arise and their influence may be taken in account qualitatively. Thus, PMMA, like other PGCP's, is considered to be conformationally flexible and is able to orient itself in response to the force fields of substrates with which it interacts. In the case of Al, a high energy surface is involved: Its surface energy γ_s consists of dispersive (D) and non-dispersive (nD) contributions. According to Carré and Schultz[10] $\gamma_s = 69$ mJm^{-2}, $\gamma^D_s =$ 55.5 and $\gamma_s^{nD} = 13.4$ mJ.m^{-2}.

To minimize the interfacial surface tension, the polymer will orient itself to favor the presence of polar ester groups in the interfacial region. This would be in keeping with our previous results,[6-8] and with the findings of Andrade, among others.[11] Our earlier work showed that when solidified against such a high energy surface, PMMA has a $\gamma_c \approx 47$ mJ.m^{-2}, as opposed to ≈ 41 mJ.m^{-2} when in contact with air, PTFE, or low energy surfaces generally.[7,8] One source of anisotropy in the PMMA used as polymer adhesive then relates to the different chain conformations at the metal interface and in the bulk polymer. This type of anisotropy presumably exists in both Type I and Type II joints and may be assumed to contribute to the initial bond strengths and to their time-dependent evolution. In Type I joints, however, a second type of polymer anisotropy is proposed. Since here part of the polymer surface was solidified against PTFE and part against Al, a lateral conformational anisotropy may be imagined. The PMMA chain conformation changes over some as yet undefined distance in response to the very different contacting force-fields. In these artificially "flawed" structures, the inherent surface stresses are greater and the kinetics of stress release more rapid than in the less complex Type II joints. Our experimental data are not sufficiently complete to allow an exact definition of mechanisms involved in this release of surface stress. One possibility is an accelerated intrusion of water into the interface. Comparisons of *Figures* 5 and 9 confirm this as

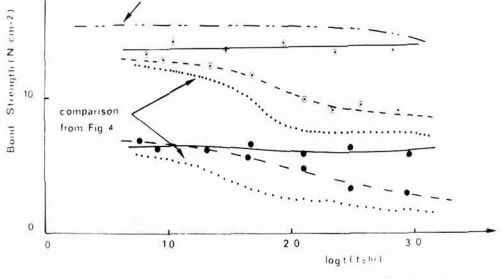

Figure 9—Bond strength retention of Type I and Type II joints with PMMA adhesive; aging at 60°C, dry N_2. Legend: ---- Type I joints; —— Type II joints; ○ from ch; ● from t

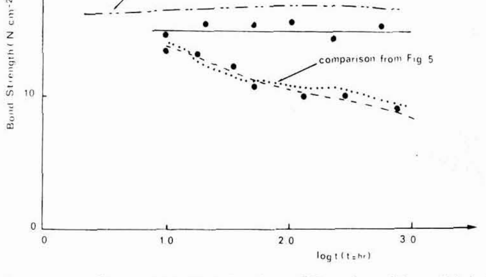

Figure 10—Bond strength retention of Type I and Type II joints with PS adhesive; aging at 60°C, dry N_2. PS deposited from cx. Legend: ---- Type I joints; —— Type II joints

a contributing but not a dominant cause for PMMA-containing joints.

In contrast for PS, X is a non-polar polymer, $\gamma_s = \gamma_s^D = 34.5$ mJ.m^{-2},[6-8] independent of the surface energy of the contacting medium. Conformational effects, such as those postulated for PMMA, cannot occur. The property changes in *Figures* 6 and 8 are therefore due to other artifacts of relaxation, as noted briefly below. It is clear from *Figure* 10 that water diffusion does not play a significant role in this regard.

One of the artifacts alluded to above leads also to the observations in *Figures* 3 and 4 suggesting that the cohesive strength of the polymer exerts a strong influence on the bond properties of joints. That strength must, to an appreciable extent, arise from the entanglement network structure present in the polymer.[12] Polymers in solution would, of course, tend to disentangle; however, even at the lowest initial concentration used in this work, (5 g/dL^{-1}), a high probability of segmental overlap would exist. The macromolecular solutes therefore are likely to exist in modified states of entanglement, the degree of modification depending on the thermodynamic quality of the solvent (as expressed, at least partly, by $[\eta]$ values in *Table* 1), and on the inherent tendency for network structuring in each polymer. In part, because of the conformational changes available to PMMA and also because this macromolecule is more flexible than PS, the response of bond strength to choice of solvent and to initial concentration is greater in PMMA than in PS. As noted elsewhere,[1] the inherent tendency for entanglement structuring in PS appears to be rather low. Inspection of *Figure* 2 tempts one to suggest that in PMMA the influence of chain entanglement structuring on bond strength goes through a "characteristic" concentration, which ranges from about $c_i \approx 10$ g/dL^{-1} when chloroform is the solvent, to ≥ 15 g/dL^{-1} when weaker solvents are involved. In PS, only the strongest of the solvents used — cyclohexane — produces an analogous effect. A further consideration of non-equilibrium aggregation states in PS is presented in a separate publication.[13]

Finally, the practical implications of these findings must not be ignored. It is obvious that polymer composition alone is an entirely inadequate guide to the performance of the material as an adhesive. An understanding of conformational, rheological, and general relaxation phenomena in polymers seems indispensable to optimizing the performance inherent in any polymer and all the more so in PGCP materials, for reasons outlined. That understanding, as yet incomplete, warrants the continued attention of basic and applied research programs alike.

ACKNOWLEDGMENTS

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Selection of a Spatial Sampling Procedure For Evaluating the Defect Area Of a Coated Steel Panel

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Various spatial sampling procedures for determining the defect area of a coated panel are assessed using Monte Carlo techniques. Spatial sampling procedures have many advantages over the comparative visual standards currently used in evaluating defect area. In a previous report, a full grid sampling procedure was employed; the primary disadvantage of this procedure was its long evaluation time. This procedure can be replaced by other sampling procedures with shorter sampling times as long as these other procedures are both accurate and easy to implement into actual practice. From the Monte Carlo simulations, systematic point sampling is found to be superior to both random point and stratified random point sampling in quickly estimating defect area proportion. Two other spatial sampling procedures may also find applications in coatings evaluation, linear sampling which effectively quantifies the corrosion area around a scribe mark and systematic area sampling which provides valuable information on the defect size distribution as well as the total defect area.

INTRODUCTION

Quantitative service life predictions have been successfully made for two coating systems exposed to a temperature and relative humidity environment using reliability theory and life testing analysis techniques.[1] These predictions are useful for making selections between coating systems, for determining the sensitivity of a coating system to different degradation factors, and for improving the resistance to aging of a coating system. To apply reliability theory, however, a more quantitative and precise estimate of the defect area must be available than that provided by the current comparative visual procedures used in evaluating coated panels.[2] One such procedure, full grid sampling, was used by Martin and McKnight.[1,2] The main disadvantage of this procedure was that the panel evaluations were very time consuming. In this paper, other spatial sampling procedures are examined that not only are quantitative, but allow for quick evaluations. This reduction in evaluation time is achieved by evaluating only a representative fraction of the total panel. These sampling techniques have been utilized successfully in the areas of land usage evaluation, timber classification, microscopy, and crop yield evaluation.[3,4]

These sampling procedures are evaluated for coating applications using Monte Carlo simulation techniques. These techniques are used because they effectively focus attention on the mathematical aspects of the sampling problem (e.g., determining the accuracy of a sampling procedure in estimating the defect area proportion) as opposed to the non-mathematical aspects (e.g., identifying small defects[2]). For each sampling procedure, estimates of the defect area are compared against a known defect area proportion. The accuracy of each procedure, along with its projected ease of implementation, is used in determining the best spatial sampling procedure for coatings applications.

SAMPLING PROCEDURE THEORY

The sampling procedures studied are shown in *Figure* 1. In all of the sampling procedures except for full grid sampling, increasing the sampling size increases the accuracy of the defect area estimate. The general

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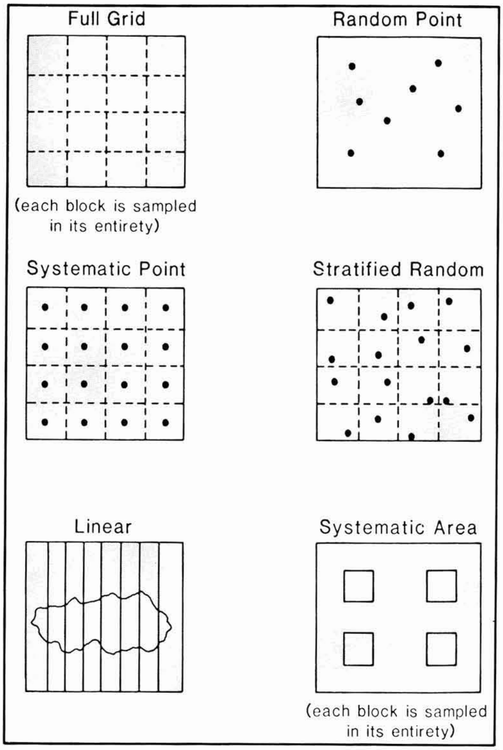


Figure 1—Sampling procedures investigated in analysis

procedure for implementing the various techniques is as follows.

Point Sampling

Point sampling involves sampling a known number of locations on a panel. This procedure can easily be implemented by overlaying a transparency containing points onto a coated panel. Sampling points impinging on defects are assigned a value of 1 while those not covering defects are given the value 0. If m points are superimposed on a panel and k of these points ($k \leq m$) impinge on defects, then k/m estimates the proportion of the total area covered by defects. This estimator holds for all point sampling procedures; the procedures differ only with respect to their arrangement of points.

RANDOM POINT SAMPLING: In random point sampling, sample points are randomly distributed over the panel area (*Figure* 1). Each point has an equal probability of occurring at any position on the panel and, thus, any subregion of the panel has the same probability of containing a point as any other subregion of equal area.

SYSTEMATIC POINT SAMPLING: As the name suggests, sampling points are systematically distributed over the panel area as follows. A square lattice-like grid is superimposed onto a panel. The sampling point locations are the central points of each of the grid blocks, so that the distance between points in adjacent blocks is constant.

STRATIFIED RANDOM POINT SAMPLING: Sampling points are distributed over the panel in a manner akin to both random and systematic point sampling. As with systematic point sampling, a square lattice-like grid is superimposed onto the panel but instead of sampling at the center of each block, one sampling point is selected at random from each block. Thus, stratified random point sampling provides both a degree of geometrical regularity and a degree of randomness.

Linear Sampling

In linear sampling, the sampling units are lines as opposed to points. The sampling procedure is implemented by placing equally spaced parallel lines onto a panel and measuring the cumulative distance along each sampling line intersected by defects.[5] An estimate of the proportion area defects is obtained by integrating these length measurements for each line over the length of the panel and dividing by the total area of the panel (Appendix A).[6]

A potential application for linear sampling procedures lies in better characterizing the undercutting along a scribe mark as compared with the current ASTM D1654 procedure.[7] ASTM D1654 provides only a measurement of the maximum undercutting width along the scribe mark. This parameter could well be the same for two different coating systems, even though their relative effectiveness in inhibiting corrosion are different. This difference in effectiveness could be better highlighted by comparing undercutting areas. Linear sampling provides a convenient method of obtaining this area measurement in that it requires only minimal adjustment to the current procedure (instead of one width measurement, several are made) and a subsequent integration process. Both adjustments can be readily automated using currently available computer image processing equipment.

Systematic Area Sampling

Systematic area sampling differs from systematic point sampling in that the sampling units have area and shape (*Figure* 1). In most disciplines, the square block has become the accepted area sampling unit. Within each sampling block, the number and size of each defect are recorded and the area of the defects estimated. Summing the area of defects within each block over all the sampling blocks and dividing by the total sampling area provides an estimate of the defect area proportion. Besides the defect area proportion estimate, this sampling procedure provides information on the number, size, and location of defects as a function of time, which can be used in modeling the growth of defects.

EXPERIMENTAL PROCEDURE

A square 15 cm × 15 cm (6″ × 6″) coated panel was symbolically represented in the computer by a square matrix of 512 × 512 points. Defects, of a known number and size distribution, were then randomly distributed over the panel using a computer simulation algorithm such that no two defects overlapped. Practically, this was accomplished by assigning a value to the defect matrix elements which was different from that assigned to the non-defect matrix elements. The number and size of defects were realistic in that they were previously observed on actual test panels.[1] Since the size of the simulated defects was small relative to the size of the panel matrix, it was hypothesized that the computer generated panel and defects adequately represent the defects on a real coated panel. This hypothesis was checked empirically by comparing the results obtained for a 1024 × 1024 matrix with those obtained for a 512 × 512 matrix. The results were not significantly different, and it was concluded that the smaller matrix was of sufficient size.

The routine for estimating the defect area was basically the same for each point sampling procedure. Starting with the smallest sampling size (approximately 100 sampling points) for each procedure, the defect area proportion was estimated for a panel. Next, the sampling size was increased and a new estimate of the defect area proportion determined. This process was repeated until a maximum sampling size of 25% of the total panel (approximately 65,000 sampling points) was reached. At this time, the same defects were randomly redistributed over the panel and the above cycle repeated until 20 estimates were made for each sampling size.

The evaluation procedures for linear and systematic area sampling were similar to those used for point sampling. In the case of linear sampling (Appendix A), sampling size was increased by decreasing the spacing between adjacent lines. Instead of relocating the defects, the effects of geometrical regularity on the defect area estimate were monitored by varying the undercutting boundary from rough and jagged to smooth. For systematic area sampling, sample size was increased both by increasing the number of sampling blocks and by increasing the size of the sampling blocks. The relative effectiveness of these two incremental techniques was determined.

RESULTS AND DISCUSSION

For each sample size, the estimation error and the standard deviation of the defect area proportion estimates were determined. The estimation error is the difference between the estimated and the true defect area of a panel. The estimation error can be computed since the true defect area is known in a Monte Carlo simulation. The estimation error is a random variable, however, since the estimate of the defect area is a random variable. If the expected value of the estimation error is zero, the sampling procedure is said to provide an unbiased estimate of the true defect area. If it is non-zero, the sampling procedure is said to provide a biased estimate.

The mean-squared error (MSE) of the defect area proportion provides a measure of the average error associated with a sampling procedure. The mean-squared error is a convenient statistic for assessing the relative merit of a sampling procedure because it combines both the estimation error and the standard deviation of the estimate into one statistic. The mean-squared error is defined as follows:

$$\text{MSE} = \text{variance (sample means)} + (\text{average estimation error})^2$$

or

$$\text{MSE} = \text{E}[(\text{T} - \tau)]^2 = \text{var(T)} + \{\tau - \text{E[T]}\}^2$$

where

T is the set of estimates of the defect area proportion;
τ is the true defect area proportion input into the Monte Carlo procedure;
var(T) is the variance of the estimates; and
E[T] is the expected value of the estimate.

In choosing between sampling procedures, one would choose that sampling procedure with the lower MSE value for a given sample size.

For the point sampling procedures, as the sample size increases, the error (*Figure* 2) and the variation in the defect area proportion estimate (*Figure* 3) tend to decrease. For the same sample size, the magnitude of the error and variation does not change significantly for different defect area proportions (*Table* 1). The low estimation error for stratified random sampling for small sample sizes, as shown in *Figure* 2, is atypical. For other defect size distributions and defect areas, the estimation error for stratified random sampling closely approxi-

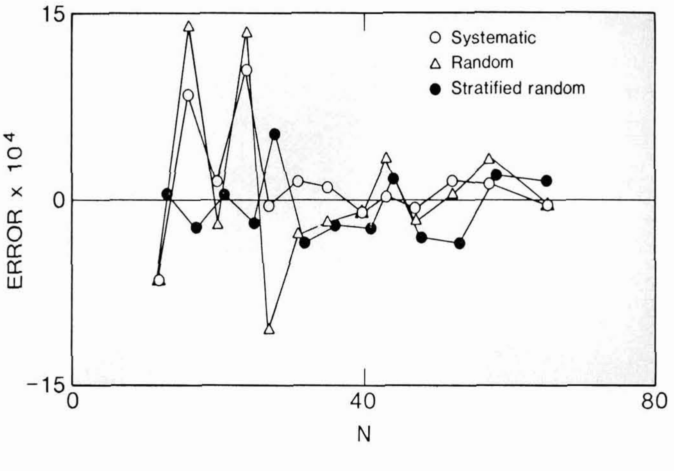
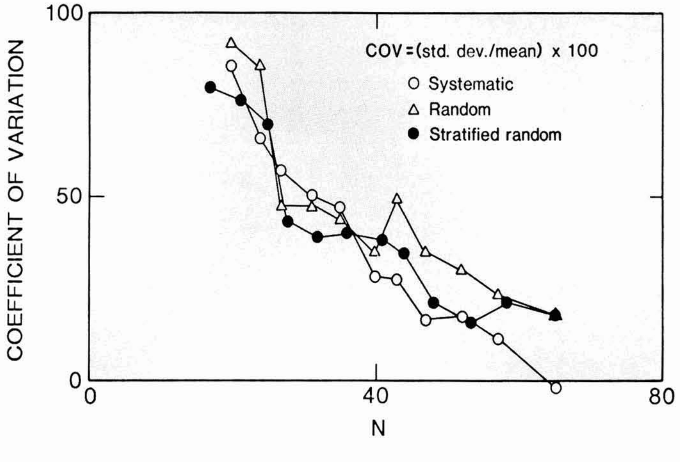


Figure 2—Estimation error vs sample size (N X N) for three point sampling procedures

Figure 3—Coefficient of variation vs sample size (N X N) for point sampling procedures



mated those for the systematic and random point sampling procedures.

From *Figure* 2, all of the point sampling procedures provide an unbiased estimate of the true defect proportion; that is, as the sample size increases, the difference between the true and estimated values of the defect proportion gets smaller and tends to zero. At small sampling sizes, variations in the estimates of the defect proportion are approximately the same for all the sampling procedures (*Figure* 3). As the sample sizes increase, however, the variation of the estimates among sampling procedures are significantly different for the three point sampling procedures. Systematic point sampling generally has the lowest variation. Changes in the mean-square error (MSE) with increasing sample size (*Figure* 4) closely follow the changes in variation. At small sample sizes, the MSE for all three procedures are equal. (The low mean-square error for stratified random sampling results from the abnormally low estimation error for this procedure at the low sample sizes). At the higher sample sizes, systematic sampling is better than or equal to stratified random sampling, which is in turn better than random sampling. The superiority of systematic over random sampling is also exemplified in *Table* 2 which compares the sampling size required using systematic point sampling with that predicted for random point sampling to achieve 20% estimation accuracy. These sampling sizes were computed using standard formulas presented by Cochran[3] and Walpole and Myers[8] (Appendix B). Here, one finds that systematic point sampling is two to three times more efficient than its random counterpart. These conclusions concur with those of Osborne,[5] Holmes,[9] Milne,[10] and Madow.[11]

Table 1—Systematic Point Sampling Results (Sample Size = 5329 Points)

Defect Area Proportion	Average Area of Estimate	Standard Deviation of Estimates	Trials Out of 20 Within 20% of Actual Value
9.92 E-03	−3.32 E-04	7.82 E-04	20
5.86 E-03	−2.49 E-04	8.43 E-04	16
3.66 E-03	7.22 E-05	6.50 E-04	16
2.72 E-02	−3.83 E-04	1.50 E-03	20
1.21 E-02	−2.36 E-04	1.02 E-03	20

From the panel simulations, a rule of thumb has been developed for determining the proper sample size to be utilized in evaluating a panel using systematic point sampling. For a panel containing a distribution of defects, the sampling points should be spaced such that the distance between neighboring points is equal to the size of the smallest defects. This sampling grid will provide accurate estimates of the defect area proportion (within 10% of true value), especially when the defect size distribution is narrow (i.e., defects are all approximately the same size). This observation can be extended to a wide defect size distribution. Here, it can be concluded that if the smallest defects, those below some critical diameter, present on a panel collectively occupy only a minor fraction of the total defect area, they may be essentially ignored in determining an adequate sample size without sacrificing accuracy. Appropriate sample sizes for a 10 cm × 20 cm (4″ × 8″) panel containing defect distributions with different critical diameters are presented in *Table* 3. Although it may appear that the sample size required when the defects are relatively small is quite large, one must remember that in the evaluation procedure only the points actually covering defects need to be counted by the evaluator.

This rule for sampling size selection provides insight into why systematic point sampling is superior to stratified random point sampling in estimating defect area proportion. When the sampling points are spaced at intervals equal to a given defect size, one can be assured that exactly one sampling point will impinge on each defect of this size when systematic point sampling is employed. With stratified random point sampling, however, this same grid size may result in between zero and four sampling points impinging on these defects. This variability causes stratified random point sampling to be inferior to its non-random counterpart.

From an applications standpoint, systematic point sampling is much easier to apply than random or stratified random point sampling. The latter two pro-

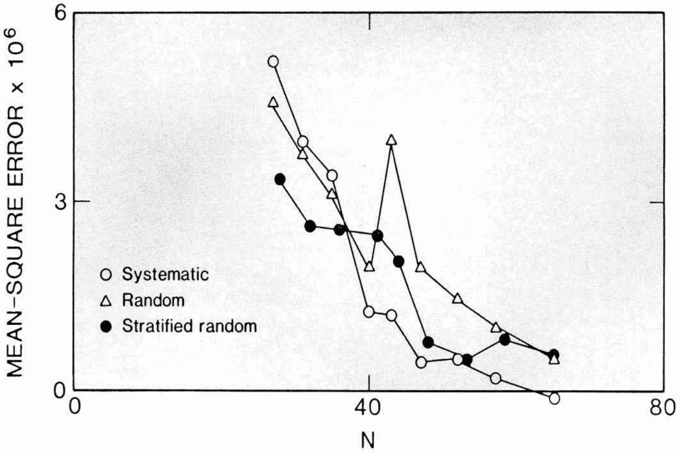


Figure 4—MSE vs sample size (N X N) for point sampling procedures

cedures require that a large number of random positions be determined anew each time the procedure is utilized, while the former uses one grid of sampling points.

Linear Sampling

Linear sampling may be the preferred procedure for estimating the defect proportion for special applications, such as estimating the undercutting area along a scribe mark. For this exercise, linear sampling performed as well as or better than systematic point sampling. A good estimate of the defect proportion was obtained even when only a small number of sample lines were employed. As expected, the accuracy of the defect proportion estimate increases as the spacing between lines decreases. The geometrical regularity of the undercutting had only minor effects on the sampling size required to obtain accurate estimates of the defect area. Linear sampling would be easier to implement than systematic point sampling for this case, since it requires only a limited number of width measurements and a relatively easy integration process.

Systematic Area Sampling

This sampling procedure requires that 30–50% of the total panel area be sampled to obtain 10–20% accuracy in the estimates. The effects of increasing the number of samples and of increasing the size of existing samples were investigated. The size of the sample blocks ranged from 4 × 4 to 64 × 64 matrix elements while the number of sample areas ranged from 10 to 200.

Increasing the area of existing samples yields more accurate results, as does increasing the number of samples of a given area placed on the panel. In the simulations, increasing the area of the individual blocks was often superior to increasing the number of sampling areas (i.e., more accurate estimations are obtained). The former results in a greater percentage of the investigated trials being within the desired confidence level, while the latter yields a narrower distribution of sampling estimates of defect area proportion. This sampling procedure would be easy to implement and has the advantage of providing information about the defect size distribution as well as the proportion of the panel area covered by defects.

CONCLUSIONS

Simulation results indicate that spatial sampling procedures can provide a quick, quantitative evaluation technique for determining the defect area for coated panels. Three spatial sampling procedures were investigated—point sampling, linear sampling, and area sampling. All of these sampling procedures provide more quantitative estimates of defect area than the currently available visual evaluation procedures.

Systematic point sampling procedures have been found to require the smallest sample size for a given degree of accuracy, while also being the easiest of the sampling

Table 2—Efficiency of Systematic Sampling Relative to Random Sampling

Defect Area Proportion X100	Sample Size for Random Sampling N_p	Sample Size for Systematic Sampling N_r	Efficiency N_p/N_r
0.37	23,538	7,225	3.26
0.59	15,241	7,225	2.11
1.22	7,552	4,096	1.84
2.72	3,391	900	3.77

For N_p calculation: Z = 1.96, E = 0.20

Table 3—Estimated Number of Sampling Points vs Critical Diameter of Defects for a 10 × 20 cm (4 × 8 in) Panel

Critical Diameter (mm)	Spacing Between Sampling Points (mm)	Sample Size Points
1	1	20,500
2	2	5,050
4	4	1,250
10	10	200

procedures to implement. The superiority of systematic point sampling over other point sampling procedures such as random point sampling has been noted in other areas of application such as timber classification and land usage evaluation.[3] These applications are similar to coated panel evaluation in that they all involve identifying the proportion of a population occupied by distinct groups.

Systematic point sampling is quite an attractive coated panel evaluation procedure, satisfying all of the requirements of an ideal panel evaluation procedure as presented by Martin and McKnight.[2] The procedure is simple, nondestructive, easily repeatable and reproducible, and of course, systematic. The accuracy of the results obtained using systematic point sampling is limited only by the sampling size selected. Since results are quantitative in nature, they could be accumulated into a database to be accessed and utilized by all researchers. Perhaps, most importantly, systematic point sampling evaluation procedures are quite rapid, with an evaluation time much less than that required by full grid sampling. Thus systematic point sampling procedures provide the user with quantitative defect area estimates that can be quickly obtained and easily validated.

Linear sampling procedures may prove useful when the defects are oblong such as when the coating is scribed to encourage corrosion. If only the area around the scribe tends to corrode, linear sampling will outperform and be easier to implement than systematic point sampling procedures. In this case, linear sampling provides more quantitative results than the ASTM D1654[7] scribe mark test and may serve as a possible replacement for this procedure.

Systematic area sampling can be used to estimate the defect size distribution, as well as the defect area proportion. Although this procedure is not as accurate as several of the others investigated for a given total sample size, it does provide reasonable estimates of the defect area proportion. Since none of the other sampling procedures are able to provide information on the defect size distribution, systematic area sampling is the procedure of choice when size distribution information is the goal of panel evaluation.

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Appendix A

INTEGRATION TECHNIQUES

In estimating the defect area proportion using linear sampling, numeric integration of the undercutting width values was utilized. These integration procedures can be carried out by hand or on a calculator, with many calculators providing this integration ability as part of a mathematical package. The equations used for integration by the trapezoidal and Simpson's rule are as follows[6]:

$$\int_{x_l}^{x_h} f(x)dx = \text{area under curve} = \text{total defect area}$$

TRAPEZOIDAL RULE

$$\int_{x_l}^{x_h} f(x)dx \approx \frac{x_h - x_l}{2n}[f(x_1) + 2f(x_2) + 2f(x_3) + 2f(x_4) + f(x_h)]$$

where

n is the number of intervals (sampling lines-1);

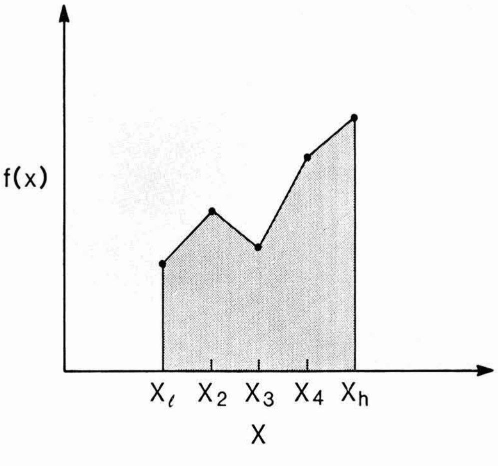
$(x_h - x_l)/n$ is the interval size (line spacing); and

$f(x_i)$ is the value of the function at x_i (width measurement at x_i location)

SIMPSON'S RULE

$$\int_{x_l}^{x_h} f(x)dx \approx \frac{x_h - x_l}{3n}[f(x_1) + 4f(x_2) + 2f(x_3) + 4f(x_4) + f(x_h)]$$

Note for Simpson's rule, n must be an even integer (i.e., odd number of sampling lines (n + 1) required).



Appendix B

SAMPLE SIZE PREDICTION

In comparing systematic point sampling to random point sampling, formulas developed by Cochran[3] for determining the sample size needed for a given degree of accuracy when using random point sampling were utilized. These equations are applicable for sampling procedures where an event either does or does not occur (in our case, corrosion). The equations presented by Cochran are as follows:

$$n_0 = Z^2 \times q/(E^2 \times p) \qquad (1)$$

where

p is the probability of the event occurring (defect area proportion);
q is the probability of the event not occurring (1-p);
E is the allowable error in estimating p (e.g., 20%);
Z is value of the normal distribution at the specified alpha level (Z.05, two-tailed = 1.96); and
n_0 is the required sample size for an infinite population.

Cochran provides a further correction for this equation in the form of

$$n = n_0/(1 + [n_0/N]) \qquad (2)$$

where

N is the population size, e.g., (512 × 512);
n_0 is the sample size required for an infinite population; and
n is the sample size for a population of size N.

Using these equations, the values of N_p given in *Table* 2 were determined.

Reaction of N-(2-Hydroxyethyl) Amido Compounds

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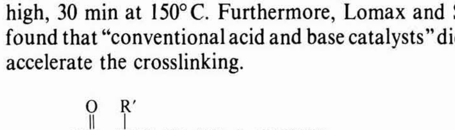
N-(2-hydroxyethyl)-N-methyl octanamide esterifies more rapidly than the corresponding acetamide and benzamide derivatives in that order and much more rapidly than octanol. Contrary to simple alcohols, amide alcohols esterify more rapidly with benzoic acid than with octanoic acid. However, the benzoate ester of the amide alcohol saponifies more slowly than the octanoate ester. Tertiary amide alcohols esterify more rapidly than secondary amide alcohols. Cyclic N-(2-hydroxyethyl) amido compounds do not show this enhanced reactivity. It was demonstrated that a factor in the lack of acid catalysis is the base strength of the amide group. The reaction rate of acyclic amide alcohols with phenyl isocyanate is slower than that of octanol. On the other hand, ethers can be obtained by reaction of amide alcohols with octanol in the presence of a weak acid catalyst. The results are not consistent with the mechanism previously proposed to explain the enhanced esterification rate. A new mechanism involving formation of an oxazolinium ion intermediate is proposed. The amide alcohols undergo self alcoholysis of the amide by the alcohol to form amide esters. N-(2-hydroxyethyl)-N,N′,N′-trimethylurea was shown to cyclize thermally to yield dimethyl amine and 3-methyl-2-oxazolidinone.

INTRODUCTION

Lomax and Swift reported that 2-hydroxyalkyl amides esterify more rapidly than conventional alcohols.[1] They also showed that polyfunctional 2-hydroxyalkyl amides are effective crosslinking agents for carboxylic acid functional acrylic resins. However, the curing schedule required for coatings based on such systems is relatively high, 30 min at 150°C. Furthermore, Lomax and Swift found that "conventional acid and base catalysts" did not accelerate the crosslinking.

$$RC(=O)\!-\!N(R')CH_2CH_2OH + R''COOH \longrightarrow R''COOCH_2CH_2N(R')\!-\!C(=O)R$$

Wicks and Chiang confirmed the rapid esterification of 2-hydroxyalkyl amides and found that, contrary to conventional alcohols, they esterify more rapidly with benzoic acid than with octanoic acid.[2] They also showed that N-(2-hydroxyethyl) N-methyl benzamide, I*c*, esterified more slowly than the corresponding acetamide derivative, I*a*. The esterification reactions, particularly in the case of the benzamide derivative, did not proceed to completion because of side reactions. One by-product from I*c*, was shown to be the benzoate ester of I*c*.



I*c*

$$2\ C_6H_5C(=O)N(CH_3)CH_2CH_2OH \xrightarrow{\Delta} C_6H_5C(=O)\!-\!N(CH_3)CH_2CH_2OC(=O)C_6H_5 + HN(CH_3)CH_2CH_2OH$$

Based on these studies, a possible mechanism (*Scheme* 1) to explain the rapid esterification of 2-hydroxyalkyl amides was proposed. The lack of strong acid, p-toluenesulfonic acid (p-TSA), catalysis, implied by Lomax and Swift, was confirmed and alternate possible explanations were suggested.

Polyfunctional hydroxyalkyl amides offer significant possible advantages over melamine-formaldehyde resins

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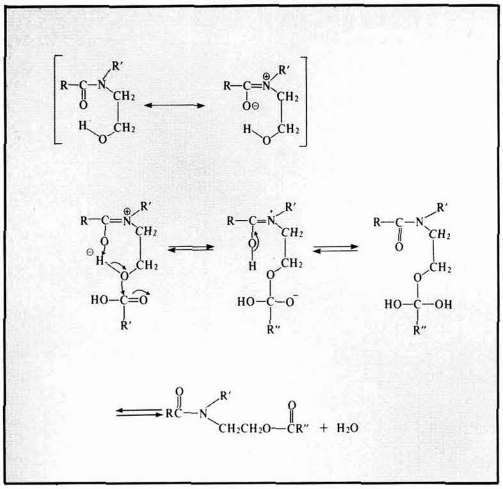

Scheme 1

as crosslinkers for industrial baking enamels. However, the curing temperatures required are higher than with melamine-formaldehyde resins. It was felt that a broader study of the reactions of monofunctional model compounds might provide a basis for design of more reactive systems.

EXPERIMENTAL

All boiling points were determined by distillation and are uncorrected. NMR spectra were determined using a Varian EM-390 90 MHz spectrometer. Chemical shifts are reported in δ ppm relative to TMS (tetramethylsilane). IR spectra were determined using a Beckman 4240 IR spectrophotometer. All melting points (mp) were determined using a Uni-Melt apparatus in open capillary tubes and are uncorrected. Elemental analyses were performed by Galbraith Laboratories, Inc., Knoxville, TN.

Preparation of N-(2-Hydroxyethyl) Amides

The various N-(2-hydroxyethyl) amides studied were synthesized under Schotten-Baumann conditions.[3] A typical procedure is described for the synthesis of octanamide I*b*.

Preparation of N-(2-Hydroxyethyl)-N-methyl Octanamide, I*b*: A one-liter three-neck flask equipped with a condenser, addition funnel, stirrer and thermometer was charged with 42.0 g (0.3 mole) anhydrous K_2CO_3, 22.5 g (0.3 mole) 2-(methylamino)ethanol, 150 mL distilled water, and 150 mL diethyl ether. A solution of 48.8 (0.3 mole) octanoyl chloride in 150 mL toluene was slowly added with stirring to the flask. During the addition, the temperature of the reaction mixture was kept between 0° and 5° C using an ice bath. Addition was accomplished over a period of approximately 12 hours. After addition, the mixture was allowed to warm to room temperature and stirring was continued overnight. The organic layer was separated and washed with 5% NaOH, 1 M HCl and water. After drying over $MgSO_4$ and filtering, the solvent was removed under vacuum. The product was vacuum distilled to give 32.2 g (54%) of octanamide alcohol I*b*, bp (138-42° C (0.1 torr)). IR (neat): 3420 cm^{-1} (OH), 1630 cm^{-1} (C=O); NMR ($CDCl_3$): 0.85 (t,3H,CH_3), 1.2-2.0 (m,10H,CH_2), 2.2-2.4 (m,2H,CH_2 C=O), 2.9-3.1 (d,3H,CH_3N), 3.4-3.9 (m,4H,NCH_2CH_2), 4.3 (s,1H,OH). Elemental Anal: Calcd. for $C_{11}H_{23}NO_2$: C, 65.63; H, 11.52; N, 6.96; O, 15.90. Found: C, 65.29; H, 11.46; N, 6.83; O, 16.07.

N-(2-Hydroxyethyl)-N-methyl Benzamide, I*c*: The NMR spectrum of the distilled product closely matched that published for I*c*.[4] NMR ($CDCl_3$): 3.00 (s,3H,N-CH_3); 3.2-4.0 (m,4H,NCH_2CH_2-); 4.19 (s,1H,OH); 7.43 (s,5H,Ph).

N-(2-Hydroxyethyl) Benzamide, I*d*: The product was an off-white solid and was recrystallized from 1:20 absolute ethanol:diethyl ether to give white needles of I*d*, mp 63-64.5°C, lit. 64-65°C.[4] NMR (DMSO-d_6): 3.25-3.75 (m,4H,NCH_2CH_2); 4.75 (t,1H,OH); 7.4-7.7 (m,3H,Ph, *m,p*); 7.8-8.1 (m,2H,Ph,*o*); 8.45 (s,1H,NH).

N-(1,1-Dimethyl-2-hydroxyethyl) Benzamide, I*e*: Recrystallization from chloroform/hexane gave, mp 88-90° C, lit. 90.2-91.2° C[5]; NMR ($CDCl_3$): 1.44 (s,6H,$(CH_3)_2$); 3.62 (s,2H,-CH_2O-); 5.08 (b,1H,OH); 6.61 (b,1H,NH); 7.22-7.64 (m,3H,Ph-*m,p*); 7.64-8.0 (m,2H,Ph-*o*).

Preparation of Octanoate and Benzoate Esters

Four esters were prepared by the addition of the corresponding acid chloride (octanoyl or benzoyl) to 1-octanol or N-(2-hydroxyethyl)-N-methyl octanamide, I*b*. A typical ester synthesis is described for octyl octanoate.

Preparation of Octyl Octanoate: A 500 mL three-necked flask equipped with condenser, thermometer, addition funnel and stirrer, was charged with 13.0 g (0.1 mole) 1-octanol, 10.1 g (0.1 mole) triethylamine, and 150 mL CH_2Cl_2. The mixture was cooled in an ice bath. Slow addition of a solution of 16.3 g (0.1 mole) octanoyl chloride in 50 mL CH_2Cl_2 was accomplished over approximately four hours. The reaction mixture was warmed to room temperature and allowed to stir overnight. The white precipitate of triethylamine hydrochloride was removed by filtration. The filtrate was washed with 5% NaOH, 1M HCl, and water. After drying over $MgSO_4$ and filtering, the solvent was removed under vacuum. The product was distilled under reduced pressure to yield 15.8 g (62% yield) octyl octanoate, bp 118-20° C (0.1 torr); IR (neat): 1742 cm^{-1} (C=O), 1170 cm^{-1} (C-C(=O)O); NMR ($CDCl_3$): 0.85 (t,6H,CH_3); 1.2-2.0 (m,22H,CH_2); 2.2 (t,2H,CH_2COO); 4.1-4.3 (t,2H,CH_2O).

Octyl Benzoate: bp. 125-6°C (0.1 torr); NMR ($CDCl_3$): 0.85 (t,3H,CH_3); 1.2-2.0 (m,12H,CH_2); 4.3 (t,2H,CH_2O); 7.4-7.7 (m,3H,aromatic-*m, p*); 8.1 (m,2H, aromatic-*o*).

2-(N-Methyl-N-octanoyl)-aminoethyl Octanoate: bp. 182-5°C (0.4 torr); NMR ($CDCl_3$):0.7-1.8 (m,26H,$CH_3(CH_2)_5$);2.2-2.4(m,4H,CH_2COO,CH_2CON); 3.5-3.8 (t,2H,CH_2N); 4.2-4.3 (t,2H,CH_2-OC=O). Elemental Anal: Calcd. for $C_{19}H_{37}NO_3$: C, 69.68; H, 11.39; N, 4.28; O, 14.66. Found: C, 69.29; H, 11.53; N, 4.55; O, 14.92.

2-(N-Methyl-N-octanoyl)-aminoethyl Benzoate: NMR ($CDCl_3$): 0.7-1.8 (m,13H,$CH_3(CH_2)_5$); 2.2-2.4 (t,2H,CH_2CO); 3.0-3.1 (d,3H,CH_3N); 3.6-3.8 (t,2H,CH_2N); 4.4-4.6 (t,2H,CH_2O-C=O); 7.3-7.6 (m,3H, Ph-*m, p*); 8.0-8.3 (m,2H,Ph-*o*). Elemental Anal: Calcd. for $C_{18}H_{27}NO_3$: C, 70.79; H, 8.91; N, 4.59; O,15.72; Found: C, 70.56; H, 8.74; N, 4.62; 0, 15.59.

Recrystallization of Cyclic Amido Compounds

Recrystallization of N-(2-Hydroxyethyl)2-pyrrolidone, III: The liquid sample, courtesy of GAF Corp., was initially crystallized by cooling in a dry ice/acetone bath. A sample of crude solid was dissolved in toluene and stored in a freezer overnight. Seed crystals, courtesy of Ray Anderson, of GAF Corp., were added and the solution stored in a freezer for one week. After filtration, the crystals were dried under vacuum and stored in a dessicator. The product melted near ambient temperatures. NMR ($CDCl_3$): 1.9-2.6 (m,4H,CH_2CH_2C=O); 3.3-3.9 (m,6H,CH_2N,CH_2O,OH).

Recrystallization of N,N′-Bis(2-hydroxyethyl)-5,5-dimethyl-hydantoin, IV: A sample of IV, courtesy of Glyco Chemicals, Inc., was dissolved in an amount of dichloroethane to obtain a weight ratio of 25:75 sample to solvent. The solution was stored in a freezer overnight. Seed crystals were added and the solution was kept in a freezer for one week. The solution was centrifuged and the solvent decanted off. The crystals were dried under vacuum, mp 64-66°C, lit. 62-65°C.[6] NMR ($CDCl_3$): 1.4 (s,6H,CH_3); 3.4-3.5 (t,4H,CH_2N); 3.7-3.9 (m,6H,CH_2O, OH).

Recrystallization of N,N′,N″-Tris(2-hydroxyethyl)-isocyanurate, V: Compound V, courtesy of Shikoku Chemicals Corp., was recrystallized by standard procedures from acetone, mp 135-137°C, lit. 133-136°C.[7] NMR (DMSO-d_6): 3.3-3.6 (t,6H,CH_2N); 3.6-3.9 (t,6H,CH_2O); 4.6-4.8 (t,3H,OH).

Imide Synthesis

Preparation of N-(2-Hydroxyethyl)phthalimide, II*a*: This compound was synthesized by the method of Wicks and Chen.[8] A mixture of 29.6 g (0.2 mole) phthalic anhydride and 12.2 g (0.2 mole) 2-aminoethanol in 200 mL benzene was heated at reflux for 2.5 hours while removing water azeotropically. The crystals obtained were recrystallized from water, mp 126-128°C, lit. 124.5-127°C.[8] NMR ($CDCl_3$): 2.65 (s,1H,OH); 3.90 (s,4H,CH_2CH_2); 7.67-7.98 (m,4H,Ph).

Preparation of N-(1,1-Dimethyl-2-hydroxyethyl)-phthalimide, II*b*: The same procedure described for II*a* was used. The product was a light brown oil and yielded white crystals upon sublimation, mp 63-66°C, lit. 66-69°C.[8] NMR ($CDCl_3$): 1.62 (s,6H,$(CH_3)_2$); 3.77 (s,1H,OH); 3.95 (s,2H,CH_2O); 6.8 (m,4H,Ph).

Preparation of N-(2-Hydroxyethyl)-N-methyl-*p*-toluenesulfonamide, VI

This compound was synthesized using Schotten-Baumann conditions in the same manner described for octanamide I*b*. Compound VI was synthesized from *p*-toluenesulfonyl chloride and 2-(methylamino)ethanol. The product was distilled under vacuum, bp 196-8°C (1.9 torr). NMR ($CDCl_3$): 2.5 (s,3H,CH_3-Ph); 2.6 (s,1H,OH); 2.9 (s,3H,CH_3N); 3.1-3.3 (t,2H,CH_2N); 3.7-3.9 (t,2H,CH_2O); 7.3-7.4 (d,2H,Ph); 7.7-7.8 (d,2H,Ph). Elemental Anal: Calcd. for $C_{10}H_{15}NO_3S$: C, 52.38; H, 6.59; N, 6.11; O, 20.93; S, 13.98. Found: C, 52.23; H, 6.78; N, 6.07; O, 20.65; S, 14.21.

Urea Derivatives

Preparation of N,N-Bis(2-hydroxyethyl)-N′-cyclohexylurea, XI*: A 250 mL flask equipped with an addition funnel, condenser, nitrogen inlet tube and mechanical stirrer was charged with 16.5 g (0.16 mole) N,N-bis(2-hydroxyethyl) amine and 100 mL dry toluene. After cooling the mixture in an ice bath, a solution of 19.8 g (0.16 mole) of cyclohexyl isocyanate in 20 mL anhydrous toluene was added over a one hour period. Stirring at room temperature for two additional hours was followed by refluxing for one hour. Recrystallization of the resulting white powder yielded 33 g (91%) of urea XI, mp 87.5-88.5°C; IR (neat): 3270-3400 (NH and OH), 1610 (C=O); NMR ($CDCl_3$): 0.90-2.10 (m,10H,cyclohexylmethylene), 3.20-3.95 (m, 9H,methylenes and methine), 4.90 (s,2H,OH), 6.13 (d,1H,NH). Elemental Anal: Calcd. for $C_{11}H_{22}N_2O_3$. C, 57.35; H, 9.63; N, 12.16. Found: C, 57.34; H, 9.54; N, 12.19.

Preparation of N-(2-Hydroxyethyl)-N,N′,N′-trimethylurea, XIII: Compound XIII was synthesized from 2-(methylamino)ethanol and dimethylcarbamoyl chloride in a manner similar to that described for the synthesis of esters of I*b*. The reaction temperature was kept at ambient temperature. The liquid product was purified using Amberlite® IR-120 cation-exchange resin since distillation under vacuum led to decomposition. NMR ($CDCl_3$): 2.8-2.9 (d,9H,CH_3N); 3.2-3.4 (t,2H,-CH_2N); 3.7-3.9 (t,2H,CH_2O); 4.7 (s,1H,OH).

Esterification Rate Studies

The esterification rate studies were carried out in refluxing xylene using equal equivalents of alcohol and carboxylic acid (octanoic or benzoic), while azeotropically removing water. The extent reaction was monitored by following the disappearance of acid as the reaction proceeded. For acid catalyzed reactions, 0.66 equivalent

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*The synthesis and reactions of N,N-bis(2-hydroxyethyl)-N′-cyclohexylurea *X* were carried out by N.C. Chiang.[9]

Amberlite is a registered Tradename of Rohm and Haas Co.

% p-TSA based on alcohol was used. A typical procedure is described:

A 250 mL three-neck flask equipped with a stirrer, an addition funnel, a Dean-Stark trap, filled with xylene and fitted with a condenser, was charged with 24.2 g (0.12 eq.) of octanamide alcohol I*b* and 120 mL xylene. For acid catalyzed esterifications, 0.15 g (0.79 mmole) of p-TSA was added to the solution. When the mixture was refluxing, 17.3 g (0.12 eq.) of octanoic acid was quickly added with stirring. To allow for mixing, time zero was taken to be one minute after addition of the acid was started. One mL samples were withdrawn periodically by a syringe and titrated with standardized alcoholic NaOH to a phenolphthalein endpoint. Water was azeotropically removed during the reaction and the amount collected was recorded. The titration data was used to calculate a second order rate constant for the reaction.

After esterification had been stopped, the xylene was removed under vacuum. The residue was dissolved in CH_2Cl_2 and washed with 5% NaOH and distilled water. The organic layer was dried over $MgSO_4$, filtered, and the solvent evaporated. NMR spectra were used to confirm the product structures.

Saponification Rate Studies

The saponification rate studies for the octanoate and benzoate esters of 1-octanol and I*b* were carried out in 95% ethanol at 25° C using equal equivalents of ester and NaOH. The extent of reaction with time was monitored by following the disappearance of NaOH from the reaction. A typical procedure is described:

A 100 mL flask, equipped with a magnetic stirrer and drying tube filled with Ascarite drier, was charged with 69.7 mL of standardized 0.1435 M alcoholic NaOH (0.01 moles), and allowed to equilibrate in a constant temperature bath at 25° C for 30 minutes. To this solution, 2.34 g (0.01 mole) of octyl benzoate were quickly added with stirring. Time zero was taken to be one minute after addition of the ester was started. Two mL samples were periodically withdrawn using a volumetric pipette. The reaction was quenched by adding the sample to a flask containing 10 mL of standardized 0.0300 M HCl and 25 mL 95% ethanol. The solution was back titrated to a phenolphthalein endpoint using standardized alcoholic 0.0429 M NaOH. Back calculations allowed the determination of the concentration of NaOH in the reaction at each sampling. The data was used to calculate a second order rate constant for the reaction.

Isocyanate Reaction Rate Studies

The studies of the rates of isocyanate reaction were carried out in anhydrous toluene at 25° C using equal equivalents of alcohol and phenyl isocyanate. The extent reaction was monitored by following the disappearance of isocyanate from the reaction. A typical procedure is described:

A 100 mL flask equipped with a magnetic stirrer and a drying tube filled with Drierite, was charged with 1.9 g (0.015 mole) 1-octanol and 72 mL toluene. The solution was allowed to equilibrate for 30 minutes in a constant temperature bath at 25° C. To this mixture, 1.8 g (0.015 mole) of phenyl isocyanate was quickly added with stirring. Time zero was taken to be one minute after addition of the isocyanate was started. Three mL samples were periodically withdrawn by a syringe. The concentration of isocyanate for each sample was determined using the standard procedure described in ASTM D2572-70.[10] The data was used to calculate a second order rate constant for the reaction.

Study of Possible Ether Formation

To study the possibility that ether formation could occur with the amide alcohols, the following reaction was carried out in refluxing xylene while azeotropically removing water. A solution of 6.0 g (0.03 mole) of octanamide I*b*, 19.5 g (0.15 mole) 1-octanol and 0.3 g (0.0015 mole) 2,4-dinitrophenol in 75 mL xylene was heated and the evolution of water in the Dean-Stark trap observed. After 48 hours, approximately one equivalent

Table 1—Second Order Rate Constants for Esterifications In Refluxing Xylene While Azeotropically Removing Water (L Equiv^{-1} min^{-1} × 10^4)

	1-Octanoic Acid		Benzoic Acid	
Alcohol	Without p-TSA	With p-TSA	Without p-TSA	With p-TSA
1-Octanol[a]	14 ± 0.5	1500 ± 10.0	2.3 ± 0.1	63 ± 4.0
1-Octanol + N-Me pyrrolidone	—	140 ± 2.2	—	—
I*a*[a]	320 ± 17.0	280 ± 20.0	570 ± 16.0[b]	500 ± 20.0
I*b*	590 ± 30.0	—	1100 ± 35.0	—
I*c*[a]	100 ± 5.0	94 ± 2.0	180 ± 4.0	160 ± 3.0[b]
I*d*	18 ± 1.0	—	—	—
III	8.7 ± 1.0	10.0 ± 0.4	—	—
IV	2.8 ± 0.8	350 ± 10.0	—	—
V	2.2 ± 0.2	490 ± 25.0	—	—
VI	32 ± 1.0	570 ± 12.0	—	—

(a) Values reported represent a composite of data from Chiang[9] and this work.
(b) Values reported here were obtained by recalculating data from Chiang.[9]

of water, based on *Ib*, had evolved. The reaction was stopped and the mixture washed with 5% NaOH and water. After drying over $MgSO_4$ and filtering, the xylene, excess octanol and other low boiling materials were removed under vacuum. The residue was vacuum distilled. The still residue and the distillate fractions were analyzed by IR and NMR.

Thermolysis of N-(2-Hydroxyethyl)-N,N′,N′-trimethylurea, XIII

In an attempted esterification of XIII, no loss of carboxylic acid was observed, however, a volatile amine was given off. Identification of the decomposition products was accomplished as follows.

A solution of 7.38 g (0.05 mole) of XIII in 50 mL xylene was refluxed in a 100 mL flask equipped with a condenser. The volatile amine, which escaped through the condenser, was trapped in a solution of phenyl isocyanate in xylene. The urea formed by reaction of the volatile amine and phenyl isocyanate was recrystallized from toluene and shown to be N,N-dimethyl-N′-phenylurea by mp 127°-132°C, lit. 127°-129°C[11] and NMR (DMSO-d_6): 2.9 (s,6H,CH_3N); 6.9-7.6 (m,5H,Ph); 8.2 (s,1H,NH). The crude reaction mixture was distilled under reduced pressure. The product was identified as 3-methyl-2-oxazolidinone, XIV, by IR, NMR, density and refractive index. The density at 25° C was measured using a Mettler-Paar DMA-46 digital density meter. Refractive index at 23°C was obtained with an Abbe refractometer. IR (neat): 1750 cm^{-1} and 1040 cm^{-1}, lit. 1748 cm^{-1} and 1040 cm^{-1}.[12] NMR ($CDCl_3$): 2.8 (s,3H,CH_3N); 3.4-3.7 (m,2H,CH_2N); 4.2-4.4 (m,2H,CH_2O). Lit. (2-oxazolidinone)[13] 3.6-3.8 (m,CH_2N); 4.3-4.6 (m,CH_2O). Density (at 25°C) 1.1587, lit. 1.1702.[14] Refractive index at 23°C 1.4569, lit. (25°C) 1.4522.[15]

Calculation of Second Order Rate Constants

Second order rate constants were determined for the esterification and saponification reactions and for the reactions with isocyanates. This was accomplished by calculating the slopes of linear second order rate plots. All calculations were done using the 1982 edition of the SAS (Statistical Analysis Service) statistical computer package available through SAS Institute, Inc., Box 800, Cary, NC. The statistical subroutine used was GLM (general linear model). For the statistical comparisons of the various rate constants GLM was employed with dummy variables.

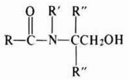
RESULTS

Esterification

A series of 2-hydroxyalkylamido compounds were esterified with octanoic and benzoic acids. The esterifications were all carried out using equal equivalents of alcohol and carboxylic acid in refluxing xylene while removing water by azeotropic distillation. The reaction rates were followed by titration for disappearance of carboxylic acid as a function of time. The initial stages of the reactions followed second order kinetics. The rate constants were determined with and without 0.66 mole percent of p-TSA. The rate constants are given in *Table* 1. The table includes data on acetamide derivatives determined previously.[2]

Table 2—Rate Constants for Saponification (M^{-1} min^{-1}) Of Esters by NaOH at 25° C

Ester	k × 10^2
Octyl Benzoate	4.0 ± 0.2
Octyl Octanoate	8.3 ± 0.2
Ib Benzoate	3.6 ± 0.2
Ib Octanoate	7.6 ± 0.2



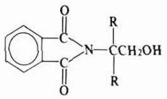
I (a) $R=CH_3, R'=CH_3, R''=H$

(b) $R=CH_3(CH_2)_6, R'=CH_3, R''=H$

(c) $R=C_6H_5, R'=CH_3, R''=H$

(d) $R=C_6H_5, R'=H, R''=H$

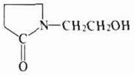
(e) $R=C_6H_5, R'=H, R''=CH_3$



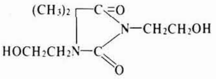
II (a) R=H

(b) $R=CH_3$

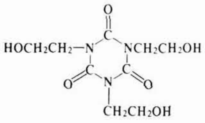
The secondary amine derived from 2-amino-2-methyl-1-propanol, *Ie*, did not esterify. Instead, the corresponding oxazoline, VII, was formed. Hydroxyethylbenzamide, *Id*, did not cyclize to the phenyl oxazoline when refluxed in xylene for 24 hours in the absence of octanoic acid. Imides, II*a* and II*b* showed no esterification after three to seven days of refluxing in xylene with octanoic acid either in the presence or absence of p-TSA.



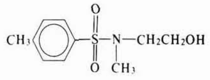
III



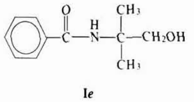
IV



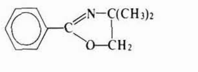
V



VI



Ie



VII

Saponification

In general, esters which form more rapidly saponify more readily. Based on the esterification mechanism proposed earlier, it appeared possible that, while 2-hydroxyalkyl amides esterify more rapidly with benzoic acid than with octanoic acid, the benzoate ester might saponify more slowly than the octanoate ester. Saponification of benzoate and octanoate esters of octanol and hydroxyethyl octanamide I*b* was studied. Saponification rates were determined at 25° C using equal equivalents of ester and alcoholic sodium hydroxide following the reaction by titration as described in the experimental section. As can be seen in *Table* 2, the benzoate ester of I*b* saponifies more slowly than does the octanoate ester reversing the order of ester formation (as expected). Statistical analysis showed that, within 95% confidence limits, the rate of saponification of both benzoate esters are slower than both of the octanoate esters and that the rates of saponification of the octanamide alcohol esters are not significantly different from those of the corresponding octyl esters.

Isocyanate Reaction

Based on the reaction mechanism proposed to explain rapid esterification of 2-hydroxyalkylamides,[2] it would be predicted that they would also react more rapidly with isocyanates than conventional alcohols. Octanol and I*b* were reacted with phenyl isocyanate at 25° C in anhydrous toluene. As would be expected,[14] the disappearance of isocyanate diverged from second order kinetics at low degrees of reaction in both cases. The initial second order rate constants were 12×10^{-3} M^{-1} min^{-1} and 7.9×10^{-3} M^{-1} min^{-1} for octanol and I*b*, respectively. Instead of reacting more rapidly with isocyanate, within 95% confidence limits, I*b* reacted more slowly than octanol with phenyl isocyanate.

Ether Formation

A possible side reaction in esterification of 2-hydroxyalkylamides is ether formation. Ethers exhibit a characteristic IR absorption band in the 1150-1085 cm^{-1} region which for aliphatic ethers is generally found around 1125 cm^{-1}.[16] IR confirmation of the presence of ether in the esterification reactions was complicated by the observation that esters such as octyl octanoate show a small absorption peak in this region also. However, octyl octanoate exhibits two absorption peaks, one at 1170 cm^{-1} and one at 1110 cm^{-1}, with a ratio of 1170/1110 of 2.3 (see *Figure* 1). Comparison of the ratio of peaks at 1170 and 1110 cm^{-1} for the crude esterification product of I*b* with octanoic acid shows a smaller ratio, 1.95 (see *Figure* 2). This suggests that some ether may be present but certainly does not prove the presence of ether. When an excess (5 moles to 1) of 1-octanol to I*b* was refluxed in xylene, approximately 50% of theoretical amount of water for ether formation was evolved over a period of 10 days. As shown in *Figure* 3, the IR spectrum of the residue after removal of unreacted 1-octanol by vacuum distillation showed a ratio of absorption at 1170 cm^{-1} to that at 1110 cm^{-1} of 1, indicating the presence of ether groups. To test whether formation of ether might be catalyzed by a weak acid, the reaction of I*b* with excess 1-octanol was repeated using 5 mole % (based on I*b*) 2,4-dinitrophenol (pKa = 3.96) as a catalyst. An approximately equimolar amount of water (based on I*b*) was evolved within 48 hr. The octanol, unreacted I*b* and the reaction product(s) were separated by distillation. The reaction product(s) had an IR spectrum with a moderately strong, but very broad absorption at 1125 cm^{-1} and an almost negligible absorption at 1170 cm^{-1}, which strongly suggests the presence of ether (see *Figure* 4). In addition to the amide carboxyl absorption at 1652 cm^{-1}, there was also absorption at 1742 cm^{-1} indicating the presence of ester carbonyl. As shown in previous work,[2] distillation of the hydroxyethyl amides leads to partial conversion to aminoalcohol and ester amide.

NMR also showed that a mixture of products was formed. The integration was consistent with a mixture of the octyl ether of the hydroxyethyl amides, VIII, and the octanoic ester of the hydroxyamide, IX. The diether from the amide, X, may also be present. No ether formed by refluxing 1-octanol in xylene with dinitrophenol for 48 hr.

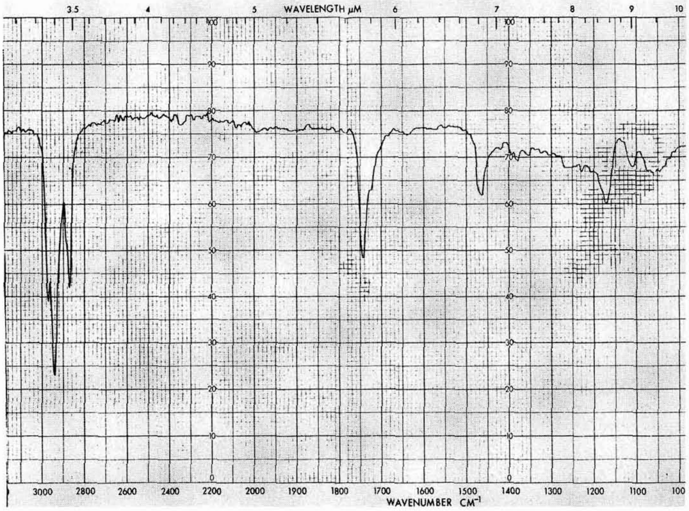
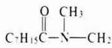
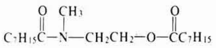


Figure 1—IR Spectrum of octyl octanoate



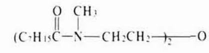
$C_7H_{15}\overset{\overset{O}{\|}}{C}-\overset{\overset{CH_3}{|}}{N}-CH_2CH_2OC_8H_{17}$

VIII



$C_7H_{15}\overset{\overset{O}{\|}}{C}-\overset{\overset{CH_3}{|}}{N}-CH_2CH_2-O-\overset{\overset{O}{\|}}{C}C_7H_{15}$

IX

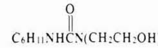


$(C_7H_{15}\overset{\overset{O}{\|}}{C}-\overset{\overset{CH_3}{|}}{N}-CH_2CH_2\!\!-\!\!)_2\!-\!O$

X

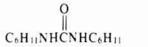
Reactions of 2-Hydroxyethyl Ureas

When N,N-bis(2-hydroxyethyl)N′-cyclohexylurea, XI, was refluxed in xylene with octanoic acid, the apparent esterification rate was slow. As the reaction proceeded, a precipitate formed.[9] This was shown to be N,N′-dicyclohexyl urea, XII.



$C_6H_{11}NH\overset{\overset{O}{\|}}{C}N(CH_2CH_2OH)_2$

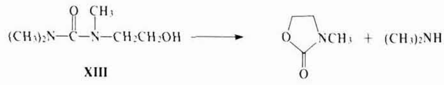
XI



$C_6H_{11}NH\overset{\overset{O}{\|}}{C}NHC_6H_{11}$

XII

When N-(2-hydroxyethyl)-N,N′,N′-trimethyl urea, XIII, was refluxed in xylene with octanoic acid, no loss of carboxylic acid was observed. However, a volatile amine was evolved. Refluxing XIII alone in xylene was shown to produce 3-methyl-2-oxazolidinone, XIV and dimethylamine.



XIII

XIV

DISCUSSION

Scheme 1 was proposed to explain the increased rate of esterification of N-(2-hydroxyethyl)-amides.[2] However, the formation of ethers by reaction of alcohols in the presence of a weak acid catalyst and the lack of enhancement of reactivity with phenyl isocyanate are not consistent with this reaction pathway.

Scheme 2 is now proposed as an alternate reaction pathway. This scheme proposes formation of oxazolinium ion (B). Formation of intermediate oxazolinium ions to explain enhancement of reactions by neighboring amide groups has been suggested previously.[17,18]

Esterification

Reactions of carboxylate anions with oxazolinium compounds to form esters of 2-hydroxyalkyl amides have been reported in the literature.[18,19] The lower reactivity of the benzamide alcohol, I*c*, could result from the fact that formation of the tetrahedral intermediate (A) requires disruption of the conjugation of the carbonyl groups with the aromatic rings.

The reversal of the rate of esterification of the amidoalcohols with benzoic acid and octanoic acid as compared to octanol reported earlier[2] has been confirmed as shown in *Table* 1. Since benzoic acid is a stronger acid, pKa = 4.19, than octanoic acid, pKa = 4.89,[20] it would be expected to be a more effective catalyst for the formation of the oxazolinium intermediate, B, therefore benzoic acid would react more rapidly than octanoic acid.

The slower rate of esterification of N-2-hydroxyethylbenzamide, I*d*, is consistent with the slower rate of esterification of secondary amide alcohols reported by Lomax and Swift.[1] In fact, the rate constant for esterification of I*d* is not significantly higher than that of octanol. They proposed that this resulted from ring closure to form an oxazoline which would, in turn, react to form the ester but at a slower rate than direct reaction of the hydroxyl of tertiary amide alcohols. In *Scheme* 2, the product of nucleophilic displacement of the hydroxyl group would be an oxazoline rather than an oxazolinium ion. It would be predicted that an oxazolinium ring would be more reactive since ring opening would be facilitated by the loss of the positive charge.

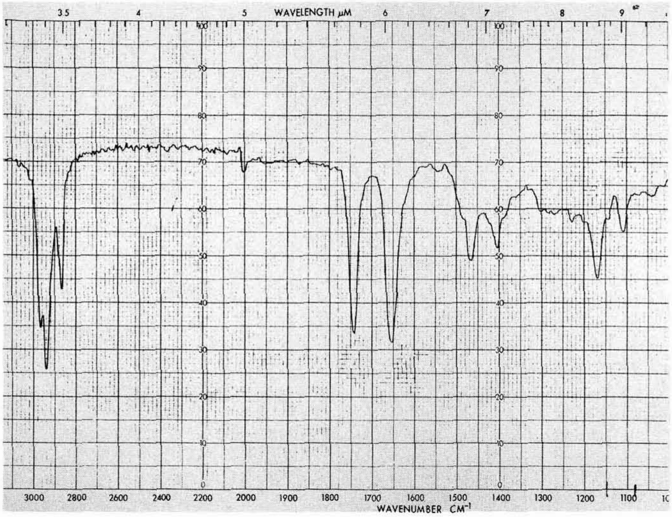


Figure 2—IR Spectrum of ester product from reaction of compound *Ib* with octanoic acid

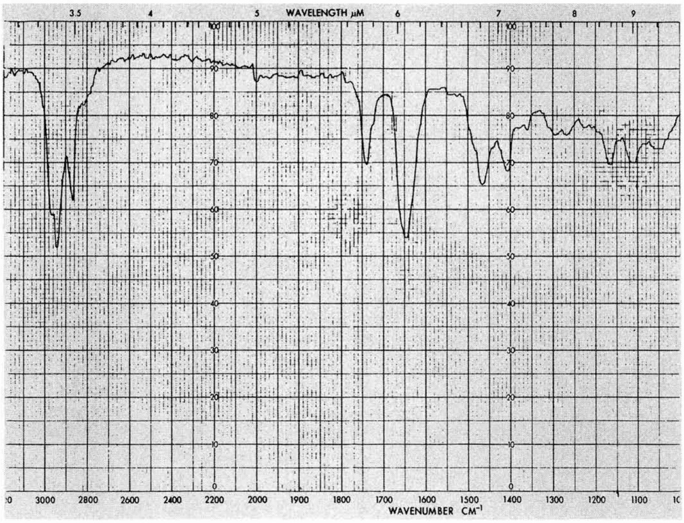


Figure 3—IR Spectrum of reaction mixture of compound *Ib* and octanol

When a solution of I*d* in xylene was refluxed, no oxazoline formed. It is possible that formation of the oxazoline is catalyzed by the carboxylic acid being esterified. No study of the catalysis of formation of oxazolines by weak acids has been found in the literature. When esterification of 2-N-(2-hydroxy-2-methylpropyl) benzamide, I*e*, was attempted no esterification occurred and oxazoline VII was obtained. The dimethyl substitution enhances oxazoline formation but the ring is so stable that it is not opened by carboxylic acid under these conditions.

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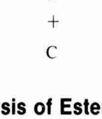
Esterification of Cyclic 2-Hydroxyethylamido Compounds

In contrast to the observed rapid esterification of the acyclic N-(2-hydroxyalkyl) amides, the esterification of cyclic hydroxyalkylamido compounds, II*a* and *b*, III, IV, and V, was found to be slow. Although it has been reported that N-(2-hydroxyethyl)phthalimide, II*a*, esterifies at temperatures over 210° C,[21] it was found that in refluxing xylene no esterification was observed after seven days. It has been said[22] that N-(2-hydroxyethyl)-2-pyrrolidone, III, is "under ordinary conditions surprisingly inert to many alcohol reactions such as esterification." As can be seen in *Table* 1, the rate constant for esterification of III was found to be slightly lower than for octanol. By statistical tests, the difference is not significant. However, III clearly esterifies much more slowly than the acyclic amide alcohols. Esterifications of N,N'-bis-(2-hydroxyethyl) dimethylhydantoin, IV, and N,N',N''-tris (2-hydroxyethyl) isocyanurate, V, in the absence of p-TSA are even slower. In these cases, within 95% confidence limits, the rate constants are lower than that of octanol.

The slower esterification of the cyclic amidoalcohols is consistent with *Scheme* 2. *Scheme* 2 would require formation of a bicyclic structure with two five member rings and a bridge C-N double bond, C. Formation of such highly strained structures is not likely.



C

Acid Catalysis of Esterification

As can be seen in *Table* 1, the lack of acid catalysis of the esterification of acyclic amide alcohols, reported earlier,[1,2] is confirmed. Esterification of III was not significantly catalyzed either. However, esterifications of

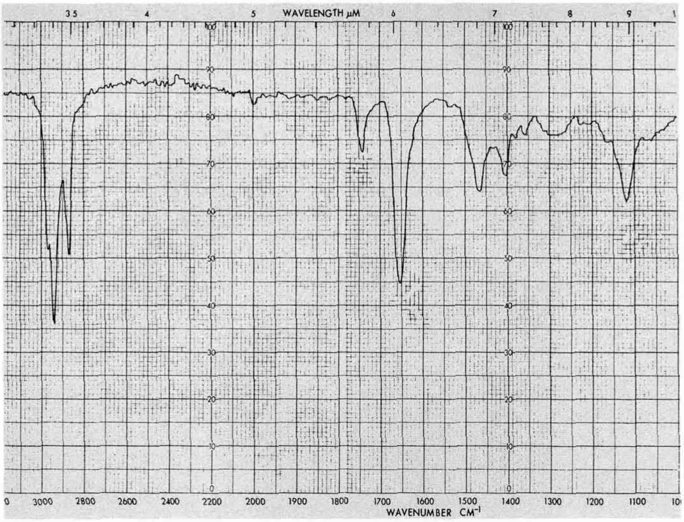


Figure 4—IR Spectrum of reaction mixture of compound *Ib* with octanol in the presence of 2,4-dinitrophenol

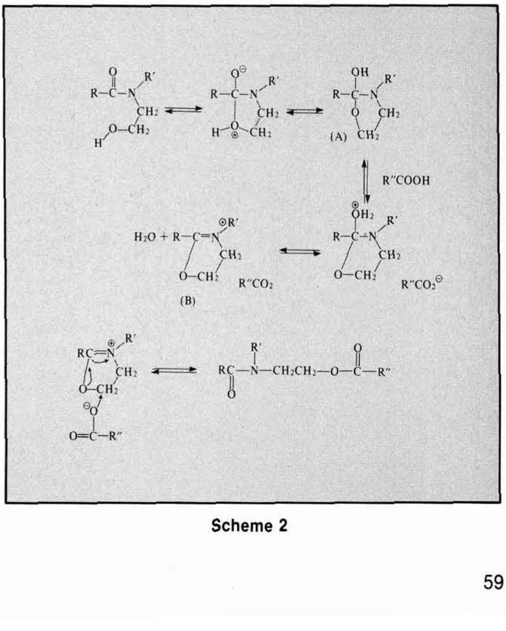
the hydantoin derivative, IV, and the isocyanurate derivative, V, were catalyzed by p-TSA. Three possible explanations for the lack of acid catalysis of acyclic amide alcohols have been suggested.[2] They can undergo an acyl shift to the salt of the corresponding 2-aminoester or might be hydrolyzed in the presence of p-TSA. In either case, the acid catalyst would be neutralized. Neither of these explanations, however, could explain the lack of acid catalysis of III. The third possible explanation revolved around the basicity of the amide group. In normal esterifications, acid catalysis results from protonation of the carboxylic acid making the carbonyl group more susceptible to nucleophilic attack by the hydroxyl group of the alcohol. The pKa's for various protonated carboxylic acids have been reported to range from −6 to −8 while the pKa's of various protonated amides range from 0 to −2.[23] Since amides are stronger bases, their presence would reduce the concentration of protonated carboxylic acid which could reduce the effect of acid catalyst. In order to test this hypothesis, the rate of esterification of 1-octanol with 1-octanoic acid in the presence of an equimolar amount of N-methyl pyrrolidone with p-TSA as catalyst was determined. The second order rate constant with 0.66 mole percent of p-TSA determined in refluxing xylene while removing water azeotropically was 1.4×10^{-2} M^{-1} min^{-1} in the presence of N-methyl pyrrolidone, an order of magnitude less than 1.5×10^{-1} M^{-1} min^{-1} observed without the N-methyl pyrrolidone. The lack of acid catalysis of III may result from its basicity. In contrast, esterification of IV and V are acid catalyzed. While no data could be found on their basicity, it seems reasonable that IV and V would be less basic than III.

Sulfonamide Esterification

As shown in *Table* 1, N-(2-hydroxyethyl)-N-methyl-*p*-toluenesulfonamide, VI, reacts less rapidly with octanoic acid than do any of the acyclic tertiary carboxamide alcohols. Furthermore, the reaction is catalyzed by p-TSA. When compared to carboxamides, sulfonamides are less basic.[24,25] Formation of an intermediate comparable to tetrahedral intermediate A by the sulfonamide is not probable. No reports have been found in the literature which suggest formation of a sulfonamide intermediate analogous to the oxazolinium ion. Also since the sulfonamide would be less basic, it would not reduce protonation of the carboxylic acid by acid catalysts as effectively as a carboxamide.

Saponification of Amide Alcohol Esters

Table 2 lists the rate constants for saponification at 25° C for the octanoate and benzoate esters of octanol and the octanamide alcohol, *Ib*. In general, if esterification proceeds rapidly, saponification of the resulting ester will also proceed rapidly as is the case comparing octyl



Scheme 2

octanoate and octyl benzoate. However, the benzoate ester of *Ib* forms more rapidly and is also more stable to saponification than the octanoate ester.

Both esterification and saponification reactions with conventional esters involve formation of a tetrahedral intermediate. Since formation of the intermediate for both aromatic acids and esters requires disruption of the conjugation of the carbonyl with the aromatic ring, both esterification and saponification reactions proceed at slower rates as compared to aliphatic acids and esters.

In considering *Scheme* 2, the saponification reaction is not the reverse of the esterification reaction. The carboxyl ester would be the one most easily attacked in saponification to yield a tetrahedral intermediate. Since this reaction is the same as that in saponification of conventional esters, it is not surprising that the saponification rates are similar and in the same order for esters of octanol and *Ib*.

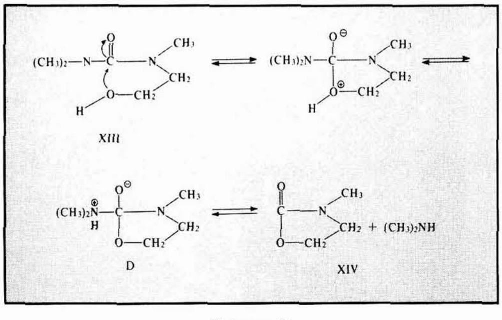
Reaction of Amide Alcohol With Phenyl Isocyanate

If *Scheme* 1 were the appropriate mechanism to explain the rapid esterification of amide alcohols, it would be expected that they would also react rapidly with phenyl isocyanate. In fact, as noted earlier, within 95% confidence limits, *Ib* reacted more slowly at 25° C with phenyl isocyanate than did octanol. Reactions with isocyanates proceed by nucleophilic attack at the carbon of the isocyanate. A reaction between the oxazolinium ion B suggested in *Scheme* 2 and isocyanate would not be expected.

Ether Formation

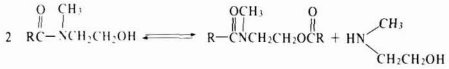
Amide alcohol *Ib* reacts in refluxing xylene with 1-octanol in the presence of weak acid catalyst to form the octyl ether of the amide alcohol, VIII. Under the same conditions, octyl alcohol did not form dioctyl ether. Significant facilitation of ether formation would not be expected by *Scheme* 1. However, ether formation in the presence of weak acid would be expected by nucleophilic attack on carbon 5 of the oxazolinium ion (B) in *Scheme* 2.

While the formation of ether VIII was shown by IR and NMR, it was accompanied by side reactions so that the product obtained was a mixture. An important component of the mixture was IX, the octanoate ester of the octanamide alcohol, IX could have formed during the prolonged reaction time or at the relatively high temperatures necessary to vacuum distill the reaction product. As had been reported earlier,[2] a side product of the esterification of *Ib* with benzoic acid was the benzoate ester of the benzamide alcohol *Ic*. A side product of the esterification of *Ic* with octanoic acid was the octanoate ester of the octanamide alcohol. It was found that amide alcohols could be purified by vacuum distillation only at low pressures (< 0.2 torr). At higher pressures (temperatures), octanamide alcohol *Ib* disproportionated to the octanoic ester of the amide alcohol, VIII; and benzamide alcohol *Ic* disproportionated to give the benzoate ester of the benzamide alcohol.



Scheme 3

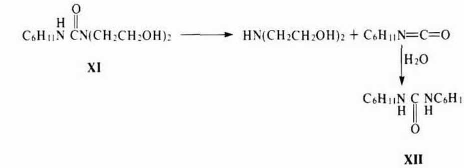
Presumably, the ester amides are formed by alcoholysis of the amide. The driving force for the reaction would be the removal of the amino alcohol (which was detected by titration) by distillation. In general, alcoholysis of amides is not expected. This reaction parallels the enhanced rate of amide hydrolysis by participation of neighboring hydroxyl groups. For example, 4-hydroxybutyramide hydrolyzes much more rapidly than butyramide.[26]



$$2\ R\overset{O}{\overset{\|}{C}}-\overset{CH_3}{\overset{|}{N}}CH_2CH_2OH \rightleftharpoons R-\overset{O}{\overset{\|}{C}}\overset{CH_3}{\overset{|}{N}}CH_2CH_2O\overset{O}{\overset{\|}{C}}R + HN\begin{matrix}CH_3\\CH_2CH_2OH\end{matrix}$$

Reaction of 2-Hydroxyethyl Ureas

It appeared possible that 2-hydroxyethyl ureas might be even more readily esterified than 2-hydroxyethyl amides. However, it was found that, when esterification of N,N-bis(2-hydroxyethyl)N′-cyclohexylurea, XI, was attempted, a significant fraction of the urea was converted to N,N′-dicyclohexylurea, XII.[9] Presumably urea XI cleaves to give cyclohexyl isocyanate which then reacts with water to give the insoluble urea, XII.



$$C_6H_{11}\overset{H}{N}\overset{O}{\overset{\|}{C}}N(CH_2CH_2OH)_2 \longrightarrow HN(CH_2CH_2OH)_2 + C_6H_{11}N{=}C{=}O \xrightarrow{H_2O} C_6H_{11}\underset{H}{N}\underset{O}{\underset{\|}{C}}\underset{H}{N}C_6H_{11}$$

XI XII

In order to avoid cleavage to isocyanate, a fully substituted urea, N-(2-hydroxyethyl)-N,N′,N′-trimethylurea, XIII, was synthesized. Attempted esterification of XIII resulted in no loss of carboxylic acid. Instead, XIII cyclized to 3-methyl-2-oxazolidinone, XIV. It is unlikely that formation of XIV would proceed by mechanisms related to *Schemes* 1 or 2. A possible pathway is shown in *Scheme* 3. Loss of dimethyl amine would be favored since it is distilled off as it forms.

SUMMARY

The facile esterification of N-2-hydroxyethyl carboxamides has been confirmed. The esterification rate increases in the order of benzamide < acetamide < octanamide derivatives. Tertiary amide alcohols react more rapidly than secondary amide alcohols. Cyclic N-(2-

hydroxyalkyl) amido compounds do not show the enhancement of esterification rate shown by the acyclic amide alcohols. The esterification reactions of acyclic amide alcohols and N-(2-hydroxyethyl) pyrrolidone are not catalyzed by p-TSA. Evidence that basicity of the amide group is a factor in the lack of acid catalysis was obtained by showing that the presence of N-methylpyrrolidone reduces the effectiveness of p-TSA as a catalyst for esterification of octanol.

It was found that, although the amide alcohols esterify more rapidly with benzoic acid than with octanoic acid, the benzoate esters are more stable to saponification than the octonoate esters. This reversal suggests that polyfunctional N-(2-hydroxyalkyl) amides might be particularly appropriate as crosslinkers for aromatic acid terminated polyesters.

In contrast to the acceleration of reaction rates with carboxylic acids exhibited by amide alcohols, formation of a urethane by reaction with phenyl isocyanate is not accelerated. On the other hand, an amide alcohol reacts more readily in the presence of a weak acid catalyst to form ethers than ordinary alcohols.

These results do not fit the mechanism previously proposed to explain the facile esterification of amide alcohols.[2] A reaction pathway involving an oxazolinium ion intermediate is consistent with the experimental data.

It is suggested that thermal disproportionation of amide alcohols to amide esters proceeds via intermolecular alcoholysis of the amide group. Similarly, it was found that a fully substituted N-(2-hydroxyethyl) urea cyclizes to an N-substituted pyrrolidinone rather than esterifying.

ACKNOWLEDGMENT

Financial support from the 3M Company and Mobil Foundation is gratefully acknowledged. The assistance of Dr. S. Peter Pappas in devising reaction mechanisms is appreciated, as are the suggestions of Dr. Graham Swift. Preliminary studies of reaction of amide alcohols with isocyanates were carried out by Anthony Walder. Walder was the recipient of a summer undergraduate research fellowship funded by a grant from PPG, Inc.

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TOLUENE	–	–	–	–	61	61
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EE ACETATE	50	–	53	–	13	–
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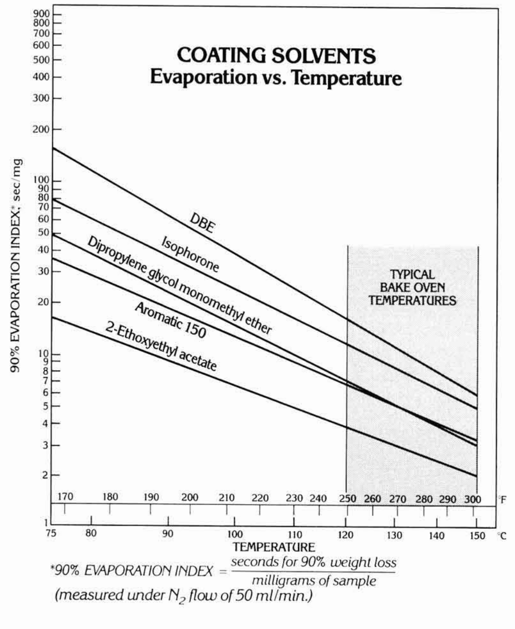

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Effect of Solvent Choice on Water-Based Coating/Wood Interactions

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S.U.N.Y.—College of Environmental Science and Forestry*

A clear water-borne alkyd resin solution was shown to swell cell walls of Eastern white pine and leave them in a partially swollen condition upon oven-drying. Cosolvent rather than resin was principally responsible for this phenomenon. Force-drying at an elevated temperature did not remove the cosolvent. However, immersion in water did remove it, showing that no permanent dimensional stabilization had occurred. Accelerated weathering of brush-coated panels appears to confirm these results because this resin performed better than the same resin dissolved in xylene, but only for a limited time. Since cosolvents are usually present in water-borne solution coatings, the technique of measuring cell wall bulking by treating and then drying the wood without exposing it to water may be an invalid measure of resin penetration into cell walls.

INTRODUCTION

Manufacturers of exterior latex coatings for wood substrates have been successful in formulating coatings that retain their flexibility for extended periods of time. Similar success in maintaining adhesion between the coating and wood is less notable. Peeling of the coating is particularly evident in species having wide latewood (summerwood) bands and having abrupt transitions between earlywood (springwood) and latewood zones. Dimensional instability of the wood substrate is one of the major causes of coating failures.[1]

One approach to improving coating adhesion would be to deposit resin molecules within the wood cell walls. Potential advantage is greater molecular attraction, e.g., hydrogen bonding, between the coating and the wood because the coating is present within the extremely fine capillaries inside the cell wall. In addition it would decrease the shrinkage and swelling of wood associated with changes in atmospheric moisture that cause cyclic stresses at the coating/wood interface. Before the resin can enter any cellulosic fiber, it is first necessary to swell the fiber wall to make its interior accessible.[2]

Objective

This investigation was undertaken to clarify the role of the solvent and cosolvent in depositing resin molecules inside wood cell walls. A clear water-borne alkyd resin was compared to the same resin dissolved in organic solvents for their ability to swell Eastern white pine and keep it permanently swollen. The behavior of both resin/wood systems to environmental factors, such as rain and UV light, was evaluated by leaching and accelerated weathering. To focus upon the resin inside cell walls, these clear alkyds were formulated at low solids content to model penetrating type finishes. This reduced the protective influence of a coating film above the wood surface.

Cell Wall Bulking

Swelling of wood occurs when water is absorbed by the cell walls which causes the wood volume to increase nearly proportionately to the volume of water. Swelling increases until the fiber saturation point is reached; that is, the cell wall is saturated. Additional water causes no further swelling, but fills the lumens with water. This process is reversible. In good building construction practice, most wood is well below the fiber saturation point, and therefore, is subject to swelling and shrinking.

Bulking is the name given to treatments that reduce the swelling of wood in contact with water vapor by depositing a solute inside the cell wall that keeps the wood swollen when the water is removed from the wood by drying. The wood, now at equilibrium with the relative

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Table 1—Alkyd Resin Composition in Percent by Weight

	Water-Borne	Xylene-Borne
Resin non-volatile	19.0	19.0
6% Cobalt naphthenate	0.10	0.10
18% Zirconium naphthenate	0.07	0.07
Activ-8[a]	0.03	0.03
Defoamer	0.03	0.03
Wetting agent	0.21	0.21
Ultra violet absorber	0.45	0.45
Butoxyethanol	11.01	11.01
Isobutanol	4.27	4.27
n-Butanol	1.91	1.91
Water	62.92	—
Xylene	—	62.92
Ammonium hydroxide	to adjust pH	—
	100.0	100.0

(a) R. T. Vanderbilt Co. Inc.

humidity, has remained in its swollen condition and will not change in dimension in response to changes in atmospheric moisture as long as the solute is present.

Two classes of solutes for bulking wood are known.[3] Those that chemically react with the cell wall remain there when wood is exposed to liquid water. The degree of permanent dimensional stabilization depends upon the chemical stability of the bonds between solute and cell wall. The second class of solutes are those that do not chemically react after being deposited, for example, poly(ethylene glycol). It may be removed by leaching only when liquid water comes into contact with the bulked wood. Wood carvings bulked with these solutes will not split when displayed in heated environments.

Cell wall bulking of wood prior to coating application has been reported for aqueous solutions of low molecular weight phenolics.[4-6] This treatment is thought to have improved coating performance by excluding water, although it may also act as a UV stabilizer for the wood.

Aqueous solutions of inorganic salts deposited in the cell wall represent another class of pretreatments. They are thought to improve coating performance by reducing the effects of UV radiation.[7] Initial toxicity before drying,[8] discoloration of the wood,[9] and high volatility of certain components, e.g., ammonia, lessen their utility.

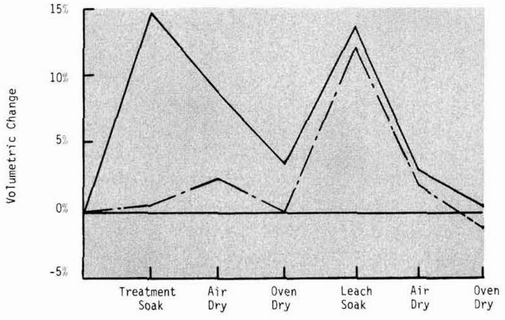

Figure 1—Volumetric changes of Eastern white pine wafers treated with water-borne alkyd (——) and xylene-borne alkyd (—-—)

In addition, both organic and inorganic systems require that the wood be treated twice—once with pre-treatment and then with the coating.

Smulski and Coté[10] have reported limited deposition of a water-borne alkyd resin within cell walls of basswood and Eastern white pine. The moderate increase in dimensional stability of the wood was a temporary phenomenon. Once dry, specimens rewetted with water returned to the normally expected shrinking and swelling behavior.

Dual Role of Solvent

The role of the solvent is critical if resin molecules are to be deposited within cell walls. In addition to its importance in film formation and promoting penetration into pores (lumens) of wood cells on the surface,[11] the solvent must swell capillaries within the cell walls and then provide an attractive medium within the cell wall to avoid a chromatographic separation of coating components by the cell wall.

In latex coatings, the water present is able to swell the cell walls, but the latex particles are too large to penetrate even the most swollen cell walls. In traditional organic coatings (e.g., varnish), the solvent facilitates the coating penetration into the pores of the wood, but neither the solvent nor resin molecules have much affinity for the cellulose component of the cell wall so that both are restricted to the lumens. On the other hand, water-borne solution coatings, with low molecular weight resin molecules and with the wood swelling ability of water, appear to have the characteristics considered necessary for depositing resin within the cell wall. These coatings, however, require an organic cosolvent in addition to water to disperse the resin in the vehicle.

EXPERIMENTAL PROCEDURE

Bulking

Wafers of Eastern white pine (*Pinus strobus* L.) were cut to 3/4 × 3/4 × 3/16″ (20 × 20 × 5 mm) in the tangential, radial, and longitudinal directions, respectively. The wafers were extracted in a Soxhlet extractor with a series of solvents (acetone, 95% ethanol, and distilled water) to remove the soluble compounds that occur naturally in wood.

All wafers were then air-dried for several days and oven-dried at 105°C for 24 hours. Their tangential and radial dimensions were measured to 0.05% with a micrometer. Two groups of wafers each containing 15 replicates were placed in glass jars and kept under 0.1 torr for about one minute before introducing either the water-borne or the xylene-borne coating (*Table* 1). These two penetrating coatings contained exactly the same components, differing only in the solvent used and the addition of ammonium hydroxide to adjust pH in the water-borne coating. Also two control groups of 10 wafers each were soaked in 20 wt% aqueous butoxyethanol or in distilled water. All four groups of wafers were submerged in their respective liquids in closed jars for 24 hours at room temperature and ambient pressure, and their tangential and radial dimensions measured. After air-drying the wafers for 24 hours, their tangential and radial dimensions again were recorded. They were oven-dried, leached in distilled water, air-dried, and oven-dried, each for 24-hour periods. At each stage the wafers were weighed. Percent volumetric swelling is approximated as[12]:

$$(\Delta V / V_d) \cdot 100\% = (\Delta R / R_d + \Delta T / T_d) \cdot 100\%$$

where $\Delta V / V_{dry}$ = volumetric swelling
R = radial dimension
T = tangential dimension
d = dimension at oven-dry condition

The leachates from the wood/coating systems, wood/aqueous butoxyethanol system and wood/distilled water system were distilled and qualitatively analyzed for the presence of alcoholic hydroxyl groups to determine if the cosolvents (and resin) had been removed from the wafers. Analysis was conducted using a ceric nitrate reagent as described by Duke and Smith,[13] that detects the hydroxyl groups present in butanol and butoxyethanol (turning a yellow solution orange-red for a positive test), but is insensitive to both water and xylene. This reagent also detected the presence of the resin by the formation of a white precipitate.

Accelerated Weathering

Panels 1/2 × 2 1/2 × 9″ (13 × 63 × 225 mm) with the grain parallel to the long dimension were planed two days before being brush coated with either the water- or xylene-borne coatings. At the time of coating the wood was at 8% moisture content. A second coat was applied 12 hours later. Panel backs and edges were painted with two coats of aluminum paint to retard moisture movement through these surfaces. A control panel having no coating on its face was coated with aluminum paint on its back and edges.

The panels were exposed in an Atlas Sunshine Weather-O-Meter XW® using Corex D filters. The exposure cycle consisted of 102 minutes of light followed by 18 minutes of light and water spray repeated for 18 hours and then a rest period of six hours. This daily cycle was repeated for five days followed by a rest period of two days each week. The maximum black panel temperature was 145°F (63°C) which dropped to 70°F (21°C) during test periods. Panels were weathered for 267, 390, and 555 hours.

RESULTS AND DISCUSSION

Xylene-Borne Resin

As with most organic solvent systems, this resin penetrated into cell lumens only, as practically no swelling was observed (*Figure* 1). Results are presented in *Table* 2. The very small amount of swelling that had occurred with these wafers during the soaking phase is attributed to the butanols in the solvent system, which are known to swell wood to a limited degree. Additional swelling during the air-drying phase resulted from absorption of moisture from the ambient air. Another indication of the accessibility of voids within cell walls to water is the highly swollen condition of the wafers during leaching with distilled water even in the presence of the xylene-borne resin.

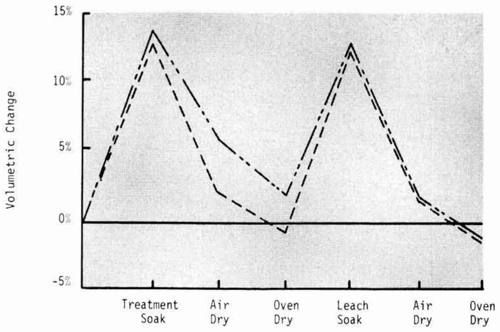

Figure 2—Volumetric changes of Eastern white pine wafers treated with aqueous butoxyethanol (——) and distilled water (----)

Water-Borne Resin

Wafers treated with this material were swollen and remained swollen upon air- and oven-drying (*Figure* 1). However, subsequent leaching removed the material from the cell walls allowing the wafer to shrink upon air drying and more upon oven-drying. Positive ceric nitrate tests revealed the presence of both resin and cosolvent in the leachate. This leachate contained on the average eight times by weight as much solid material when compared to specimens treated only with distilled water indicating that resin was leached from these wafers. The results are presented in *Table* 3.

With this material, cosolvents entered the cell walls only because the water enlarged the void spaces inside the walls. Upon drying, water was removed but the cosolvents remained, causing the wafers to remain swollen. This was confirmed with experiments using an aqueous butoxyethanol solution without resin and distilled water alone (*Figure* 2). Assuming that the resin in the cell lumens is solvent-free, as in the case of the

Table 2—Volumetric Change in Pine Wafers From the Original Oven-Dry Condition in Percent and the 95% Confidence Limits

	Water-Borne Alkyd	Xylene-Borne Alkyd	Butoxyethanol-Water	Distilled Water
Treatment soak	14.6±0.3	0.4±0.2	13.6±0.6	12.9±0.5
Air dry	9.0±0.2	2.3±0.2	6.5±0.3	1.9±0.2
Oven dry	3.8±0.2	0.1±0.1	2.1±0.2	−1.0±0.3
Leach soak	13.9±0.2	12.7±0.3	12.6±0.5	12.5±0.4
Air dry	3.2±0.1	2.2±0.1	1.7±0.3	1.5±0.1
Oven dry	0.5±0.2	−1.1±0.3	−1.3±0.3	−1.5±0.3

Atlas Electric Devices Co., Chicago, IL.

Table 3—Treated Pine Wafers Leached with Distilled Water

Pine Wafers Treated with:	Substances Detected in Leachate
Water-borne alkyd	Cosolvent and alkyd
Xylene-borne alkyd	Neither
20 wt% Butoxyethanol	Cosolvent only
Distilled water	Neither

xylene-borne material, then the cosolvent detected in the leachate had to come from within the cell walls.

Once inside the cell walls, organic cosolvents also can become trapped within cellulosic fibers and be retained even at elevated temperatures until leached by water[14,15] or water vapor.[16] This temporary swelling phenomenon has generally been explained in terms of mechanical entrapment of the solvents in the fibers as the fibers dry and shrink. Specific interactions, e.g., hydrogen bonding, may not always be responsible, since even non-polar cyclohexane has been reported to become trapped within a fiber that had previously been swollen.[17]

Resin Penetration into Cell Walls

Residual bulking of the wafers after leaching with water occurred only with those impregnated with the water-borne alkyd. Furthermore, wafers treated with xylene-borne alkyd, butoxyethanol, and distilled water shrank to less than the original dimension after leaching with water. This shrinkage below the original wafer dimensions was observed in all replicates. A very small, but statistically significant, difference existed between the sizes of water- and xylene-borne alkyd wafers after each of nine leaching cycles. This suggests a more permanent bulking agent, namely resin, had entered the cell walls.

The presence of resin in the leachate of wafers treated with water-borne alkyd may be accounted for in two ways. First, the resin was inside the cell wall where, in the presence of cosolvent, polymerization might be incomplete. From the viewpoint of molecular size, the resin should be able to enter the cell wall where the transient capillaries are thought to be 25 to 50 nm in diameter.[18-20] A substantial portion of its molecular weight distribution is below 1000 MW (particles below 20 Å in radius of gyration, according to GPC).[21] A limiting size of poly(ethylene glycol) that could enter the cell wall was reported as PEG 3000 (radius of gyration 18–20 Å according to dilute solution viscometry).[22] It is possible then that an alkyd molecule could enter the cell wall where it might be isolated from other alkyd molecules and unable to polymerize.

A second explanation for alkyd resin being found in the leachate is that the cosolvent, upon removal from the cell walls during leaching, dissolved the resin in the lumens. No clear answer to this question has been found, although one can conclude by examining the macroscopic properties of the system that the amount of resin inside the cell walls is insufficient to cause the observed bulking.

A measured amount of leachate from wafers treated with the water-borne alkyd was evaporated to dryness and the mean weight loss calculated to determine how much resin was removed. This loss amounted to 0.4 wt% based on the initial (untreated) oven-dry weight of the wood. If the entire 0.4% had come from within the wood cell wall, it could not account for the 3.8% volumetric bulking found after the wafers were oven-dried (*Figure* 1). This is seen clearly by comparison to

Figure 3—SEM photo of brush-coated xylene-borne alkyd on Eastern white pine after 267 hours of accelerated weathering

Figure 4—SEM photo of brush-coated water-borne alkyd on Eastern white pine weathered for 267 hours

Figure 5—SEM photo of xylene-borne alkyd panel after 555 hours of weathering. Note openings (cracks) up to 100 µm wide. Arrows point to two cross-grain checks

Figure 6—SEM photo of water-borne alkyd panel after 555 hours of accelerated weathering has narrower checks; arrows point to two cross-grain checks

the wafers soaked in the aqueous butoxyethanol solution that required a weight gain of 4.2 wt% to remain swollen 2.1% above the original volume after drying assuming that these materials would have similar densities within cell walls.[3] Additional credibility is lent to these values for butoxyethanol when they are compared to the calculated values for water. These wafers would swell 1.8% on a weight gain of 4.2% water assuming a 30% fiber saturation point.[23]

Accelerated Weathering

Scanning electron micrographs illustrate the condition of the white pine panels brushed with xylene- and water-borne alkyds after 267 hours of exposure (*Figures* 3 and 4, respectively). The xylene alkyd panel has developed many checks and some cracks exposing much of the wood beneath the surface to UV light and water. This panel has deeper, wider, and longer checks compared to the water alkyd panel, where checks occur less frequently. After 555 hours, both panels exhibit more severe checking, but the xylene alkyd panel (*Figure* 5) has reached a second stage of degradation, namely cross-grain checking of cell walls. Large sections of wood and coating have cracks, and ray cells beneath the wood surface have begun to degrade. Initial stages of this cross-grain checking are evident in the water-borne alkyd panel (*Figure* 6).

The temporary improvement in weathering resistance of the water-borne alkyd panels over the xylene-borne panels appears to be compatible with the results of the bulking study. Initially the coating film offered some barrier to the removal of cosolvent from cell walls. As more cracks formed, the leaching effect of the water spray became more pronounced. Greater stresses were incurred by the wood/coating system as larger dimensional changes occurred during spray-dry cycling. After 555 hours the advantage of the water-borne alkyd had been essentially lost.

There is, of course, a difference between brush-coated panels and impregnated wafers. The diffusion of alkyd resin into the cell wall should occur quite slowly, as judged by the long treatment times required even for thin wood sections to reach equilibrium with PEG treatment.[22] These long treatment times are not even approached during the wet phase of a brush-coating process. It should be noted, however, that only moderate amounts of PEG (less than 7 wt%) can reduce checking[24] so that a limited treatment may be effective under certain circumstances.

SUMMARY

This study of a water-borne and a xylene-borne alkyd with small wafers of Eastern white pine has demonstrated that the latter did not cause bulking of the wafers while with the water-borne alkyd a very small amount of permanent bulking agent remained inside the cell walls resulting in 0.5% increase in wafer size.

When both resins were brushed on panels and artificially weathered, the water-borne coating improved the surface checking resistance of the wood. Scanning electron micrographs revealed that the checks were shallower, narrower, and shorter after 267 hours of weathering. After 555 hours, however, the differences between them were less apparent as both panels showed evidence of cross-grain checking.

The results indicate that organic cosolvents in a water-borne resin can remain in the wood causing the wood to remain partially, but only temporarily, swollen.

Methods of measuring the amount of bulking include that portion caused by the cosolvent, which was found to be the principal swelling agent; that is, it remained in the wood upon drying. Water must be present for the cosolvent used in this study to enter the fine capillaries within cell walls, but when it enters it can remain even upon force-drying at elevated temperatures. However, when the dried coating is subjected to liquid water, cosolvent is easily removed. Then, the wafers shrink leaving only a limited bulking above original wafer size.

Partial bulking of wood cell walls appears to improve wood/coating performance in accelerated weathering tests. However, evaluation of water-borne coatings containing cosolvents must include water-leaching tests to determine if cosolvent has only swollen the wood, thus providing only a temporary improvement in performance.

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Water-Borne Corrosion Inhibitive Primers Evolve to Be Competitive

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In previous reports, corrosion inhibitive primers were seldom found to perform as well as solvent-borne systems. In this report, two water-borne primers, a latex-based system with an inorganic corrosion inhibitive pigment and a water-borne alkyd pigmented with a corrosion inhibitive non-toxic complex inorganic oxide, were chosen for further study. In outdoor exposures, even in extremely corrosive conditions, the experimental water-borne primers performed at least as well as a red lead solvent-based standard primer. The efficacy of surface preparation by sandblasting, so often shown by the Steel Structures Painting Council, was confirmed in comparison to wire brushing or solvent washing. Two aluminum pigment-based topcoats were also beneficial in outdoor exposures. The correlation between the outdoor exposures and the popular laboratory exposures test systems was poor at best.

INTRODUCTION

In recent years, the main objective in development of the water-borne protective coating systems has been to replace the solvents so long suspected as contributors to the air pollution problems in areas subject to photochemical smog. Alternative reasons for replacing solvents with water are the cost of the petroleum-based solvents, especially in times of oil shortages, and the potential toxicity of the solvents manufacturers and consumers of coatings. The lore of corrosion inhibitive coatings has been that water-borne systems never have quite measured up to the protective performance shown by solvent-based systems. Typical reports from the Steel Structures Painting Council,[1] and the Northwestern Society for Coating Technology[2] bear this lore out.

The work has another driving force, in that lead and chromate pigments are suspected toxic agents. Threshold Limit Values (TLV) have been recommended[3] and lead standards have been established by OSHA.[4] One concern is that the workers handling such pigments in their manufacture or in the manufacture of paint will experience toxic effects. Another concern is that the workers sand blasting or wire brushing old painted surfaces will unknowingly be exposed to the lead or chromate hazard. Although they create formulation problems, many alternatives for lead and chromates have been offered as corrosion inhibiting substitutes.[5]

However, there was always hope that water-based systems were improving. Warness[6] showed the progress made in water-borne coatings following promulgation of California legislation and regulations aimed at reducing VOC emissions. The Golden Gate Society raised the level of expectation when some of the water-borne variations were shown to approach the corrosion protection levels seen with a red lead control during its study.[7] Boxall[8] reviewed several details in the formulation of corrosion inhibitive water-borne systems, and Heitkamp[9] makes the point that corrosion protection can be equivalent for solvent-borne or water-borne formulations using identical alkyds, provided the formulations are well thought out. His commentary included the observation that the previously reported non-equivalence was on the basis that about twice the film thickness was required for the water-bornes to match the performance of the solvent-borne systems.

This work is a continuation of the aforementioned Golden Gate Society work,[7] in which the most promising

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water-borne systems were selected with supplier recommended improvements on the formulations. The Technical Committee prepared test panels according to an experimental scheme with variation of the following:

(1) the coatings (two experimental and two controls);

(2) the surface preparations on the steel panels (sandblast, wire brush, or solvent wash);

(3) topcoats (none or one of two aluminum pigmented systems); and,

(4) exposures (three outdoor sites and three laboratory exposure systems).

One set of coated panels compared air-dry or oven-dry for any differences that may have occurred in their laboratory exposures.

PROCEDURE

The control coatings were standard formulations often purchased by the U.S. Government for corrosion protection—a red lead alkyd in Rule 66 solvents[10] and a zinc chromate alkyd in xylene.[11] The red lead alkyd primer was the better of the two controls evaluated in the preceding work.

Table 1—Formulation of Water-Borne Alkyd Primer "XP"

Component	Pounds	Gallons
Water	130.0	15.61
Triethylamine	5.0	0.83
Kelsol 3902[i]	80.0	9.14
Titanium Dioxide R-902[a]	70.0	2.05
Raven Black 1020[b]	2.0	0.14
Barytes W-1430-F[c]	100.0	2.72
Halox SW-1111[d]	40.0	1.68
Talc 399[e]	80.0	3.56
Foamkill 639Q[f]	1.0	0.14
Propasol "P"[g]	15.0	2.04
Ben-A-Gel EW (4% in Water)[h]	20.0	2.34
Potassium Tripolyphosphate	1.0	0.05
Pebble Mill Grind to 6 Hegman		
Kelsol 3902	190.0	21.71
Aroplaz 1271[i]	20.0	2.40
Ammonium Hydroxide	8.0	1.07
Propasol "P"	6.0	.82
Cobalt Hydrocure[j]	2.0	.26
Manganese Hydrocure[j]	2.0	.26
Activ-8[k]	1.0	.13
Exkin #2[l]	0.5	.07
Water	290.0	34.81
	1063.5	101.83
Pounds/Gallon		10.44
Pigment/Binder		1.31
Percent Solids (weight)		48.4
Percent Solids (volume)		33.3
pH		7.8–8.2
Viscosity K. U.		75–80
Grams/liter VOC		233

(a) DuPont Co.
(b) Cities Services
(c) Pfizer Corp.
(d) Hammond Lead Products Div.
(e) Whittaker, Clark and Daniels, Inc.
(f) Crucible Chemical Co.
(g) Union Carbide Corp.
(h) NL Industries, Inc.
(i) Spencer Kellogg Div.
(j) Mooney Chemical Co.
(k) R. T. Vanderbilt, Inc.
(l) Tenneco Chemical, Inc.

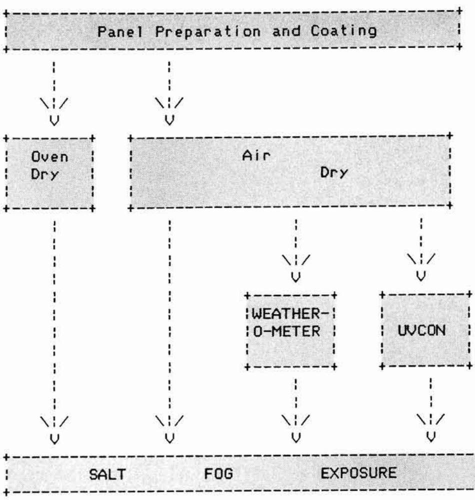

Figure 1—Laboratory exposure scheme

The experimental systems, selected from among the best of those evaluated in the previous report,[7] were formulated as shown in *Table* 1 for the water-borne alkyd "gray primer" designated as XP, or as shown in *Table* 2 for the latex-based primer designated as YP. The topcoats were a leafing aluminum pigmented latex system[12] or a similar non-leafing formulation.[13]

The panels were hot rolled steel. Surface preparations were by sandblasting (Steel Structures Painting Council 10 standard), wire brushing, or solvent washing (mineral spirits). The primer coatings were applied by wire wound rods to assure consistency of thickness on the whole panel and among the panels. Topcoats were applied to only the lower two thirds of the panel, so that one panel had segments that were coated with: (1) primer only; (2) primer and one topcoat (non-leafing); and, (3) primer and both topcoats (leafing last). Topcoats were applied by wire wound rod, as well.

Exposures were outdoors at three facilities and in two laboratories using three different devices. The outdoor exposures were at:

(1) Muir Beach, westward exposure to the Pacific Ocean over rocky cliffs generating substantial spray (two years);

(2) Golden Gate Bridge, westward exposure to the Pacific Ocean with an unusually high propensity for fog conditions (three years); and,

(3) Sacramento CALTRANS rooftop exposure, with higher and lower ambient temperatures recorded and less moisture than the other two facilities (three years).

The two former facilities are aggressively corrosive, with a measurement of 10.2 mils per year at Muir Beach reported in the previous work by this group. The laboratory exposures were done in:

(1) Weather-O-Meter® (two labs)[14]; and,

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Robert Athey, Spokesman	Athey Technologies
Robert Duncan	Glidden Coatings & Resins
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Patricia Tostenson	Pacific Anchor Chemical Co.
Ray Warness	California State Division of Highways

(2) UVCON® (1 lab)[15]; prior to

(3) Salt Fog Cabinet (two labs)[16] along with oven- and air-dried panels with no UV exposures.

Figure 1 shows the exposure flow sheet for the entire lab study. Corrosion assessments used by all participants in lab or field were by the standard rusting ratings,[17] blister ratings,[18] and scribe undercut.[19]

The panels were coded with an identifier consisting of four letters and a number. The four letters designated the panel set, the first two letters being the coating used, and the last two letters denoting the surface preparation. The numbers identified the panel within the set. This nomenclature is used in the exposure tabulations and the text for panel identification.

DISCUSSION OF RESULTS

Outdoor Exposures

MUIR BEACH: The exposures had extensive data recorded. Pacific Gas & Electric (PG & E) workers recorded observations on general appearance, gloss, chalking, erosion, checking, cracking, flaking, peeling, dirt, mildew, fading, darkening, and yellowing. Reported here are their corrosion protection assessments, rusting, and undercutting at the vertical scribe through all three segments of the coating. Note that space was available for only one of the experimental coatings, so the water-borne alkyd system, designated XP, was the only experimental coating evaluated at Muir Beach.

The evaluations of scribe undercutting by rust are shown in *Table* 3. Our interpretations, based on mostly marginal differences, are:

The water-borne alkyd primer (XP) is at least equivalent to the red lead primer (RL) in all cases, and may be better than the zinc chromate primer (ZP); and,

There are distinctive differences between the surface preparations with sandblasting (SB) far outperforming the wire brush (WB) or solvent wash (SW) preparations.

Film thickness measurements showed the XP water-borne primer (mean thickness ± one Standard Deviation = 3.2±0.5) probably comparable to the RL red lead solvent-borne primer (thickness = 3.2±0.3), but likely to be substantially thicker than the ZP zinc chromate solvent-borne coating (thickness = 2.4±0.2). Hence, at equivalent thickness, the ZP control may perform as well in rusting at the scribe as the experimental XP water-borne system.

The PG & E rusting evaluations, sometimes done with Society personnel present, are shown in *Table* 4. The differences in protection levels among the coating formulation variations are so marginal as to be insignificant. The differences among the surface preparations

Table 2—Formulation of Latex Maintenance Primer "YP"

Material	Pounds	Gallons
Water	80.0	9.60
QR-681 Dispersant[a]	22.0	2.40
Igepal CTA-639[b]	2.0	0.23
Nopco NDW[c]	1.6	0.20
Ethylene glycol[d]	26.0	2.70
28% Ammonium Hydroxide	2.7	0.3
Mix at Low Speed		
Nalzin SC-1[e]	100.0	2.96
Titanox 2101[e]	150.0	4.39
Water Ground Mica[f]	40.0	1.71
Kadox 515[g]	11.0	0.23
Grind at high speed to 4 North Shore Let down at low speed		
Rhoplex MV-23[a]	507.0	57.16
Foamaster VL[c]	4.0	0.53
Premix before adding		
Aroplaz 1271[h]	30.0	3.58
Igepal CTA-639	1.5	0.17
6% Zr Nuxtra[i]	1.6	0.22
6% Co Nuxtra	1.4	0.18
Then add		
Ethylene Glycol	14.0	1.45
Texanol[d]	6.0	0.76
Skane M-8[a]	2.0	0.23
28% Ammonium Hydroxide	3.0	0.41
Water	72.7	8.72
Then add at low speed		
Rheolate 1[c]	16.0	1.79
Total	1094.5	99.99

Pounds per gallon	10.95	
% Non-volatile (wt)		46.6
% Non-volatile (vol)		38.0
Percent PVC		24.4
Viscosity, K.U.	24 hrs	72
	3 mos	78
pH		9.2–9.6
Sag resistance, mils		12
Application		Spray, brush, roll
Freeze/thaw stability		Pass, 5 cycles
Heat stability		Pass, 140°F/10 days
Roller stability		Pass, 10 days

(a) Rohm and Haas Co.
(b) GAF Corporation
(c) Diamond Shamrock Corp.
(d) Eastman Chemical Co.
(e) National Lead (NL Industries)
(f) English Mica Co.
(g) NJ Zinc Co.
(h) Spencer Kellogg Div.
(i) Nuodex, Inc.

Table 3—Undercutting by Rust on Outdoor Exposure Panels at Muir Beach

Test Panel	Number of Coat	Depth of Coat mils	Time to Undercut Rating,[a] in months				
			6	10	13	17	20
XPSB1	1	3.2	2.5	2.5	2.5	5	10
	2	0.9	2.5	2.5	2.5	5	10
	3	1.2	slight	slight	slight	slight	5
XPSB6	1	3.2	2.5	2.5	2.5	5	10
	2	0.6	2.5	2.5	2.5	5	10
	3	0.6	2.5	2.5	2.5	5	5
RLSB3	1	3.5	slight	slight	slight	slight	slight
	2	1.0	slight	slight	slight	slight	slight
	3	1.5	slight	slight	slight	slight	slight
RLSB5	1	3.5	slight	slight	slight	slight	10
	2	1.0	slight	slight	slight	slight	slight
	3	1.0	slight	slight	slight	slight	slight
ZPSB1	1	2.4	slight	slight	slight	5	10
	2	0.7	slight	slight	slight	5	10
	3	1.0	slight	slight	slight	slight	5
ZPSB7	1	2.6	slight	slight	5	5	10
	2	0.5	slight	slight	slight	slight	5
	3	0.6	slight	slight	slight	slight	slight
XPWB5	1	2.6	10	10	10	10	20
	2	0.6	10	10	10	10	20
	3	0.8	10	10	10	10	20
XPWB4	1	2.6	5	10	10	20	20
	2	0.7	5	10	10	20	20
	3	1.1	5	10	10	20	20
RLWB7	1	3.1	5	10	10	10	20
	2	0.8	5	10	5	10	20
	3	0.8			5	10	20
RLWB3	1	2.8	10	10	20	20	40
	2	2.1	5	10	20	20	40
	3	1.6			10	20	40
ZPWB2	1	2.5	20	20	30	30	30
	2	0.6				10	10
	3	1.0				10	10
ZPWB4	1	2.2	20	30	30	40	40
	2	0.8					60
	3	1.0					60
XPSW3	1	3.5	10	10	10	20	40
	2	0.8				20	40
	3	1.2				20	40
XPSW4	1	4.0	10	10	10	10	20
	2	0.6					8
	3	0.5					8
RLSW4	1	3.0	5	10	20	20	40
	2	1.5	5	10	10	20	30
	3	1.5	5	10	10	20	30
RLSW2	1	3.0	10	20	20	40	60
	2	2.0	10	20	20	40	60
	3	1.5	10	20	20	40	60
ZPSW2	1	2.3	20	20	40	40	60
	2	0.6	10	20	20	20	20
	3	1.1			20	20	20
ZPSW3	1	2.6	20	20	40	40	60
	2	1.0	10	20	20	20	20
	3	0.8	10	20	20	20	20

(a) Undercut at scribe in mm.

Table 4—Rust Ratings on Outdoor Exposure Panels at Muir Beach

Test Panel	Time to Rust Rating, in months				
	6	10	13	17	24
XPSB1	9	—	10	9	10
XPSB6	9	—	9	9	10
RLSB5	9	—	10	10	10
RLSB3	9	—	10	10	10
ZPSB1	9	—	10	10	9
ZPSB7	9	—	10	10	10
XPWB5	9	—	9	9	9
XPWB4	9	—	9	9	9
RLWB7	9	—	9	9	9
RLWB3	9	9	9	9	8.5
ZPWB2	9	—	9	9	9
ZPWB4	9	—	9	9	8
XPSW3	9	—	10	10	9.5
XPSW4	8.5	—	10	10	10
RLSW4	9	9.5	9	8	8
RLSW2	9	9	9	9	8
ZPSW2	9	—	9	9	9
ZPSW3	9	—	9	9	8

may not be as unimportant in the long run, as the effects may take longer than two years to show up. Although it was expected, it appears that sandblasting is the best preparation.

SACRAMENTO: The rusting evaluations from the Sacramento exposure are essentially meaningless, as all the panels are still at a 10 rust rating with insignificant scribe undercut after three years. A more aggressive exposure environment would be required to show a difference. This

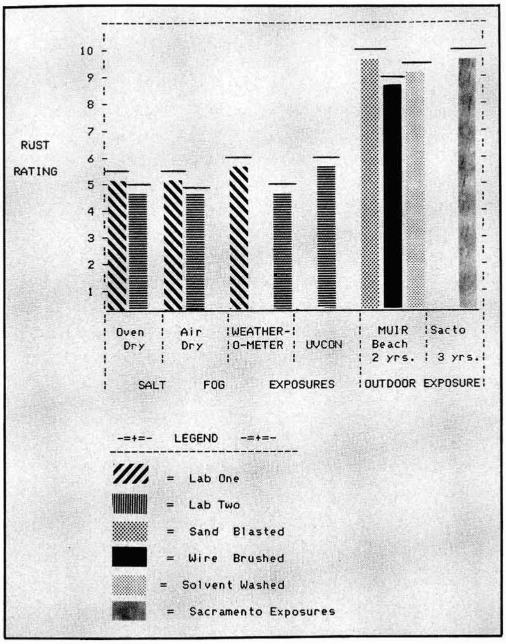

Figure 2—Rust ratings on primer X exposures

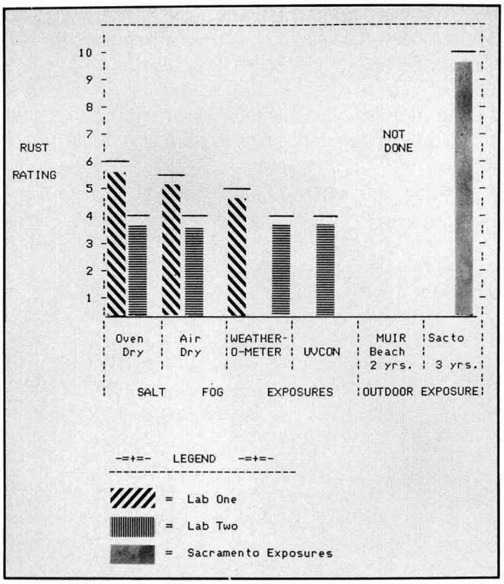

Figure 3—Rust ratings on primer Y exposures

suggests the water-borne systems may be (and indeed are) recommended for central valley coatings in California.[7]

Examination of the steel panels, after stripping off the coatings, showed that the undercut by rust at the scribe was substantially greater on the red lead pigmented controls, while the experimental XP and YP coating formulations were essentially completely protected. Indeed, one scribe mark showed half its length with clean shiny metal having no rusting.

GOLDEN GATE BRIDGE: Examinations of the panels were done at 9, 18, and 36 months. *Table* 5 contains the evaluations at 18 months. The space available was again limited, and only the water-borne alkyd XP primer was exposed with the two controls. We noted that the scribe undercut was most drastic for the red lead pigmented control, with the experimental and chromate pigmented coatings essentially equivalent and both better than the red lead control. Sandblasting was again the preferred surface preparation. Examination of the stripped panels after three years' exposure confirmed the undercut advantages of the XP experimental coating, as compared with the solvent-based red lead control.

The blister ratings appear almost equivalent throughout the study. Noted was the apparent increased blistering for the sandblasted experimental system with no topcoat, but that was not confirmed in the solvent washed or wire brushed experimental panels with no topcoat.

Laboratory Exposures

The laboratory exposures are apparently more aggressive than Muir Beach or the Golden Gate Bridge exposures. The intent of the complex laboratory system of exposures was to answer whether the thermal, UV, or UV/condensation attacks were the culprit in the degradation of outdoor exposures. Thus, comparison was made among the salt fog exposure ratings for the air dried coating against the coatings which were oven dried, UV exposed, or combined UV/condensation exposure. The exposures of the XP water-borne alkyd experimental coating are rated for rusting in salt fog, and the outdoor exposures in *Figure* 2. The same rust rating assessments for the YP water-borne acrylic experimental coating are shown in *Figure* 3. In both cases, the rusting was more severe in the laboratory environments than in outdoor

Table 5—Ratings for Outdoor Exposure Panels at Golden Gate Bridge

Test Panel	Number of Coat	General Comments	Blister Rating	Creep at Scribe, in mm
XPSB2	1		6 VF	7.5
	2		8 VF	5
	3		8 VF	5
XPSB5	1		6 VF	5
	2		8 VF	5
	3		8 VF	5
RLSB1	1		8	12.5
	2		8	9
	3		8	8
RLSB4	1		8	10
	2		8	7.5
	3		8	5
ZPSB2	1		NONE	7.5
	2		8 VF	2.5
	3		8 VF	2.5
ZPSB5	1		NONE	NONE
	2		8 VF	5
	3		8 VF	2.5
XPWB7	1		8 VF	15
	2		8 VF	14
	3		8 VF	7.5
XPWB6	1		8 VF	14
	2		8 VF	9
	3		8 VF	7.5
RLWB4	1		8 VF	25
	2		8 VF	17.5
	3		8 VF	19
RLWB1	1		8 VF	22.5
	2		8 VF	15
	3		8 VF	9
ZPWB3	1		8 VF	12.5
	2		8 VF	7.5
	3		8 VF	7.5
ZPWB6	1		8 VF	12.5
	2		8 VF	12.5
	3		8 VF	5
XPSW2	1		8 VF	10
	2		8 VF	6.5
	3		8 VF	5
XPSW7	1		6 VF	8.5
	2		8 VF	7.5
	3		8 VF	3.5
RLSW1	1	Film Crumbling at Scribe	8 VF	20
	2		8 VF	14
	3		8 VF	17.5
RLSW7	1		8 VF	20
	2		8 VF	18
	3		8 VF	18
ZPSW4	1		8 VF	10
	2		8 VF	7.5
	3		8 VF	10
ZPSW5	1		8 VF	10
	2		8 VF	10
	3		8 VF	5

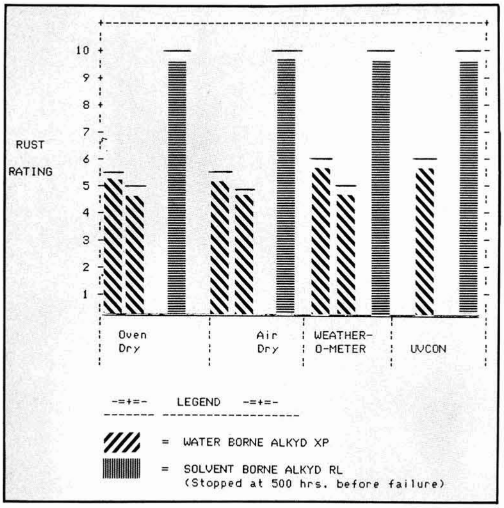

Figure 4—Rust ratings on primer XP and RL salt fog exposures

exposures. These results do not resolve the question originally posed.

The variation from one salt fog cabinet to another was also rather severe. This was observed in the past (Figure 2 in Reference 8). *Figures* 2 and 3 show the data from two of the three laboratories.

Comparison of the RL red lead control panel exposures in the laboratory to the same exposures for the XP alkyd primer shows a substantial difference not seen in the aggressive outdoor environments. *Figure* 4 shows the rust ratings for the experimental sets of panels in all environmental configurations. These are the ratings at 500 hours for the RL control coating and at failure for the XP experimental coating. An alternative assessment of the difference is the time to failure as measured in one of the participating labs, which is shown in *Figure* 5. Here the drastic difference in either method of comparison is seen, whereas in the field no such differences were noticed, and indeed, the experimental coating was performing better than the red lead control. Hare[20] noted reasons why this may happen in salt fog chamber test systems. Funke,[21] in his critique of salt fog testing, raises the question of osmotic pressure driving permeability of coatings by corroding species.

Perhaps the accelerated laboratory exposures are useful only as an internal guide to the relative ranking of a series of coatings, although these data may be used to question even that hypothesis. Interestingly, there was more variation in reported results from laboratory to laboratory than there was from coating to coating or from exposure method to exposure method. Perhaps these interlaboratory variations are too small to be meaningful, compared to the drastic (and unexpected) large differences shown from laboratory to outdoor exposures.

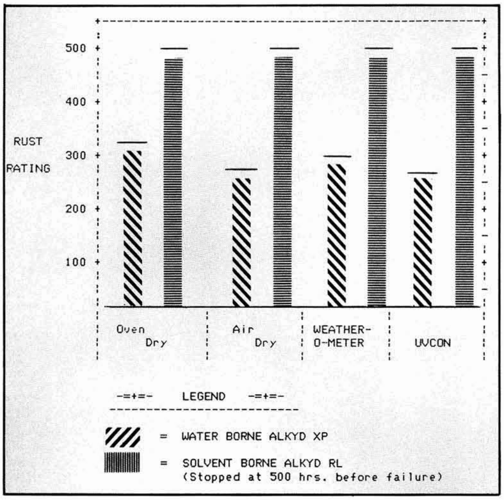

Figure 5—Time to fail on primer XP and RL salt fog exposures

CONCLUSION

The results of three years of testing rather clearly show the equivalence of water-borne corrosion inhibitive primers to the more mature solvent-borne systems. The evolution of the low VOC, non-toxic, pigmented systems for corrosion protection coatings arrives at viability just when needed. This study shows the efficacy of protection levels of water-borne coatings in outdoor weathering in aggressively corrosive exposure environments.

Other findings in this work include:

(1) The Steel Structures Painting Council preference for sandblasting as surface preparation over wire brushing or solvent washing was confirmed;

(2) The hypothesized laboratory exposure schedules to identify the origin of coating degradation (in salt fog cabinets) by preliminary thermal, UV, or UV/condensation combination treatments was unsuccessful, as the coatings essentially behaved the same;

(3) The laboratory exposure systems are apparently more corrosive to the water-borne coatings than the aggressive outdoor exposures chosen herein; and,

(4) The aluminum pigmented topcoats did ameliorate the corrosive attack on steel.

The Golden Gate Society feels this work, covering almost 10 years, is now complete.

ACKNOWLEDGMENT

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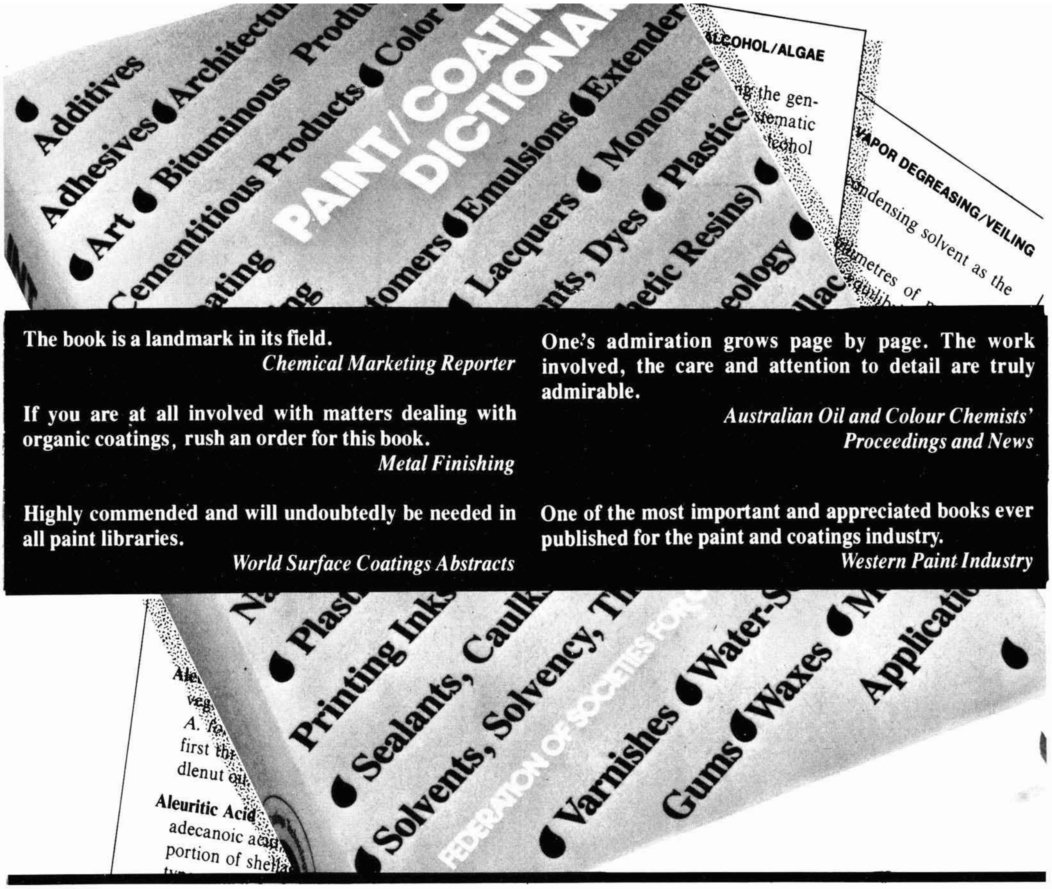

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OPEN FORUM

Barriers to Innovation In the Organic Coatings Industry

Milton A. Glaser
Consultant*

The organic coatings industry must organize to innovate more effectively during the next decade in order to prosper or perhaps even to survive as a discrete industry. Studies have identified both organizational and personal barriers to this objective. Such barriers may be imposed by internal or external factors. A list of these barriers is presented. Typical case histories are reported. A method for monitoring the progress of R&D projects is suggested. In addition to more and better technological innovations, better overall management practices are needed to optimize R&D effectiveness.

Introduction

It is a fact that all industries are confronted with barriers to innovation. These barriers are surprisingly similar in most cases. There are variations in the importance of any of these barriers between countries and even sections of the same country because of industrial, cultural, and historical factors. The barriers discussed here are those believed to exist in the United States of America, but many of them may be found elsewhere as well.

Having thought about and studied R&D/Innovation for many years, I still wonder why innovation regularly occurs in some laboratories and consistently fails to evidence itself in other laboratories. Is it because of rigid budgeting constraints? Is it technology policy as articulated by top management? Could it be the quality and experience of the chemists and R&D managers involved? The degree of communications within the company? An unrealistic and stifling "organization chart" structure? Is lack of challenge an important negative factor? Lack of satisfying recognition and reward? Even if one may be searching for them, it will often be difficult to detect barriers to innovation in one's *own* organization. Things are too personal, too imminent, too subjective. Some answers to the questions posed are available from studies which have been made and which are even now objects of intense research. It is information from these studies which we plan to discuss in this report.

Stultifying barriers to innovation can be organizational, personal, or a combination of the two. These barriers are sometimes imposed from above, as in autocratic organizations, and they can be passively accepted by those people lower in the hierarchal ladder, e.g., by chemists, engineers, and other technologists. But it should be stressed that not all product or process innovations in industry are conceived by R&D or Engineering. Many potentially innovative ideas come from marketing, sales, production, technical service, et al. At times, outside ideas have been suppressed by autocratic R&D managers before work on them was even started. And many potentially innovative concepts by technical or scientific personnel are either denigrated or aborted because of managerial myopia. Hill[1] expresses the startling opinion that "the greatest barrier to R&D Innovation is the research director himself."

Objectives

First, let me cite my opinion that what we *do* know about managing research, barriers, etc. may be only a painfully small part of what we do *not* know. Also, let me confess here that I share the tendency of writers in many fields of endeavor to draw "universal truths" from their own experiences. So, please forgive me if you do not agree with some of my findings and conclusions—perhaps your own insights and knowledge in certain situations are to be preferred. With this caveat, I propose to discuss the selected list of barriers, basing my comments on both the literature and on my own findings.

After consolidating these sources, *Table* 1 presents the list of barriers which I currently consider the *major* obstacles to innovation in important R&D projects.

We ourselves may be able to remove or alleviate many of these barriers if we

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would only stop, recognize them in our particular situation, think seriously about them, and then take the logical steps indicated. Many managers have confronted similar problems before, have solved the barriers involved and have recorded their experiences in the literature for the benefit of others. In some cases, the success or failure in removing "barriers" may determine whether or not a research organization or even a whole company survives or perishes. It should be stated here that there are undoubtedly other identifiable barriers. In this paper, however, we shall limit ourselves to a discussion of this widely applicable list.

There will be no attempt to draw a rigorous definition of the word "innovation." Suffice it to say that we all have our own ideas as to the meaning of "innovation" and that the word generally refers to the taking of concepts and technologies—new *or* old—and combining them to fulfill a need, either economic, technological, or social.

Barriers to Innovation

CHAMPION: A "champion" has been described as a senior executive or manager who is deeply and actively dedicated to the support and successful completion of a specific project.[2] He has usually played a dominant role in obtaining "top management" approval of the major project in the first place. Sometimes a member of "top management" may even function as a champion, but "top management" involvement is usually too diffused for the champion function. A champion will encourage when things are going poorly, will criticize constructively when he believes that one of the sectors involved is not performing properly, and will successfully attempt to obtain additional resources when required. Above all, a champion will exude quiet confidence in the ultimate success of the project. He will calm the irritated ones, try to reconcile the differing views of the participants. He will always be available to listen, to sympathize, to "pitch in" with high-level criticism or encouragement. A champion will try to understand the bewilderment and will try to alleviate the hopelessness which often intrudes into a difficult R&D project. A champion will be able to change hopelessness to optimism. This optimism must be supported by the willingness of all involved, including the champion, to work hard, to think hard, and to envelop one's self in the problems. In my experience, few important projects calling for technological innovation succeed without a champion.

Table 1—Barriers to Innovation

(1) Absence of an effective "champion"
(2) Absence of competent R&D supervisors (technically, managerially)
(3) Absence of suitable "atmosphere" or environment for R&D
(4) Excessive number of R&D projects
(5) Excessive "paper work"
(6) Frequently changing R&D priorities
(7) Geographical separations
(8) Hierarchal imbalances
(9) Inadequate communications
(10) Inadequate monitoring of projects underway
(11) Inadequate identification of technical opportunities
(12) Inadequate initial product specifications
(13) Inadequate recognition and reward policies
(14) Inadequate Technical-Customer Interface
(15) Inadequate Technical-Marketing Interface
(16) Inadequate Technical-Production Interface
(17) Insufficient resources for exploratory research
(18) Low interpersonal competence of R&D personnel
(19) Over-involvement of R&D in sales and manufacturing problems
(20) Perceived lack of support by "Top Management"

Floyd, et al.[3] in discussing operating factors affecting innovation, believes that the perceived priority of the (R&D) program to members of the research team is "greatly enhanced by the mere presence of high level management...." One of his conclusions is that "success appears to stem from attention by high level management" to the managerial factors involved.

R&D SUPERVISORS: Supervisors of innovative R&D projects/programs must be both technically and managerially competent. R&D managers must have the technological respect of the people under their direction. Managers must have the requisite knowledge so they can understand and, when necessary, challenge the scientific and technical approaches of their subordinate colleagues. They must possess the ability to skillfully re-direct R&D programs where necessary. Many R&D managers who possess most of the required technical attributes are not, unfortunately, competent managers in the non-technological areas. Kegan[4] has found that many individuals are often inhibited by their own defensive mechanisms and by the social situations in which they live. Kegan also found that some laboratories were indeed training *out* many of the creative qualities they said they wanted in research people. The work assigned and monitored by the R&D supervisors was neither intrinsically nor psychologically satisfying. These findings obviously apply to both R&D managers and technologists. Many creative technologists make poor R&D supervisors.

ENVIRONMENT: The proper "atmosphere" for research and development, although an intangible, has been much discussed in the literature.[5,6] A constructive and supportive environment should be present in all departments of a company and must diffuse to the various company sectors from the very top executives. What is needed is a reasonably relaxed atmosphere where there is a proper appreciation of human values, the dignity of the individual, of company objectives, and of the role to be played by all members of the organization. The environment should be suffused by a spirit which sympathetically understands and even sanctions occasional "unauthorized" projects which by-pass normal business channels.[3] The late Leo Szilard, a famous atomic scientist, noted it so clearly when he said that he could tell when things were *not* going well in a research laboratory. He could not *say* what made a good or a great laboratory; he only knew that there was a sense of wholeness and a certain quality of magic." The atmosphere to which I refer will radiate this magic and this wholeness.

TOO MANY PROJECTS: What R&D manager has not been plagued with the imposition of "too many projects?" While being involved in a diversity[7,8] of projects has proven to be a positive thing in encouraging creativity and innovation, being burdened with far more work than a given R&D organization can handle can be not only disheartening to the people involved, but destructive to the innovative productivity which a company needs and has a right to expect from its scientists and engineers. It might be worthwhile to cite a case history in my experience to demonstrate this point.[9]

The laboratory in this instance was losing the confidence of its management because of R&D's failure to make significant progress on its two major projects. The R&D group seemed to be well qualified by education and experience. The people involved were alert and eager to produce positive results on these major projects. Why was no significant progress being made on these two vital research projects? It seems that, in common with most laboratories, this R&D facility also had many "small projects" in addition to the two difficult, major projects. In fact, the laboratory people were very good at producing the satisfactory prototypes required by these smaller projects. As a result, more and more of this type of work was sent to the laboratory.

Sales/marketing pressures for the rapid completion of these minor projects were constant and intense. Consequently, the two long-term, major projects received little attention and the marketing people were understandably unhappy.

After a study, it was pointed out that the laboratory section involved had been assigned two or three times as many projects as it could fairly be expected to handle in a professional manner. Because it was not their nature to do so, the well-meaning laboratory people found it impossible to tell their superiors about their excessive work load and the R&D managers involved appeared to be paralyzed by the situation. It was pointed out that the project selection responsibilities should be on the shoulders of the marketing and sales managers concerning their relative strategic importance and on the shoulders of the technical managers for technical feasibility critiques and "work load" judgements. When eventually implemented, this double screening took relatively little time and resulted in a sharply reduced number of total projects. Soon, there was encouraging progress on the two major projects. Marketing management had wisely decided that the successful completion of even *one* of the two major projects would be more important to the future profitable growth of the company than the successful completion of several dozen of the smaller projects. The possibility of establishing a special group to take care of the smaller projects exclusively was also being explored.

TOO MUCH PAPER WORK: One of the deadliest barriers confronting R&D departments is the excessive amount of "paper work" required of many laboratories and R&D managers. As Boyd[10] and others have pointed out, paper work, which is a part of tight "management controlled R&D," demands much time and energy which could be channeled into more creative activities. In addition to weekly, monthly, quarterly, and annual reports, there are project justification reports, progress reports, meeting reports, meeting preparation work, etc., etc., almost ad infinitum. In an actual instance where the writer was involved as a consultant, it was found that the top R&D managers and technologists were spending as much as one-third of their time writing reports, handling a voluminous amount of internal correspondence and doing other menial paper work which should have been done by less costly non-technical personnel. I am happy to report that, when this waste of scientific resources was pointed out to the vice-president for R&D, he made prompt and radical changes in his company's procedures. Studies have shown that, unless the reasons for all reports, "paper work," etc. are scrutinized and re-assessed regularly, their volume will continue to grow steadily. Fundamentally, laboratory people should be doing research and development work, *not* paper work. I have a sad and puzzling observation to share with you here. Some chemists seem to *prefer* writing long, detailed reports to doing R&D! It has been observed that the quality and quantity of a technologist's R&D work are frequently inversely proportional to the length of their reports!

> ***"One of the deadliest barriers confronting R&D departments is the excessive amount of paper work required . . ."***

CHANGING PRIORITIES: In many laboratories, especially those of small or medium-sized companies, it has been observed that priority ratings of projects change with dismaying frequency. These changes can only have negative results on R&D effectiveness and productivity. Frequently, changing R&D project priorities are more likely to occur when the laboratories are controlled or dominated by other departments (sales, production, purchasing, etc.) and/or when the laboratory executive lacks the experience, the personality, the seniority, or the power to firmly resist such changes or to cease making such changes himself.

GEOGRAPHICAL SEPARATIONS: Morton[11] reported that physical separation and/or segregation of different organizational groupings are guaranteed to create serious barriers to good communications and thus to the innovation process. Allen[12] has documented the extent to which distance between technical people affects the communications between them. Studies by Rubenstein[13] and others[14] on the roles of "gatekeepers" in organizations demonstrate that the manner in which technical information is communicated is rarely through formal channels like data banks, literature, information retreival systems, and the like, but rather by people-to-people communications. "Gatekeepers" are those unusual people who read widely, go to technical meetings and who, when asked for technical information or orientation by their colleagues, are likely to furnish a helpful quantity of relevant information. In addition to the technical gatekeepers, there are also marketing and manufacturing gatekeepers whose inputs are vital for good overall communications and innovation. R&D productivity becomes much more difficult and time-consuming in the absence of physical nearness and close communications with/by the company sectors involved.

HIERARCHAL IMBALANCES: When the head of production or marketing is a company vice-president while the laboratory head bears a title like project leader or even "technical director," difficult and non-productive situations are likely to occur. A dynamic and successful sales/marketing official may not even wish to hear what the technical director has to say about a problem, what direction he thinks the development work should take, problems in priority, etc. I have heard of sales/marketing executives telling senior laboratory personnel things like, "I don't have time to listen to your ideas on this matter. Just do as I say, do it quickly, and all will be well." We can imagine the reactions of the technologist involved—despair, discouragement, fear, hostility—directed to the executive involved, the company, and even to his R&D project. For best communications and effectiveness, dialogues between R&D and other company departments should be on approximately the same hierarchal level when at all possible. An introvert chemist should not be required to confront an extrovert sales manager when difficult decisions or unpleasant revelations are to be made. In introvert/extrovert meetings like this, the technical person involved should be accompanied by or represented by a laboratory executive with a position comparable to that of the sales/marketing executive representing his department.

INADEQUATE COMMUNICATIONS: So much has been written (see References)

Table 2—The "Glaser Innovation Index" Model

(Major Significant Factors for Technological Innovation)

	Weighting	FFF[b]	Actual Score
(1) Effectiveness of Communications (TM^{10}, TC^5, TT^5, TP^5, TTM^5)	30	21	
(2) Scientific & Technological Competence	20	14	
(3) Effectiveness of a "Champion"	15	10.5	
(4) Market Opportunities	15	10.5	
(5) Technical Opportunities	10	—	
(6) Competitive Factors	5	—	
(7) Timing	5	—	
Innovation Potential	100		GII[a]

(a) The "critical index." A GII score of 75 is usually the minimum score required for a good chance of success
(b) Fatal Flaw Factor—score below which project is probably doomed

about this critical factor and the closely related "NIH" syndrome (Not Invented Here) that I shall not belabor this barrier here. The next section will show that "communications" is perhaps *the* most important asset of a successful R&D project.

Inadequate Monitoring of Projects Under Way: Many projects flounder for months or years, never develop any meaningful momentum and are often terminated with considerable economic loss, lowered departmental morale, and acrid recriminations from both marketing and R&D. It is imperative for R&D managers to monitor their important projects regularly to determine how much progress is being made and to report their findings to the appropriate people in marketing and other areas of management. If not enough progress is evident, a "check list,"[15] such as that suggested by my "Innovation Index" model in *Table* 2 can be very helpful. First announced in 1974, this Model was later refined to its present form.[16,17]

No more need be said here about the use of the GII Model. Those readers unfamiliar with its use should study the details as revealed in the referenced articles if there is an interest. It should be emphasized that this Model has been used effectively in other industries besides organic coatings—in laboratories of widely different segments of the chemical industry, in machine tool laboratories, etc.

Inadequate Identification of Technical Opportunities: Proper identification should be mainly a responsibility of the technical and marketing departments. Technical opportunities, however, can be pointed out by *anyone* in the organization and such suggestions should be heard sympathetically and, if objectively deemed worthwhile, acted upon—whether the suggestion came from the company president or the most recently hired chemist in the R&D laboratory. Certainly every person on the technical staff is capable of visualizing opportunities brought about by new scientific findings. Their ideas must not be casually discredited or cynically disparaged by their peers or their superiors. Rather, their ideas should be professionally discussed in an appropriate manner. When no one will listen to their ideas, technologists often give up trying, resort to the "bootleg" or "unauthorized" option or find another employer.

Inadequate Product Specifications: We have all seen instances where good laboratory work has been largely wasted because either the initial product specifications were not correct or the new product requirements were not kept up-to-date with changing market needs.

Both aspects of this particular barrier can be largely eliminated by periodic checking with the customers or industry involved as to changing requirements and by additional methods. As Pearson[7] has noted, "R&D people seldom can foresee all of the manufacturing or marketing needs and limitations during the initial product development. Often, in fact, substantial numbers of customers must be tested with a product before we arrive at the final specifications or configurations. We know, for example, that with certain products, the process of manufacture imparts subtle but important differences from a laboratory- or pilot-plant-produced product. These differences may well require a change in product design, possibly a change in manufacturing method, or in extreme cases even limit the segment of the market that can be successfully serviced. We also know that the product and market parameters that are developed early on by our sales and marketing people are subject to the same kinds of errors. They are subject to adjustment as we gain real customer response to the product."

Sales and marketing people who obtain details of customer needs prior to R&D work on a given product but then remove themselves from active participation in the project until the laboratory tells them that the project has been successfully completed are making a serious and costly mistake! Especially on long-term new projects, customer needs and perspectives change and the sales/marketing groups *must* keep R&D informed of such changes. It has been found to be very helpful for sales/marketing to take along an R&D person familiar with the project on such periodic review visits.

Sometimes the sales/marketing people who compile the initial specifications on industries or customer needs obtain an incorrect or incomplete view of the *real* needs and specifications. Especially for long range and costly research projects it is often desirable to have a second delegation make a separate exploratory visit to the customer's facilities, speaking to personnel other than those interviewed by their colleagues in the original visit. Only if the specification requirements and customer needs are reasonably congruent in both cases should the R&D project be initiated at that time.

Inadequate Recognition and Reward: R&D people are of the firm opinion that generous salaries for high quality and productive laboratory personnel are essential. Such salaries should be commensurate with those paid to comparable sales/marketing people, production personnel, etc. In order to demonstrate fairness in this area and to facilitate both the hiring of new employees and retaining current employees, the following steps should be considered:

(1) Rewarding outstanding performance through written communications.

(2) Training R&D managers in human resources skills.

(3) Giving productive R&D personnel recognition by top management.

(4) Granting periodic awards, when justified, for outstanding technical innovation. Such awards could consist of money (perhaps commensurate with the economic value of the innovation) and a plaque or certificate.

(5) Making certain that R&D salaries are comparable to those received by comparably performing members of other departments in the company.

Organizations which have adopted reward and recognition procedures have found them to be very gratifying from the standpoints of both R&D productivity and high morale. Companies ignoring such strategies impose serious barriers to innovation productivity.

INADEQUATE INTERFACE WITH CUSTOMERS: Technical-Customer interface is a very important line of communication without which formidable problems can arise. From their view, the best way for a technical group to get information about a customer's needs[18] is in direct discussion with the knowledgeable people in the customer's liaison group. Sometimes a marketing or sales person is reluctant to allow technical people to share customer contacts. Reasons given are, "I don't want him (the technologist) present, he may say something indiscrete, he's not diplomatic enough." Such expressions may be just excuses and are generally invalid! No one individual, salesman or chemist, can report "everything that's mentioned" or perceive all the nuances expressed at a meeting. Communications theory tells us that two people are likely to understand something quite different from the very same statement.

One of the common reasons for undesirable delays in an R&D project is that the laboratory investigations were based on incorrect or incomplete specifications. A good Technical-Customer interface can eliminate many such costly delays. And the technologist involved, in my experience, will be just as diplomatic as his sales counterpart! I think that it is psychologically indefensible to tell technical people responsible for an important project that they cannot be trusted to speak discretely to a customer!

INADEQUATE INTERFACE WITH MARKETING: The Technical-Marketing interface is perhaps *the* most important communications line—it can be an important area for success or it can be a profound barrier. The Technical-Marketing interface must be consistent, broad, and sincere. It must form an integral part of every R&D project. Communications between marketing and technical people must be governed by honesty and mutual respect. A "climate" must exist so that a person can readily admit a mistake in judgment or an omission without overt condemnation or friction. It has been suggested that innovative product development is closely related to the art of managing the people involved. In this case, the people who must be managed skillfully are the technical people concerned and their marketing peers.

All technically-oriented organizations[19] have seen the disastrous effects on innovative efforts when the technical and marketing partners on an important project are simply incompatible. In such instances, there is neither personal nor professional respect, there is no trust or faith in the abilities, the efforts, or the integrity of a partner. Groups like this must be promptly separated or selectively terminated if the malady is acute. This destructive type of situation is more likely to occur when there is a substantial hierarchal difference between the marketing and technical leaders involved. The "super-important" marketing man cannot discuss the project's problem objectively with his "lower rung" technical colleague; he may be arbitrary and positive that *his* is the only route to pursue. Or, the "self-important" technical manager finds it personally demeaning to take direction or suggestions from his marketing colleague. When hierarchal or incompatibility problems exist, we often see an informal network arise where the individuals involved communicate constructively outside the prescribed channels.

A constructive and effective Technical-Marketing interface must form an integral part of every important R&D project. Among other things, this requires that there be representation from both sectors at project status meetings, that there be a regular exchange of technical and sales reports, etc. There must be an attitude of fraternal concern and cooperation. False pride and authoritarian management are two major inhibitors of innovation. Studies have shown that in most companies the *poorest* communications were generally those among R&D/Engineering and Marketing.

> ***"A constructive and effective Technical-Marketing interface must form an integral part of every important R&D project."***

INADEQUATE TECHNICAL—PRODUCTION INTERFACE: Laboratory people must also have constructive, continuing contacts with their manufacturing colleagues. These working relationships should exist both during the laboratory work on major projects and in the technology-transfer phase to pilot/small scale/full scale production.

In recent years, there has been much concern about this interface which, in many companies, was virtually ignored in the past.[20] In the United States there has been a welcome resurgence of the economy and a consequent demand for manufactured goods. Whether the appliances, automobiles, coatings, adhesives, etc. now in demand are the old products which had been made in the past—or whether they are new or improved versions based on recent innovations—there have been notable problems in keeping productivity and quality up to the desired high levels. Preliminary studies suggested that there may be serious problems at the R&D-Production interface. Holusha[21] addresses the future solution of this problem optimistically when he writes that "a growing list of companies (has discovered) that excellence on the factory floor, rather than in the accounting, marketing or acquisitions departments, can be the key to success."

A grant from the National Science Foundation funded a study to be made at Northwestern University on problems at the R&D-Production interface because this institution has a recognized, ongoing research program on the various aspects of the Management of Research and Development (POMRAD). I am privileged to be participating in this particular research. The major purposes of the study are to:

(1) Increase the understanding of the R&D-Production interface

(2) Provide helpful guidelines for people working at this vital interface.

At this writing the investigation is still underway. However, I can report some interim findings as they do reveal important facts about barriers to innovation at this important interface.[22]

Figure 1 shows typical patterns of involvement of different chemical company functions in R&D projects. But what happens when R&D involvement diminishes and the manufacturing department is unable to get production "on stream" in an effective manner? Some of the R&D people involved may have already moved on to another project.

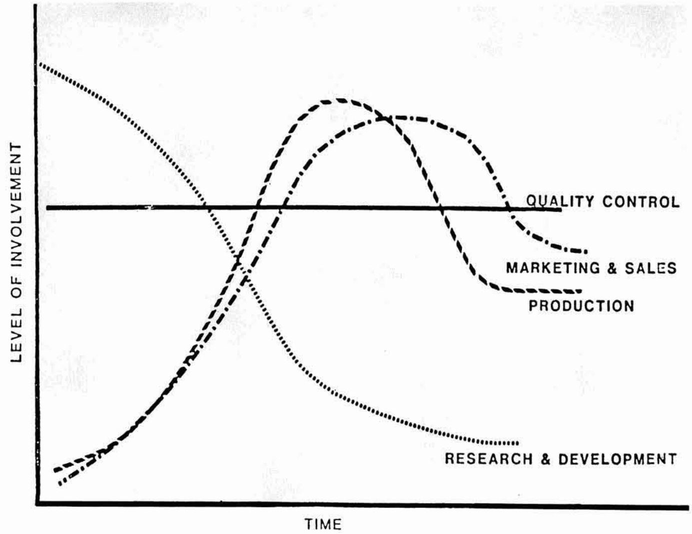

Figure 1—Patterns of involvement in projects

Marketing and Sales have already told prospective customers to expect the new product whose advantages they may have extolled in somewhat exaggerated terms! The frustrations and blame-placing among R&D, production and sales/marketing will usually be:

(1) Detrimental to organizational morale; and/or,

(2) Devastating to the real job of getting economical and quality products to the market-place as soon as possible.

A very similar situation can exist when initial shipments of new products show deficiencies. In such cases, quality control is also involved. *Table* 3 shows the major barriers found at the R&D-Production interface with 20 companies. Awareness of these 10 barriers *before* moving a new product from R&D to production may be very helpful to organizations having difficulties in the laboratory-to-production transition.

Table 3—Important *Barriers* At the R&D/P Interface

(a) Technical problems in product, process, packaging
(b) Limited market potential
(c) Premature scale-up
(d) Premature market introduction
(e) Poor communications, R&D/Manufacturing
(f) Vague initial specifications
(g) Raw material variability, shortages
(h) Critical processing required, new technology
(i) Inadequate product development time allowed
(j) Failure of project managers to use specialized resources outside of their "project team"

INSUFFICIENT RESOURCES FOR "EXPLORATORY" RESEARCH: We are not referring here to *basic* research but to something else with which all forward-looking companies must be involved. The Industrial Research Institute suggests this definition: "Exploratory Research—is that research which generates or focuses knowledge to provide a concept and an information base for a new development program." Many coating companies today do little, if any, exploratory R&D. They devote all their R&D resources to producing lower cost or minor variations of their current products. Also coating companies have become much more dependent on technology directions urged upon them by their raw material suppliers. Do these companies realize that new technologies which may be *right* for raw material manufacturers may be *wrong* for coatings manufacturers? Because of the lamentable, increased dependency on raw material suppliers for new technologies, many coatings companies have become either unable or unwilling to do their own exploratory work. And what are the raw material suppliers doing as coatings manufacturers become more dependent upon them? We find them going into the coatings business! The raw materials suppliers are producing the raw materials and doing the coatings R&D involved anyway, so why shouldn't they integrate downwards and manufacture the coatings too?

LOW INTERPERSONAL COMPETENCE OF R&D PERSONNEL: We have probably all encountered or heard of technical people who just could not work amicably and effectively with colleagues in the laboratory or in other sectors of the company. This unfortunate characteristic may be found, unhappily, in people filling all categories of organizational work—extending even to the highest executive positions. However, Argyris[19] sees technically proficient researchers as generally lower in their interpersonal competence than members of other areas of the organization and states that this lower interpersonal competence may well lead to misperceptions and defensive activities that are difficult to change. He visualizes that both managers and researchers may behave in ways that tend to inhibit, dissatisfy, and frustrate one another because they are not interpersonally competent to do otherwise. The chemist with low interpersonal competence may be one with high creative and innovative talents. In such cases, an alert and sensitive R&D manager must discover procedures which will maximize the creative/innovative contributions of the scientist involved while minimizing the numbers of situations where the low interpersonal competence characteristics will introduce undesirable antagonisms and controversies.

OVER-INVOLVEMENT OF R&D IN OTHER AREAS: In many companies R&D people are often used as technical service or support personnel—for both manufacturing and sales "problems." If used judiciously, there is perhaps nothing basically wrong with such practices. If employed to a larger extent, however, negative situations can develop. At the first sign of a problem—whether the product being manufactured is old or new—production demands R&D attention. When there is any kind of difficulty at a customer's plant, it is easy for a salesman to requisition a laboratorian for support during the customer visit. *Table* 4 shows the possible results of such R&D over-involvement with the problems of other departments.

PERCEIVED LACK OF SUPPORT BY TOP MANAGEMENT: This is a sometimes subtle, usually pernicious enemy to morale and to innovation. Let me cite a case history from my own experience. This case is typical of those found in several organizations. A senior research manager in a medium-sized company complained that he had no incentive to innovate because "top management wasn't interested in research." My measured appeals to his pride, his professionalism and to his personal growth needs fell on unheeding ears. When I

Table 4—*Over*-Involvement of R&D in Sales, Manufacturing, Etc.

(1) R&D has too little time for exploratory work
(2) Management wonders why costly R&D does not innovate enough
(3) Manufacturing doesn't learn how to handle its own problems
(4) Sales doesn't learn to handle *its* own problems
(5) The company suffers in the following respects:
  a. lower output of innovative new products
  b. lowered reputation for innovations
  c. lower profits (new products are usually more profitable)
  d. lower internal morale

inquired why he believed that "top management" was not interested in his research, he replied that he had not received even one expression of interest by the head of his company for the last year.

Interviews with other members of this R&D organization brought out supporting evidence. Certainly the vice-president/technology was in continual contact with the research work being done. But the company's president, who was observed to have time and interest to consult frequently with marketing, manufacturing, accounting, computer, etc., departments seemed to have no time or interest (or so the R&D people thought) to talk to the laboratory people about *their* projects and their *problems*. R&D people are observant and sensitive. They saw what was going on around them and drew the "logical" conclusion that "top management" was not interested in their research. As a result, R&D people began to feel neglected, insecure, unneeded and, in some cases, even hostile to their management and somewhat indifferent to their projects. When these findings were brought to the attention of the company's president, he first indignantly denied that "he had no interest in research." When confronted with the reiterated comments on this topic from his R&D people, the president finally agreed that he had probably not been showing very much interest in research during the past year because of other company problems, geographical distances between departments (caused by rapid growth), etc. He thought that the R&D people would "understand" but he had never actually explained the situation to them.

Summary

There are barriers in every type of work. Perhaps this is especially true in activities like research and development where innovative abilities are vital and where creative contradictions exist. These contradictions often transcend ordinary logic. We are beginning to learn how many of these factors impact on our research and development activities.[23] We must work intelligently and persistently to remove barriers to innovation. We may then expect to be more successful in turning our creative ideas and new technologies into innovations, into new products which will sell and earn the gratifying profits which our industry needs for its healthy and vigorous growth.

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FSCT Technical Committee Chairmen Meet

Society Technical Committee Chairmen Meet with FSCT Technical Advisory Committee

Recently, 15 Society Technical Committee representatives met with members of the Federation Technical Advisory Committee (TAC) to discuss their respective programs. An annual event, this year's meeting was held in Cleveland, OH.

FSCT Technical Advisor, Royal A. Brown, reported on the Federation-sponsored Proficiency Testing Program as well as the cooperative project on Mildew Research, in which nine Society Technical Committees are participating.

The Proficiency Testing Program, conducted by Collaborative Testing Services, Inc., McLean, VA, is designed to offer participating laboratories a means of comparing periodically the level and uniformity of their testing with that of other industry labs. Paint samples are shipped to participants six times during the program year, with two different ASTM test methods being conducted on each. Summary reports for each test method are distributed to participants (code number ID is used to maintain confidentiality). The program will hopefully lead to improved testing reliability and development of reproducible test methods.

Initiated in 1984, the program began with 35 laboratories enrolled; currently, 72 labs are taking part. Results thus far clearly indicate the need for the program. Several tests, notably that for Volatile Organic Content (ASTM D-3960), demonstrate that the ability of a large number of laboratories testing the same paint product to get reproducible results is not very good.

A second round of tests will begin at mid-year. Current participants will be surveyed to determine what test methods will be included in the 1985-86 program.

Nine Societies are participating in the Mildew Research project, testing paints formulated with mildew-inhibiting polymer. The aim is to determine whether a mildewcide chemically attached to the polymer will provide mildew resistance in the paint and whether the mildew resistance will last longer than the same mildewcide incorporated as a stir-in additive.

Participating Societies produced three paints from a formula supplied to them, using "active" and "blank" latex polymers. Exposure panels were then made from all three experimental paints and placed on exterior racks, along with panels of commercial mildew-resistant paints. Reports on exposure testing so far are fragmentary and inconclusive. It is hoped that by Fall 1985 the exposures will yield meaningful data; by that time, some of the panels will have been exposed from 18 months to two years.

The committee reviewed several of a set of 15 videotapes donated to the Federation by McWhorter, Inc. The tapes describe correct procedures for conducting quality control tests on liquid resin solutions or coatings. The committee thought the tapes to be useful, but would require polishing and editing prior to packaging them for addition to the Federation library of training aids.

JCT Editor, Bob Ziegler, reported that the overall quality of Society papers was improving, and consequently more were being published in the JOURNAL OF COATINGS TECHNOLOGY. He reminded the Society Technical Committee representatives of the availability of space in the JCT for publication of "progress reports" on current technical work, and invited the submission of reports whenever sufficient data have been collected. This information would alert other Societies to work underway and thus avoid duplication of effort.

FSCT TAC member Jan Grodzinski, of Toronto Society, reviewed the basics for producing quality slides for audio-visual presentations. He emphasized that Society paper presentations can be enhanced with little additional effort or expense by using good visual aids. While listing several reference publications to assist in slide production, Jan offered the reminder to "keep it simple" and avoid the temptation to put too much information on a slide.

Highlighting the meeting was a tour of the Glidden D.P. Joyce Research Center in nearby Strongsville. Hosted by Glidden's Drs. Alex Raming and George Pekarek, the group was escorted on an hour-long tour of the Center.

Society Technical Committee representatives attending were: Gerry Noren (Chicago); Dick Gohman (Dallas); Chuck Linahan (Detroit); Tim Specht (Golden Gate); Jerry Hefling (Kansas City); Bud Jenkins (Los Angeles); Jesus Visconde (Mexico); John Hall (Montreal); Ed Ferlauto (Northwestern); Emil Iraola (Pacific Northwest); Bill Fabiny (Philadelphia); Bill Meadows (Rocky Mountain); Russ Horne (Southern); Frank Chau (Toronto); and Al Waite (Western New York).

Technical Advisory Committee members attending were: Chairman Saul Spindel (New York); Colin Penny (Baltimore); and Jan Grodzinski (Toronto).

Guests attending were: Federation President-Elect Bill Mirick (C-D-I-C); Cleveland Society President Bob Thomas; and Cleveland Society Representative Fred Schwab.

Also attending were FSCT Technical Advisor, Roy Brown; JCT Editor, Bob Ziegler, and FSCT Director of Field Services, Tom Kocis.

Following are summary reports on Society Technical Committee activity.

Baltimore

Efforts continue to revive project work; committee currently consists only of chairman; Virginia Section participating in Federation mildew-inhibiting paint testing program; paints have been formulated, and panels placed on exposure site.

Chicago

Four projects in various stages of activity. *Study of Renewable Resources for Coatings*—Report on second phase of this project was presented at 1984 Annual Meeting; although the report reflects an abundance of petroleum for raw materials for coatings use, developments are being monitored and an update report on technology in this area will be presented . . . *Federation Mildew-Inhibiting Paint Testing Program*—Panels have been exposed for about one year in Illinois and Florida; although there is very little mildew growth on the samples exposed in Illinois, the most mildew has been observed on the blank paint and the least on the commercial paint. Mildew ratings for the Florida exposures are as follows (self-primed vs alkyd-primed): Blank paint—no fungicide, 6 vs 6; Biomer emulsion, 8 vs 7; Pentachlorophenol (2.6%), 7 vs 9; Commercial paint, 8 vs 9. These panels are painted on pine and exposed at 90° South, direct inland. Unfortunately, both the biomer and the pentachlorophenol paints are cracking and peeling badly over the alkyd primer at both sites. These paints are also losing adhesion in the self-primed area . . . *Oven vs Shelf Stability*—Round-robin testing has been completed of the properties of 10 model latex paints which were stored either at room temperature or in an oven. Ten local companies participated in the study, with each company testing three of the paints. The test paints consisted of interior, semi-gloss, and exterior paints, and included tinted bases. Four of the paints were intentionally formulated to fail the stability testing. The initial properties of each paint were measured and then measured again after 1, 2, 6, 12, and 18-month intervals of storage at room temperature. These properties will be compared with those of samples of the same paints stored at 120 and 130° F for 1, 2, 3, 4, and 8-week intervals; data now being analyzed and paper planned for either the 1985 or 1986 Annual Meeting . . . *Corrosion*—Subcommittee has been reactivated to continue literature review; a better-defined project is anticipated based on the review.

C-D-I-C

Activity hampered by loss of two key members who were recently transferred out of the area. Project work continues on study of Corrosion Resistance of Can Linings by Latex Paints; paper planned for 1986 Annual Meeting.

Cleveland

Committee currently being reorganized; hope to generate interest among local firms to be supportive of their personnel engaged in project work.

Dallas

Activity has slowed following completion of projects and paper presentations at recent Annual Meetings (two in 1982 and one in 1984); committee work hurt by loss of key member who has retired and moved from area.

Detroit

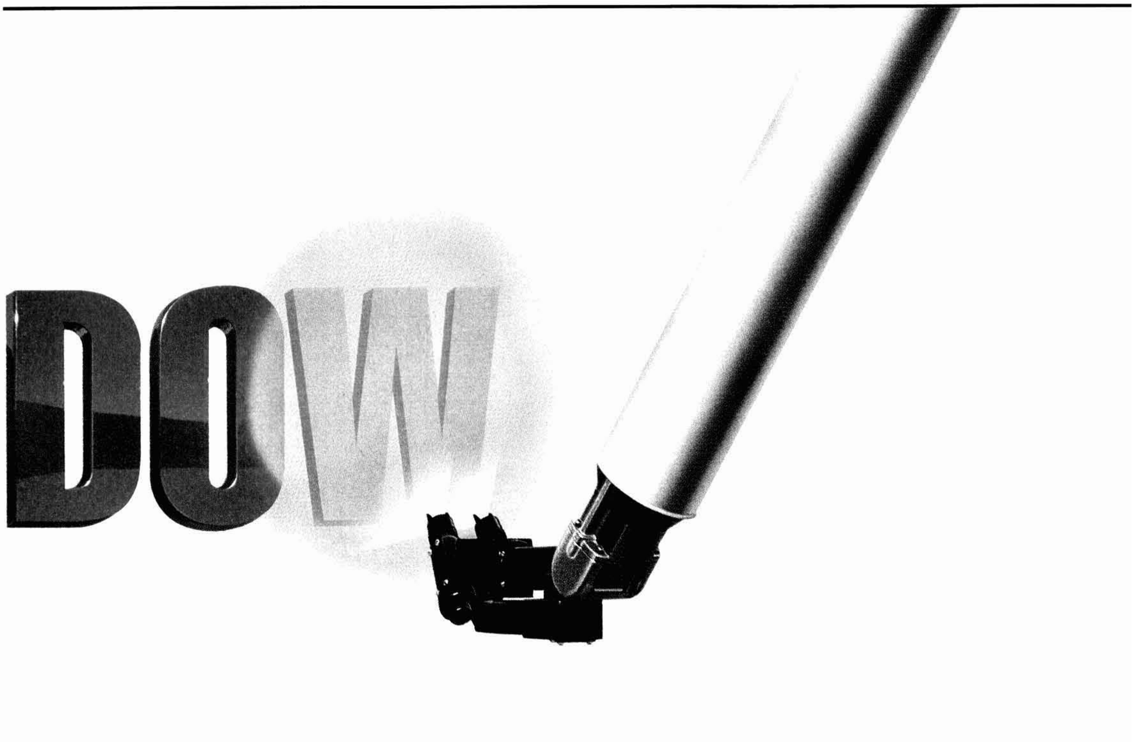
Continuing study of Urethane-Acrylic Interpenetrating Polymer Networks (IPN), which was reported on at 1984 Annual Meeting. This work is being conducted in conjunction with University of Detroit's Polymer Institute; update report planned for presentation at 1985 Annual Meeting.

Golden Gate

Testing methodology being studied for accelerated ultraviolet light testing, e.g., how do cycle changes affect gloss retention in generic trade sales paints. Paints of various binder types will be exposed to equivalent hours of UV exposure; cycle times and amount of condensation time will be varied. Currently, there is only mention of cycle changes in the literature; paper planned for presentation at 1985 Annual Meeting . . . Participating in Federation mildew-inhibiting paint testing program; panels have been placed on exposure sites and are being monitored.

Kansas City

Continuing study of Coating Performance on Exterior Hardboard Siding. Original hardboard exposure tests are to be terminated in June, and five-year results evaluated; hope to have paper ready for presentation at 1986 Annual Meeting. New hardboard samples have



been requested from the American Hardboard Association. To date, seven manufacturers have submitted boards in the unprimed, primed, smooth, and textured categories. Further exposure testing is being considered to evaluate some of the more recent latex polymers introduced for both primer and topcoat paints; also, may do some work with semi-gloss or low-sheen exterior products, limiting the exposure series to two or three PVC ranges, as well as evaluate recoat systems on boards previously exposed. May also try to evaluate specific raw materials within a given formulation for their effects on performance over hardboard substrates . . . Participating in Federation mildew-inhibiting paint testing program; paints have been formulated and panels prepared for exposure siting.

Los Angeles

Work currently underway on four projects: *Block Resistance of Gloss Latex Enamels and Water-Reducible Coatings*—A quantitative measurement of the block resistance of coatings will be taken. Tests will be conducted on commercially-available products as well as experimental formulations. The effectiveness of different additives used in the industry to improve block resistance of these systems will be examined; the results will be compared with conventional systems, with special attention focused on identifying formulation parameters and application techniques which improve block resistance . . . *Spontaneous Combustion of Surface Coatings*—This is study of effects of different solvent-based spray coatings and the contribution made by different substrates in enhancing spontaneous combustion; study is focused primarily on spray booth-type applications where the build-up of paint overspray on filters poses a fire hazard. Initial aim is to classify the different types of filters into well-defined substrate groups, then develop a test method to measure their contribution to spontaneous combustion . . . *Laboratory Paint Formula Calculations on an Apple II® Micro-Computer*—Project is nearly completed and paper is planned for presentation at 1985 Annual Meeting. The design and coding of a program written in Applesoft® Basic to perform standard lab calculations is detailed; hardware configuration and limitations are explained. Program will store information on over 1,000 raw materials on one diskette, and will do standard calculations on these formulas utilizing this information; output can be viewed on monitor screen or printed on paper . . . *Federation Mildew-Inhibiting Paint Testing Program*—Paints have been formulated and panels set out on exposure sites in Los Angeles area and are being monitored.

Mexico

Two projects being carried out: *Raw Materials Specifications and Test Methods for Inert Pigments Locally Manufactured*—Aim of project is to assist in development of written specifications, including test methods available and used in paint industry, to assure good quality control . . . *Toxicological and Psychological Effects of Solvents Used in the Paint and Ink Industries*—Subcommittee is working with Mexican government (through the Health Secretary) on a project for determining which solvents are hazardous by inhalation, and the critical level-of-use; also will investigate approved methods for determining critical levels-of-use of these materials.

Montreal

Sponsored mini-symposium in December on "Rheology Modifiers in the Coatings Industry." . . . Project work nearing completion on Influence of Thickener on Flocculation and Flow of Latex Paints—Series of gloss, semi-gloss, and flat latex paints were prepared based on six commercially available thickeners (HEC, CMC, two alkali-soluble acrylics, and two associative thickeners). All paints were prepared to approximately the same Stormer viscosity. Rheological properties of the prepared paints were studied using a variety of methods, including application of the Casson equation to predict flow and leveling and sag resistance of each system. An extensive range of optical properties was also determined, including quantifying degree of pigment flocculation in each of the paint systems using the flocculation gradient technique. Aim is to offer useful information on the performance of each type of thickener, hopefully giving the paint formulator an indication of the potential of the somewhat confusing array of products currently available; paper is planned for presentation at 1985 Annual Meeting.

Northwestern

Two projects previously underway have been dropped because of inability to complete them (Water-Borne Thickener Study; and Evaluation of 3.5 VOC Alkyd Primers with Various Anti-Corrosive Pigments) . . . Two new projects being considered: Study of Effect of Low Molecular Weight Components in High Solids Coatings on Stability of Applied Coatings; and Study of Effect of Reactive Diluents, Solvents, Defoamers, and Air-Release Agents on "Popping" in High Solids Coatings.

Pacific Northwest

Planning seminar-type presentations to high school students, industrial education instructors, and architects, on "Generic Paints and Stains." . . . Participated in writing of Repaint Manual, in conjunction with local chapter of Painting and Decorating Contractors of America . . . Yellow Poplar Hardwood Exposure Study continuing; panels have been exposed at two locations in the Seattle area. Study is 14 months old and only minimal differences have been noted. Panels are checked at six-month intervals.

Philadelphia

Arrhenius Plot Study—This project was initiated some time ago to determine Arrhenius Plot Techniques as applicable to time/temperature variables for lab and field tests. An extensive literature search was initiated and by means of computer input, approximately 100 technical papers have been indexed and categorized. Subcommittee is now negotiating with local college to produce new data to fit Arrhenius Techniques; Paper is planned for presentation at 1986 Annual Meeting . . . *Diffusion Study*—Project to determine solvent diffusion of high solids systems by means of gas chromatography is being carried out in conjunction with the Philadelphia College of Textile and Science. Initial phase has been completed, and second phase will be carried out with head space G.C. to overcome technical problems encountered with regular G.C. Paper is planned for 1986 Annual Meeting . . . *HLB Systems for Water-Dispersible Resins*—A test method has been developed to classify water-dispersible resins according to the HLB classification system. A round-robin testing program has been initiated and, based on the results, 10 resin categories will be tested; paper is planned for 1986 Annual Meeting . . . A/V program being developed on Microbiological Audit for the Paint Plant, and another on Color . . . Sponsoring full-day seminar in May on "Additives for New Technology Coatings."

Rocky Mountain

Work nears completion on Contribution of Fine Particle Size Extenders to Opacity: The Titanium Extension or Spacer Concept. This is scanning electron microscope study of paint films containing titanium plus various fine particle size extenders, to determine if there is any visual evidence of actual titanium particle separation by extender particles. Paper is planned for presentation at 1985 Annual Meeting.

Southern

Committee being reorganized, to consist of one member of each section (Atlanta, Central Florida, Gulf Coast, Memphis, and Miami) . . . Work completed on paint quality brochure on Latex Exterior Flat Paints . . . Participating in Federation mildew-inhibiting paint testing program; panels have been set out on exposure sites and are being evaluated.

Toronto

No projects currently underway, but three are being considered: Effect of Co-Solvent on Latex Performance; Effect of Various Zinc Grades (with Varying Types and Quantities of Impurity), on Corrosion Resistance of Zinc-Rich Coatings; and Fungicide Study to Examine Effects in Canadian Environment.

Western New York

Technical project work has been lacking for long time; small Society membership poses problem in staffing committee; currently trying to enlist member support and select project(s).

Society Meetings

CHICAGO .... APR.

"Paint Examination Techniques" and "Influence of Pigments"

The following slate of officers have been elected for the 1985-86 year: President—Ross C. Johnson, The Enterprise Companies; Vice-President—Ronald L. Kleinlein, Sherwin-Williams Co.; Secretary—Ray Czicz.o, Reliance-Universal Inc.; Treasurer—Evans Angelos, Kraft Chemical Co.; and Society Representative—John T. Vandeberg, DeSoto, Inc.

David W. Nichols, of the U.S. Federal Bureau of Investigation, discussed, "PAINT EXAMINATION TECHNIQUES UTILIZED IN THE F.B.I. LABORATORY."

Mr. Nichols' presentation included an overview and general background information relating to FBI Special Agent training and jurisdiction as well as support facilities to aid other federal, state, and local law enforcement agencies. Mr. Nichols then discussed the responsibilities of the FBI Laboratory, where the paint analyses are performed, and how it fits into the total Bureau system.

In addition, "THE INFLUENCE OF ACTIVE AND INACTIVE PIGMENTS ON CORROSION INHIBITING PROPERTIES OF PAINT FILMS" was presented by Rolf H. Odenthal, of Mobay Chemical Corp.

Dr. Odenthal described the corrosion inhibiting properties of synthetic iron oxide. He also discussed the relationship between water diffusion and vapor permeation through pigmented alkyd films and the PVC.

R.L. KLEINLEIN, *Secretary*

CLEVELAND .... MAR.

"Rheology for the Paint Formulator"

A presentation on "RHEOLOGY FOR THE PAINT FORMULATOR" was given by Carl Knauss, of Kent State University.

Using rate versus stress curves, Dr. Knauss defined typical viscosity types: thixatropic, shear thinning, and shear thickening. He also described hysteresis loops, and how the size of the loop may relate to structural changes.

Next, Dr. Knauss explained the differences between fluids which are Newtonian, shear thinning, and shear thickening. In addition, he gave a detailed description of the use of various viscometers, including cup and bob, Brookfield, rotational, cone and plate, capillary pipette, falling sphere, and parallel plate.

Dr. Knauss's presentation closed with an explanation of the use of tensile creep, relaxation, and dynamic rheometers to determine rheological properties.

MADELYN K. HARDING, *Secretary*

CLEVELAND .... APR.

"Lead Chromate Pigments"

Honored guests in attendence were Federation President-Elect William Mirick and Executive Vice-President Frank Borrelle.

Mr. Mirick's presentation highlighted some of the scheduled activities planned for the Annual Meeting and Paint Industries Show in St. Louis, October 7-9. He urged all to attend.

A slide presentation was given by Mr. Borrelle. He spoke on the projects, programs, and other activities carried forward at the Federation level.

The technical speaker for the evening was Pete Marr, of Dominion Color Co. His talk focused on "LEAD CHROMATE PIGMENTS."

Mr. Marr presented an overview of the technological, environmental, and regulatory factors which could affect the future of lead chromate pigments.

MADELYN K. HARDING, *Secretary*

KANSAS CITY .... APR.

"Environmental Update"

Gene Wayenberg, of the Nominating Committee, read the following nominees for officers for 1985-86: President—Jerry Hefling, Loctite Auto & Consumers; Vice-President—Steve Bussjaeger, Davis Paint Co.; Secretary—Steve Johnson, Cook Paint & Varnish Co.; Treasurer—Roger Haines, Farmland Industries, Inc.; and Society Representative—Norman Hon, Cook Paint & Varnish Co.

Hugh Smith, of Sun Chemical Co., gave an "ENVIRONMENTAL UPDATE."

Dr. Smith's informative presentation centered on trends of various environmental agencies. He also reviewed new regulations and discussed those to be implemented in the coming year.

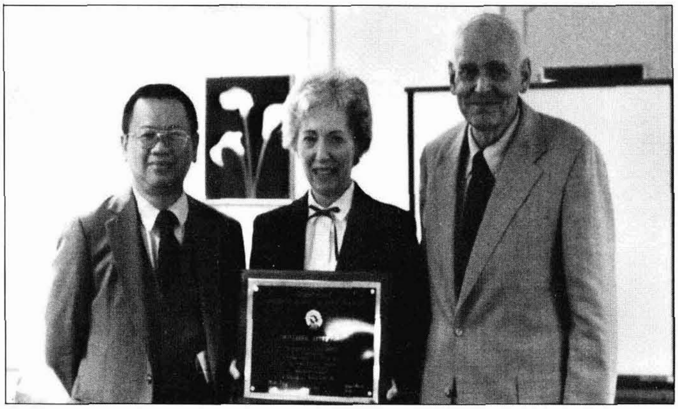
JERRY P. HEFLING, *Secretary*

LOS ANGELES .... APR.

"Water-Borne Coatings"

A moment of silence was observed in memory of Al Yerby, of Valspar Corp., who died recently.

Dodwell DeSilva delivered a report on the Technical Committee. He stated that his committee has been working on seven projects. One project, entitled, "Paint Calculations Using the Apple II Computer," is completed. This paper is pro-



At the December meeting, Piedmont Society President Phil Wong (left) presented Past-President Dave Bouldin with the First Annual Distinguished Service Award. Accepting the award with Mr. Bouldin was his wife. Mr. Bouldin passed away in early March

posed to be presented at the Federation Annual Meeting in October. Mr. DeSilva added that another project, "Spontaneous Combustion of Surface Coatings," by Bud Jenkins, would probably be ready this year as well.

Don Curl, President of the SCPCA, reported that their Legislative Committee had hired an environmental lawyer, Sharon Rubakava. Ms. Rubakava will carry the work of Lloyd Haanstra's task force, to the S.C.A.Q.M.D. Board. The committee's first endeavor would be the 380 gram per liter limit which must be kept from being reduced to 250 gram per liter, stated Mr. Curl.

The Legislative Committee has subscribed to a service in Sacramento which will send all Legislative Bills that pertain to the coatings industry to the Committee for review and comment. Al Seneker will review these Bills and disperse them to committee members.

Kurt Bimmler, of Polyvinyl Chemical, spoke on "FORMULATING WATER-BORNE COATINGS FOR PLASTICS—PROBLEMS AND SOLUTIONS."

Mr. Bimmler's presentation examined the problem areas with water-borne coatings such as pigment dispersion, selection and evaluation of dispersants, use of flatting agents, modification of water-borne acrylics with waxes, and properties resulting from blends of acrylics with urethanes.

Q. What techniques can I use to make a water emulsion adhere to plastic which goes through a freeze cycle?

A. The urethane approach would give you more flexibility in the film and would withstand the freeze cycle.

RAY DIMAIO, *Secretary*

MONTREAL .... MAR.

"Rheology Modifiers"

Paul Hodgson, of Tioxide Canada, Inc., presented the results of the Technical Committee project entitled, "RHEOLOGY MODIFIERS—ARE THEY ON THE LEVEL?"

Mr. Hodgson explained that the project was an evaluation of current commercially available thickeners in a gloss, semi-gloss, and flat latex system. He added that by including cellulosic, alkali soluble, and associative thickeners, together with cellulosic and associative blends, an attempt was made to supply the paint manufacturer with the information necessary to choose the thickener(s) best suited to his requirements. Mr. Hodgson also stated that the full range of optical, physical, and rheological properties were studied in each case, together with cost effectiveness in relation to paint performance.

VIJAY SHARMA, *Secretary*

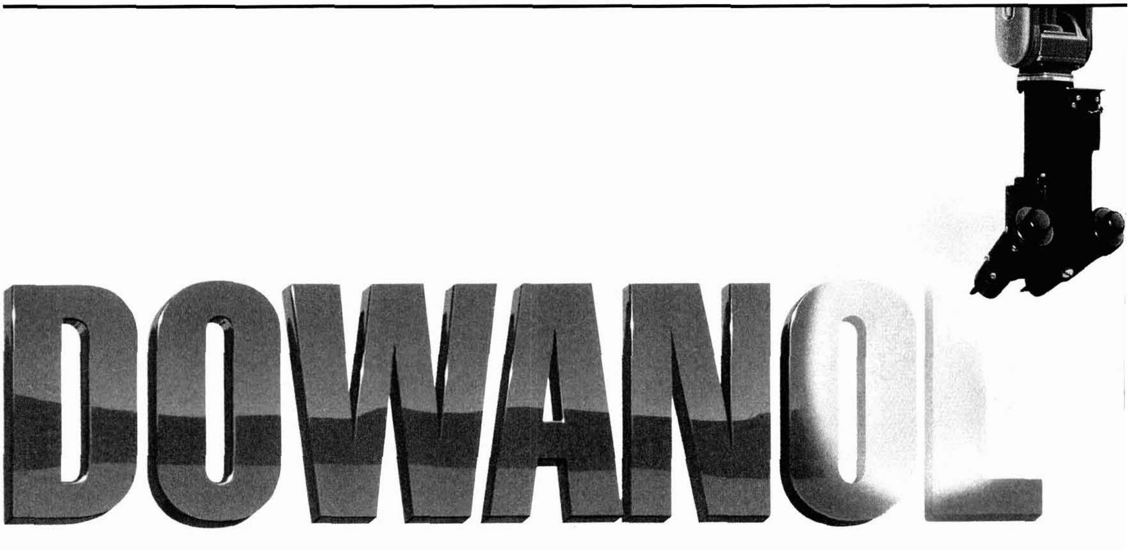
NORTHWESTERN .... APR.

"Dispersion Pilot Plant"

Dr. Frank Jones, of North Dakota State University, accepted a check for $1000 on behalf of the university's Polymers and Coatings Department.

Marty Feldman, of Nuodex, described "DISPERSION PILOT PLANT—THE SHORTEST DISTANCE BETWEEN LAB AND PRODUCTION."

Mr. Feldman discussed the effect of dispersion on brightness, gloss, transparency, stability, and strength. Examples of materials which had worked in the



lab, but had to be corrected in the pilot plant versus production are obvious, concluded Mr. Feldman. He also stressed that the Hegman reading is not equated with strength, it only tells if there are large agglomerates left.

LARRY BRANDENBURGER, *Secretary*

PIEDMONT .... MAR.

"Driers and Related Additives"

A moment of silence was observed in memory of Dave Bouldin, Society Past-President, who died recently.

Sam Bellettiere, of Nuodex, Inc., addressed the topic of "DRIERS AND RELATED ADDITIVES."

Mr. Bellettiere began his presentation by defining the composition and applications of driers. He then discussed the different types of driers and compared active and auxiliary driers for both air-dry and bake systems.

In closing, Mr. Bellettiere discussed the problem areas for driers. They included water-based systems, high solids coatings, lower temperature dry, and thick film coatings.

STEVE LASINE, *Secretary*

ST. LOUIS .... APR.

Education Night

The following were elected to Society offices for 1985-86: President—Charles Grubbs, of U.S. Paint; Vice-President—Al Zanardi, of Thermal Science, Inc.; Secretary—Jim McDerby, of F.R. Hall, Inc.; and Treasurer—Howard Jerome, of Spatz Paint.

Howard Jerome announced that Herman Lanson, of Lanchem, was voted to Society Honorary Membership, in recognition of over 40 years of service to the coatings industry.

Jim McDerby, Chairman of the Education Committee, reported on the educational activities of both the Federation and the Society. Within the Society, he stated that the activities involved four areas: the St. Louis Science Fair; the coatings activities occurring at University of Missouri-Rolla; the efforts for coatings and polymers courses in the St. Louis area; and the Education Night.

Dr. Jim Stoffer, of University of Missouri-Rolla was presented with a check for $500 for Rolla's coatings activities.

Taki Anagnostou, of Akzo Coatings America, reviewed the developments of the polymers program at the University of Detroit.

JAMES N. MCDERBY, *Acting Secretary*

WESTERN NEW YORK .... APR.

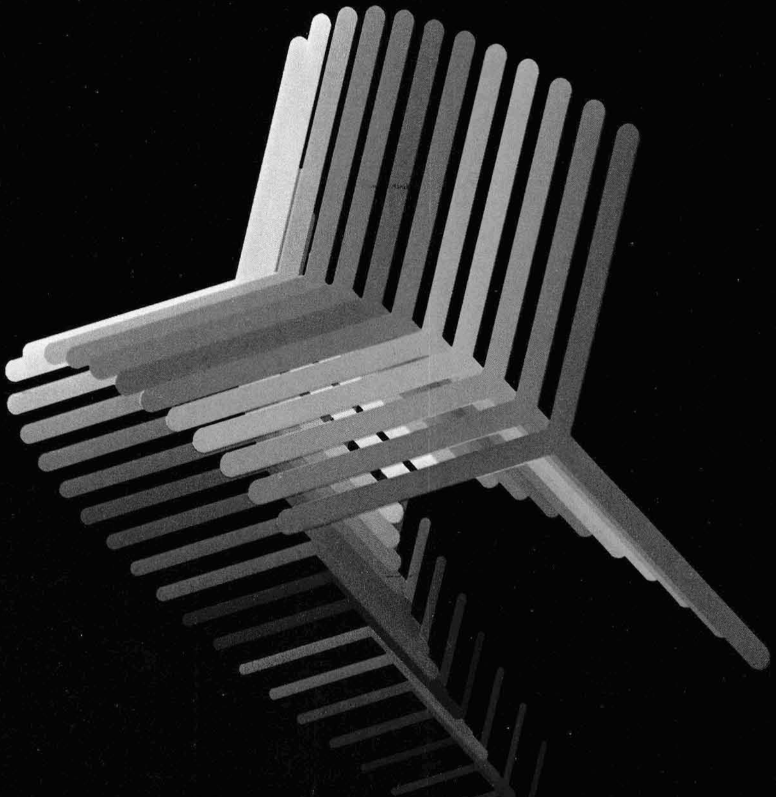
"Melamine Resins"

The following were nominated for Society offices for 1985-86: President—Charles C. Tabbi, Spencer Kellogg Div., Textron, Inc.; Vice-President—Michael L. DePietro, Spencer Kellogg Div.; Secretary—Jean L. Luck, Pratt & Lambert, Inc.; Treasurer—Gerald Ivancie, Pratt & Lambert, Inc.; and Society Representative—Thomas E. Hill, Pratt & Lambert, Inc.

The topic of "MIXED ETHER MELAMINE RESINS" was addressed by Nick Albrecht, of American Cyanamid Co.

Mr. Albrecht discussed the advantages and disadvantages of using fully alkylated mixed ether melamine resins for crosslinking high solids baking systems.

MICHAEL L. DEPIETRO, *Secretary*



Elections

BIRMINGHAM

Active

Davies, William R.—Carrs Paints Ltd., Birmingham, England.

Morris, David—International Paint, Birmingham.

CHICAGO

Active

Brogan, Kern W.—Glidden Coatings & Resins, Chicago, IL.

McMahon, Victoria A.—Sherwin-Williams Co., Chicago.

Opsahl, Ross—Atlas Coatings Ltd., Addison, IL.

Osting, Nick L.—DeSoto, Inc., Des Plaines, IL.

Patel, Ron—Barrett Varnish Co., Cicero, IL.

Rossomando, Robert—Cellofilm Corp., Chicago.

Stewart, R.S.—Sherwin-Williams Co., Chicago.

Ziech, Helen R.—Rust-Oleum Corp., Evanston, IL.

Associate

Gallas, Rick—S.C. Johnson & Son, Inc., Racine, WI.

Romance, Todd W.—Mooney Chemical Co., Elgin, IL.

Severns, John D.—Bausch & Lomb, Schaumburg, IL.

Retired

Steiner, Hanus J.—Chesterton, IN.

CLEVELAND

Active

Beck, Charles K.—Coatings Development Co., Painesville, OH.

Bohland, Robert J.—Teledynie Monarch, Hartville, OH.

Komocki, David S.—Loctite Corp., Cleveland, OH.

Messerly, Mark T.—Man-Gill Chemical Co., Bedford, OH.

Runcis, John Arthur—Glidden Coatings & Resins, Strongsville, OH.

Sheehan, Timothy P.—Foseco Inc., Brookpark, OH.

Traffis, Lawrence A.—Sherwin-Williams Co., Cleveland.

Zimmer, David J.—Lord Corp., Erie, PA.

KANSAS CITY

Active

Cossins, Michael C.—Valspar Corp., Kansas City, MO.

Sutton, Karen S.—Valspar Corp., Kansas City.

NEW ENGLAND

Active

Baldvins, Jon O.—Markem Corp., Keene, NH.

Calligano, Dyan—Dryvit System Inc., West Warwick, RI.

Dussault, Laurie—Whittaker Corp., Haynes Div., Chicopee, MA.

Leman, Arthur A.—Touraine Paint, Inc., Everett, MA.

Mendoza, Carlos—Raffi & Swanson, Inc., Wilmington, MA.

Modrak, Robert G.—California Products Corp., Cambridge, MA.

Mumford, Ernest C., Jr.—American Seal Mfg. Co., Waterford, NY.

Reinhart, William—A.W. Chesterton Co., Groveland, MA.

Shearer, Charles C.—Raffi & Swanson, Inc., Wilmington.

Smith, Lisa—Dryvit System Inc., West Warwick.

Spice, Earl C.—Whittaker Corp., Haynes Div., Chicopee.

St. Laurent, Dennis—Whittaker Corp., Haynes Div., Chicopee.

Topor, Daniel—Whittaker Corp., Haynes Div., Chicopee.

Associate

Finck, Keith B.—GE Silicones, Framingham, MA.

Nuttle, Robert G.—D.N. Lukens Inc., Westboro, MA.

O'Keeffe, Dennis—Mattiace Petrochem, Glen Cove, NY.

Scanlon, Daniel—The New Jersey Zinc Co., Cumberland, RI.

PIEDMONT

Active

Carder, C.H.—Union Carbide Corp., Cary, NC.

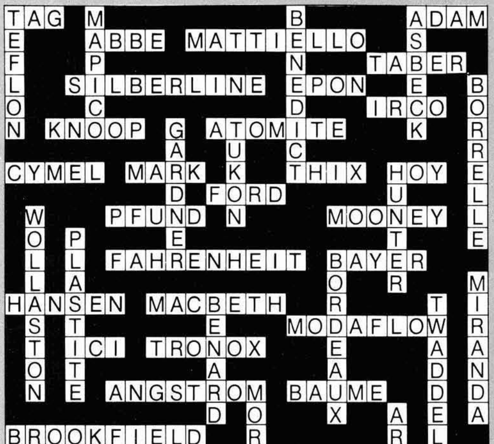
Patterson, Joseph R., Jr.—The Lilly Co., High Point, NC.

Woodruff, John D.—Whittaker, Clark & Daniels, Matthews, NC.

Associate

Busche, Jeff A.—Dow Chemical USA, Charlotte, NC.

Kline, Edward L.—Inland Leidy, Baltimore, MD.



Solution to June "*CrossLinks*"

Federation of Societies for Coatings Technology

AUDIO/VISUAL PRESENTATIONS

(All A/V presentations include slides, cassette tapes and scripts)

CAUSES OF DISCOLORATION IN PAINT FILMS

Some of the common causes of paint discoloration, such as mildew, sulfide staining, dirt retention, and staining by cedar or redwood, are illustrated on houses and on painted panels. Chemical tests for distinguishing between these types of stains are shown. A test for distinguishing efflorescence and chalking of paint films is also described. 15 minutes (37 slides) **$40**

THE SETAFLASH TESTER

Produced by the Technical Committee, Birmingham Paint, Varnish and Lacquer Club

The Setaflash Tester offers the capability to quickly ascertain the flash point of a volatile product. This presentation describes the equipment and explains the procedures for determining flash point in two temperature ranges (ambient to 110° C; 0° C to ambient) by both the flash/no-flash method and the definitive method. 54 minutes (134 slides) **$100**

FEDERATION TRAINING SERIES ON TEST METHODS*

Volume II

(3 Lessons) Lessons vary from 7 to 11 minutes (79 slides . . . **$70**

Lessons	***Producing Society***
A Simple Method to Determine Microbiological Activity	Philadelphia
A Salt Spray (Fog) Testing Cabinet	Golden Gate
Wet Film Thickness Gages	Golden Gate

*Volume I not available at this time.

HIGH SPEED DISPERSION

Produced by the Manufacturing Committee, Montreal Society for Coatings Technology

The program covers theoretical and practical techniques used for dispersion in paint plants, showing laboratory test equipment and plant scale manufacturing procedures. 20 minutes (60 slides) **$65**

INTRODUCTION TO RESIN OPERATIONS

Produced by the Manufacturing Committee, Toronto Society for Coatings Technology

This presentation has been developed to assist in the selection and training of resin plant operators, and focuses on basic concepts of manufacture and the role of a resin operator. 12 minutes (58 slides) **$65**

A BATCH OPERATED MINI-MEDIA MILL

Produced by the Manufacturing Committee, New York Society for Coatings Technology

This presentation describes the design and operation of a batch operated mini-media mill, and was developed to assist in the training of plant personnel to operate such equipment. 8½ minutes (51 slides) **$60**

NOW AVAILABLE!

OPERATION OF A VERTICAL SANDMILL—(Produced by the Manufacturing Committee, Kansas City Society for Coatings Technology). This program describes the design and operation of a vertical sandmill, to assist in the training of plant personnel to operate such equipment. 14 minutes (73 slides).............................. **$75**

☐ Causes of Discoloration in Paint Films...... **$40**
☐ The Setaflash Tester.................... **$100**
☐ Volume II, Test Methods.................. **$70**
☐ High Speed Dispersion................... **$65**
☐ Introduction to Resin Operations........... **$65**
☐ A Batch Operated Mini-Media Mill.......... **$60**
☐ Operation of a Vertical Sandmill **$75**

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People

Dr. Thomas J. Miranda, Staff Scientist at Whirlpool Corp., Benton Harbor, MI, has been selected as the recipient of the Indiana University South Bend's 1985 Distinguished Business Alumni Award, given to those alumni who have gone on to achieve "something extra."

In 1969, Dr. Miranda joined Whirlpool as Senior Research Materials Scientist, and a year later was promoted to his current post of Staff Scientist. His responsibilities include developing and exploiting new material concepts for corporate use, as well as long-range project research in the areas of organic and polymer chemistry. Over the years, his research studies have resulted in 11 patents and 45 publications on polymer chemistry and coatings.

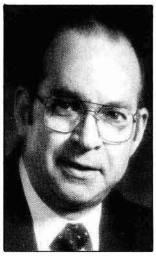
A member of the Chicago Society, Dr. Miranda was honored by the Federation with the 1980 George Baugh Heckel Award for his years of service as Chairman of the Publications Committee and Editorial Review Board, and as Technical Editor of the JOURNAL OF COATINGS TECHNOLOGY—a position he has held since 1972.

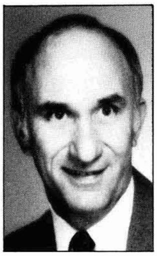
Ferro Corp., Cleveland, OH, has appointed **James F. Fisher** to General Manager, Color Div. Mr. Fisher will have overall responsibility for the manufacturing and marketing of Ferro's inorganic pigments, glass enamels, and forehearth colors. He will also direct the activities of the division's plants located in Cleveland; Pittsburgh; Orrville, OH; and Toccoa, GA. Mr. Fisher succeeds **Richard C. Oudersluys** who has moved to Executive Vice-President of Operations at Ferro (Holland) B.V. Mr. Fisher is a member of the Cleveland Society.

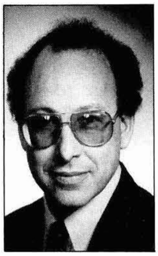
Ferro's Color Div. has also promoted **William A. Jarrett** to Manager of the Technical Services, Plastics and Coatings. Mr. Jarrett will direct operations of the technical service lab and provide customer support.

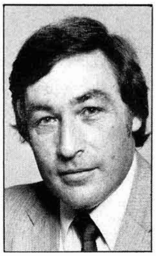
Glidden Coatings and Resins, Div. of SCM Corp., Cleveland, OH, has appointed **Thomas R. Korn** to Regional Director of Midwest Chemical Coatings. Mr. Korn has been with Glidden for 18 years.

In addition, two managers for container coatings have been appointed by Glidden. **Richard D. Lane** will become Market Manager and **Edward A. Green** will succeed Mr. Lane as Sales Manager.


T.J. Miranda


J.F. Fisher


E.W. Lanson


J.S. Dragonetti

Elliot W. Lanson has been named General Manager of Lanchem, an Akzo America Company. Dr. Lanson is a member of the St. Louis Society.

Hendrik Van Der Stoep has been promoted to Quality Manager for Akzo Coatings America, Inc., Troy, MI. Dr. Van Der Stoep will be responsible for establishing and implementing quality standards for all of Akzo's manufacturing facilities.

Sikkens Wood Finishes, a division of Akzo Coatings has appointed **J. Theodorus Bouwens** to General Manager. Mr. Bouwens brings 23 years of experience from the European Akzo organization to his new post.

PPG Industries, Inc., Pittsburgh, PA, has named **James E. Jones** Senior Research Chemist for the Coatings and Resins Group. Mr. Jones will be stationed in the firm's Research and Development Center at the facility located in Allison Park, PA. Mr. Jones is a member of the Pittsburgh Society.

Howard Ellerhorst, Jr., President of Chemical Marketing Services, Inc., Cincinnati, OH, has been elected President of the Association for Finishing Processes of the Society of Manufacturing Engineers. Mr. Ellerhorst, a charter member of the organization, became a member in 1975 and has previously served two terms on the AFP/SME Board of Directors.

William R. Klotz has been promoted to Vice-President at Coatings for Industry, Incorporated, Souderton, PA. Mr. Klotz has been with the firm for 13 years and most recently held the position of General Manager. He is a member of the Philadelphia Society.

Shell Chemical Co., a division of Shell Oil Co., Houston, TX, has announced three key changes in its polymers and catalysts organization. **Bill Butin** has been named Manager, Resins Business Center, replacing **Mike Grasley** who has moved up to the post of Vice-President, Industrial Chemicals. **Joe Dragonetti** has become Marketing Manager, Polymers and **Fred Newton** has moved to Marketing Manager, Elastomers.

Thomas A. Waltermire, formerly Vice-President, Commercial Services, for the Chemical Group of BFGoodrich Co., Cleveland, OH, has been named Vice-President and General Manager of the Elastomers and Latex Division. Mr. Waltermire succeeds David H. Hall, who has been named Senior Vice-President and General Manager of the Group's new vinyl division.

W.R. Grace & Co., Lexington, MA, has appointed **Frederic R. Huber** to the position of Executive Vice-President of the Organic Chemicals Div. Mr. Huber will have the general management responsibilities for the Hampshire Chemical, Polymers, and Evans Chemetics operations.

James S. Smith, President of Roll Coater, Inc., Greenfield, IA, has been re-elected President of the National Coil Coaters Association. Mr. Smith will serve a one-year term.

Chosen to serve again as Vice-Presidents of the NCCA, are **William A. Boyd,** of Vail Rubber Products Corp., Hammon, IA, and **Francis D. O'Neill,** of Teledyne Rodney Metals, New Bedford, MA. **Robert S. Parsons,** of Reynolds Aluminum Co., Richmond, VA, was elected Secretary/Treasurer.

The Specialty Chemicals Div., Engelhard Corp., Iselin, NJ, has named **Harmon M. Garfinkel** to Vice-President of Research and Development. Dr. Garfinkel will be responsible for the worldwide research and development activities of the division.

The Chemical Manufacturers Association has appointed **Dexter F. Baker,** President of Air Products and Chemicals Inc., to the Office of the Chemical Industry Trade Advisor. Mr. Baker succeeds **Leo H. Johnstone,** who held the post since 1983.

William C. Black has been named President of The New Jersey Zinc Co., Brooklyn, NY. Mr. Black has been with the company since 1963 and most recently held the position of Senior Vice-President.

Earnest W. Deavenport, Jr., has been appointed an Assistant General Manager of the Eastman Chemicals Div., of Eastman Chemical Products, New York, NY. Mr. Deavenport began his Eastman career at Tennessee Eastman Co., as a Chemical Engineer.

Richard G. Tonkyn has advanced to Vice-President of Research and Development at Petrolite Corp., St. Louis, MO. Dr. Tonkyn is a member of the American Chemical Society.

During their May meeting, the New York Society presented the PaVac Award, given for outstanding contributions to the advancement of the protective coatings industry and the New York Society, to **Alfred A. Sarnotsky,** Vice-President of Spraylat Corp., Mt. Vernon, NY. Mr. Sarnotsky has served the Society for over 20 years and the coatings industry since 1960.

Within the Society, Mr. Sarnotsky has held the position of Treasurer, Secretary, Vice-President, and in 1976, as President. In 1971 he received the Roy H. Kienle Award. He has served as Chairman of many Society committees, including the Manufacturing Committee where he conducted mini-workshops and paint plant tours and the Technical Committee. Currently he serves on the MMA Awards Committee of the Federation.

At the May meeting, it was also announced that two members of the New York Society have been elected to Society Honorary Membership: **Elias Singer,** of Troy Chemicals Corp.; and **Sidney B. Levinson,** of Sidlev Associates.

Ball Chemical Co., Glenshaw, PA, has recently expanded marketing activities in Texas, Oklahoma, and Louisiana. Complete responsibility for all sales, warehousing, production, and distribution of Ball products in this territory has been given to **John H. Lohman,** the newly appointed Southwest Regional Manager.

Obituary

William T. Cavanaugh, President of the American Society for Testing and Materials, Philadelphia, PA, died at the age of 63 on April 18, 1985. Active in ASTM's management since 1967, he had served as Chief Executive Officer since 1970.

Franklyn Levy, Vice-President of Federated Paint Mfg. Co., Chicago, IL, died on April 15, at the age of 60. In 1955 Mr. Levy established the Federated Paint Co. Since 1947 he had been an active member of the Chicago Society. He was awarded the Technical Award from the Chicago Society in 1952.

Sid Lauren Retires from CRGI; Succeeded by Fred G. Schwab


S. Lauren

Sid Lauren, Executive Director of Coatings Research Group, Inc., Cleveland, Ohio, retired on May 1 after 13 years of service with that international organization of coatings manufacturers. He was succeeded by Fred G. Schwab, who joined CRGI in 1962, and who has served as assistant director since 1972.

Mr. Lauren came to CRGI in 1972 with many years of diversified experience, including 17 years at the former Johns-Manville Research & Engineering Center where he was Chief of the Finishes Research Section. Previously, he had worked for the C. J. Osborn Co., where he started his coatings industry career, rising to the position of Chief Chemist. From 1955 to 1968, he was an Adjunct Professor of chemical engineering in the evening graduate school of the Polytechnic Institute of New York, where he taught courses in organic coatings technology.

An honorary member of the New York Society for Coatings Technology, Mr. Lauren was the recipient of that Society's Kienle and PaVac Awards. In 1983, he received The Heckel Award from the Federation of Societies for Coatings Technology. He served for six years on the Federation's board and on many of its committees. He plans to resume active involvement in the coatings industry and in the professional pursuit of other technical interests after he and his wife move to New England.


F.G. Schwab

Fred Schwab, a native of Louisville, Kentucky, began his career with the Jones-Dabney Co. in that city after his graduation with a B.S. in chemistry from Vanderbilt University. He later worked for the Ferbert-Schorndorffer Co. in Cleveland before he joined CRGI as a senior chemist. He has served as president of the Cleveland Society for Coatings Technology and on the executive committee and board of directors of the Federation. He has served also as Chairman of the Federation's Annual Meeting Program, Mattiello, and By-Laws committees.

High Attendance Recorded at April Symposium Of Pacific Northwest Society in Victoria, B.C.

The second-highest attendance in 12 years—346—was recorded at the annual symposium of the Pacific Northwest Society, April 25-27, at the Empress Hotel in Victoria, B.C., Canada. The previous high was set in 1973, the previous year the PNWers met in Victoria.

The Symposium Committee was chaired by Yvon Poitras, of General Paint Corp. Assisting him were Bob Welch, Deryk Pawsey, John Physick, Bill Almond, John Riddell, John Berghuis, Stu Taylor, Stefan Nozewski, Mike Griffin, and Bob Pinfield.

Program Sessions

Papers presented were:

"Super Dispersible Organoclays—Fact or Fiction"—Thomas W. Powell, of United Catalysts.

"CPVC of Latex Paints and Formula Optimization"—William D. Meadows, of Cyprus Industrial Minerals.

"Small Media Milling for the Non-Expert"—Leo Dombrowski, of Chicago Boiler Co.

"The Pitfalls of Pigment Strength Assessment"—Bill Bartsch, Jr., of Ciba-Geigy.

"High Solids Systems for Improved Telegraphing Resistance"—Richard Johnson, of Cargill, Inc.

"Formulating Waterborne Coatings for Metal"—Gail Pallano, of Polyvinyl Chemicals, Inc.

"TiO_2—Why So Many Grades?"—Dick Ensminger, of NL Chemicals.

"Water Absorption of Latex Films"—Frank Delguidice, of Union Carbide Corp.

"Influence of Inactive and Active Pigments on the Corrosion Inhibiting Properties of Paint Films"—R.H. Odenthal, of Mobay Chemical Corp.

James J. Leider Award

The 1985 James J. Leider Award of the PNW Society was presented to Deryk R. Pawsey, of Rohm and Haas Canada, Inc. Mr. Pawsey is a Past-President and current Society Representative of the Society. He is a member of the Federation's Executive Committee and a Past-Chairman of the Paint Show Committee. Mr. Pawsey received the Federation's George Baugh Heckel Award in 1984.

New Officers

PNW Society Officers for the coming year will be: President—Gerald McKnight, of Rodda Paint Co.; President-Elect—Dennis Hatfield, of J.F. Shelton Co.; Secretary—Yvon Poitras, of General Paint Corp.; and Treasurer—John Daller, of McCloskey Varnish Co. William Shackelford, of Gaco-Western, Inc., carries on as Administrative Secretary.

1986 Symposium

The 1986 PNW Society Symposium will be held in Portland, OR, May 1-3.

Detroit Society Hosts 10th FOCUS Conference

The Detroit Society sponsored its 10th annual FOCUS (Future of Coatings Under Study) Conference entitled "Trouble Shooting" on April 9 in Troy, MI.

Those attending were provided with a variety of presentations concerning trouble shooting techniques. The topics and speakers for the conference included:

"Trouble Shooting Techniques for Paint Systems"—Donald R. Hays, General Motors Corp.

"Problem Solving in Phosphate Systems"—Leroy R. Weinmann, Parker Chemical Co.

"Trouble Shooting Electrocoat"—Glenn Thompson, PPG Industries, Inc.

"Paintability of Pre-Coated Metal with Cathodic Electrocoat Primer under Production Conditions"—John Vincent, Ford Motor Co.

"Dirt Defects in Paint"—Peter L. Olson, duPont Troy Labs.

"Use of the Scanning Electron Microscope to Resolve Paint Related Defects"—Donald Trinklein, Chrysler Corp.

"Solvent Problems"—Tim Wing, Gage Products Co.

"To Match or Not to Match"—Donald P. Mordis, Ford Motor Co.

"Craters"—Clifford Schoff, PPG Industries, Inc.

'Conference '85' Presented by Golden Gate Society

Packaging, warehousing, and labelling were the topics highlighted at the "Conference '85" program presented by the Manufacturing Committee of the Golden Gate Society on June 17 in San Francisco, CA. In addition, rules regulation, future laws on labelling, and practical use of computers and automation were addressed.

The following presentations were given:

"USHA—The Hazard Communication Standard: How to Use HMIS as a Means of Compliance"—James A. Doyle, of NPCA.

"DOT—Overview of the Federal Hazardous Materials Transportation Regulations"—Ken Zacharias, of NPCA.

"Labelling—Paint Industry Labelling and Recent Trends"—Ken Zacharias.

"Update. Super/RCRA and Community Right to Know"—James A. Doyle.

"Evolution of Control and Information System"—moderated by Ken Trautwein, of Sherwin-Williams.

"Practical Use of Computer-Production Control, Batch Tickets"—Terry Hines, of Parallex Corporation.

"Practical Use of Computers—Warehousing"—Terry Tysselend, of Trammel-Crow Distribution Co.

"Trends in Automation Information Systems"—Jerold L. Stockweather, of Advanced Control Technology.

Committee Chairman for the event was Louie Sanguinetti, of Jasco Chemical Corp. Conference co-chairmen were E. "Bud" Harmon, of Borden Chemical Corp., and A. Gordon Rook, of Nuodex Chemicals.

EMU's Center for Coatings Technology Announces 1985 Program Schedule

The Center for Coatings Technology of Eastern Michigan University, Ypsilanti, MI, will present a series of programs to be held in Ann Arbor, MI, beginning July 23.

The courses will be offered in one of three Ann Arbor hotels, and each will be two to four days in duration. These courses are:

(July 23-26)—"Fundamentals of Coatings Formulation for Increased Productivity"

(Aug. 12-15)—"Quality Assurance in Industrial Coatings"

(Sept. 9-12)—"Introduction to Coatings Technology"

(Oct. 21-23)—"Symposium on New Chemistry for Product Diversification and Specialization in Coatings"

(Dec. 4-6)—"Advanced Chemical Coatings for Technical Managers"

(Dec. 9-10)—"Introduction to Paint Job Estimating"

(Dec. 11-13)—"Update on Coatings for Painting Contractors."

Program Director

The 1985 Center for Coatings Technology program is under the direction of John A. Gordon, Jr., a leading coatings educator in the U.S. Dr. Gordon has held research, development, production, technical service, and marketing positions in companies producing alkyd resins, polymer emulsions, amino resins, architectural coatings, and industrial finishes.

Since his retirement from Union Chemicals Div. of Union Oil Co. in 1978, Mr. Gordon has been active in continuing education programs in coatings at the University of Missouri-Rolla and Kent State University, as well as in various seminars and symposia sponsored by the Federation, government and private industries, and other professional societies.

A Past-President of the Los Angeles Society, Mr. Gordon currently serves on the Steering Committee of the FSCT Education Committee. He is a member of the board of directors and is President-Elect of the AFP/SME.

For more information on the 1985 CCT program series, contact Alan Green, Project Director in the Technology Services Center at EMU, 150 Sill Hall, Ypsilanti, MI 48197.

Call for Papers

The program entitled "A Symposium on New Chemistry for Product Diversification and Specialization in Coatings," to be held from October 21-23, is accepting papers for presentation. This coatings symposium will discuss the chemistry of new monomers, catalysts, and crosslinkers and their potential role in generating new or unique polymer systems. The audience will be exposed to a variety of specialty chemicals with application to diverse areas of polymer science.

The symposium will be held at the Campus Inn, Ann Arbor, MI, located 20 minutes from the Detroit Metropolitan Airport.

Interested parties should submit a 50-word abstract by September 1 and a final manuscript by October 1 to: October Symposium, Center for Coatings Technology, 150 Sill Hall, EMU, Ypsilanti, MI 48197. Answers to questions can be obtained by contacting Mr. John Gordon or Dr. John Graham.

KTA-Tator Offers Training In Coatings Technology

KTA-Tator, Inc., a coatings consulting firm located in Pittsburgh, PA, has recently introduced an educational and training service designed to help individuals understand the importance of coating protection.

Training courses, which are given either at a client's facility or at the KTA office in Pittsburgh, are adapted to client needs and range from one to five days. Content varies from a simple instrument overview to the more sophisticated technical and documentation requirements of coatings for nuclear generating facilities.

Lectures focus on corrosion theory, the purpose of protective coatings, general and specific coating characteristics, and the uses of different generic coating types, as well as on surface preparation and coating application techniques.

Surface preparation and coating application inspection methods, and instrumentation, coating application specification review and interpretation, coating failure investigation, prevention, and problem solving, and the development of preventative maintenance painting programs round out the curriculum.

In addition, courses also include hands-on use of inspection instrumentation, blasting, and painting equipment and a course manual for each participant's future reference.

For more information, contact KTA-Tator, Inc., 115 Technology Dr., Pittsburgh, PA 15275.

EMU Plans Summer Internships For Selected High School Students

The Center for Coatings Technology of Eastern Michigan University, Ypsilanti, MI, plans to organize and direct a summer internship program in polymers and coatings for high school students.

Six science-oriented high school junior and senior students, chosen from nominees selected by their science teachers, will spend two weeks in a modified polymers and coatings lecture/laboratory course. Lectures will cover the various phases of polymer chemistry as they relate to coatings. The interns will have an opportunity for hands-on experience in making and testing various kinds of coatings in the laboratory and will also work in the classification and identification of coatings-type polymers.

Students chosen will be housed in EMU dormitories and will enjoy full university student status. They will be paid $300 for the two-week internship and will be provided with free room and board.

At the conclusion of the program, each student will receive a certificate of completion and a year's subscription to the JOURNAL OF COATINGS TECHNOLOGY.

Funding for the 1985 summer program is provided by the Detroit and Chicago Societies, the Chicago PCA, and the Office of Research Development of EMU.

For information, contact either Dr. John C. Graham or John A. Gordon, Center for Coatings Technology, Eastern Michigan University, Ypsilanti, MI 48197.

Charles Parker Scholarship Fund Established by EMU

Eastern Michigan University, Ypsilanti, MI, has established a scholarship fund in memory of Charles H. Parker, who died on January 26, 1985. A pioneer in the development of aminoplast resins, Mr. Parker held research and technical service positions at American Cyanamid and Monsanto Co.

According to EMU, the fund is a fitting memorial to "Charlie" Parker because he had a deep and continuing interest in coatings and in the training of young people to fill the technical needs of the industry. He donated an extensive library of coatings books and journals to universities and did much to encourage students and instructors in schools with coatings-oriented courses.

The fund is titled, "The Charles H. Parker Memorial Scholarship Fund" and will be administered by the Polymers and Coatings Coordinator, Dept. of Interdisciplinary Technologies, College of Technology, of Eastern Michigan University. It is planned that the fund will be used primarily for undergraduate student scholarships in the Polymers and Coatings curriculum. Donations to the fund are gifts to a non-profit educational institution and, as such, qualify for tax relief.

Persons wishing to make contributions to the fund should send them to: Coordinator, Polymers and Coatings Curriculum, IDT 122 Sill Hall, Eastern Michigan University, Ypsilanti, MI 48197. Checks should be made payable to Eastern Michigan University. Acknowledgment of the receipt of gifts will be made. Special requests will be honored insofar as possible.

AFP/SME Conference To Be Held in Detroit, Sept. 16-19

The Association for Finishing Processes of the Society of Manufacturing Engineers (AFP/SME) has scheduled its Fifth Finishing Conference and Exposition for Sept. 16-18 at Cobo Hall in Detroit, IL. The theme for the event is "Finish It Right the First Time—Quality Pays—Technology Saves."

The Finishing '85 Exposition will feature finishing applications and systems for surface preparation and cleaning, coatings and coating materials, quality control and testing, curing, materials handling, safety, engineering services, pollution control devices, and related exhibits. Exhibit hours on Tuesday, Sept. 17, through Thursday, Sept. 19, will be 11:00 am to 6:00 pm.

Full-day conference workshops are scheduled from 9:00 am to 4:30 pm and half-day sessions run from 9:00 am to 12:00 noon, and 1:00 pm to 4:30 pm.

For attendance information, contact the Public Relations Dept., AFP/SME, One SME Dr., P.O. Box 930, Dearborn, MI 48121. For exhibiting information, contact Dan Dembicki, Exhibits Development Manager.

Flame Retardant Coatings Conference Scheduled For October 27-30

The Fire Retardant Chemicals Association has scheduled its fall conference for October 27-30 at the Pinehurst Hotel, Pinehurst, NC. The topic of the conference will be "Flame Retardant Coatings—Problems and Opportunities."

Arranged with the assistance of the Fire Retardant Coatings Committee of the NPCA, the conference is intended to present companies which produce coatings, polymers, or flame retardant chemicals with a platform to explore areas of mutual interest.

Program Chairman, Dr. Philip E. Rakita, of M & T Chemicals, Inc., is assembling an agenda of presentations from fire safety experts representing government and industry.

For additional information, contact Dick Carpenter, 20 East 46th St., New York, NY 10017.

Color Science Is Topic Examined at Munsell

The Munsell Color Science Laboratory, located on the campus of Rochester Institute of Technology in Rochester, NY, will present "Advanced Concepts of Color and Color Measurement: An Intensive Short Course for Industry," August 26-28, a course that will provide scientists and engineers with advanced levels of information about selected topics in color science and engineering, featuring the industry's leading experts and scientists.

Specifically, the course will cover advances in the CIE systems of colorimetry, in a lecture by Dr. Roy S. Berns, of RIT; color vision, perception, and psychophysics and their relationships to colorimetry, Dr. C. J. Bartleson, of Eastman Kodak Research Laboratories; computer colorant formulation theory for subtractive coloration systems, Dr. Eugene Allen, Professor Emeritus, at Lehigh University; standardization and instrumentation requirements for colorimetric accuracy, Dr. Franc Grum, R. S. Hunter Professor and Director of the Munsell Color Science Laboratory; electronic color displays: unique measurement problems and system design considerations, Leroy DeMarsh, of Eastman Kodak Research Laboratories; and nonimpact full color printing, Dr. Vsev Mijhalov, of Xerox Corporation.

The course is designed to most benefit those involved in such coloration systems as reprographics, color electronic imaging, coatings, textiles, and polymers.

Dr. Grum will direct the course. The tuition is $500.

For additional information and registration details, contact the Technical and Education Center of the Graphic Arts, RIT, One Lomb Memorial Drive, Rochester, NY 14623, or call 716/475-2757.

Dick Sutherland, General Chairman (left center), presented plaques for the best exhibits in the 1985 Western Coatings Societies Symposium and Show to (left to right): Bill Moore, of Norton Containers; Don Arntfield, of Lorama Chemicals; Doug Melton, of Morehouse Industries; Bob Buvall, of McCloskey Corp.; and Joseph Feldman, of EM Chemicals

Literature

Photoinitiators

A line of cationic photoinitiators for radiation-cured coatings, inks, and adhesives is featured in a product bulletin. UV-cured coatings formulated with these products are reported to be hard and flexible, glossy and non-yellowing. They also exhibit excellent adhesion to most substrates making them useful in metal decorating and finishing, as well as in the electrical, electronic, plastics, and paper coatings markets. Further data can be obtained from Union Carbide Corp., Specialty Polymers and Composites Div., Dept. M1553, 39 Old Ridgebury Rd., Danbury, CT 06817.

Attrition Mills

Information sheets detailing product specifications of a new line of attrition mills are now available. The mills are constructed to produce superfine grinds using a minimum of energy and of floor space. Write to Netzsch Incorporated, 119 Pickering Way, Exton, PA 19341-1393 for leaflets on the mills.

Monomer

Introduced in a product bulletin are the benefits and performance features of a new trifunctional monomer. The coating is useful where good exterior durability is required and also where room temperature cure is necessary. Further information can be obtained by contacting Polymer Production Div., American Cyanamid, Wayne, NJ.

Dissolvers

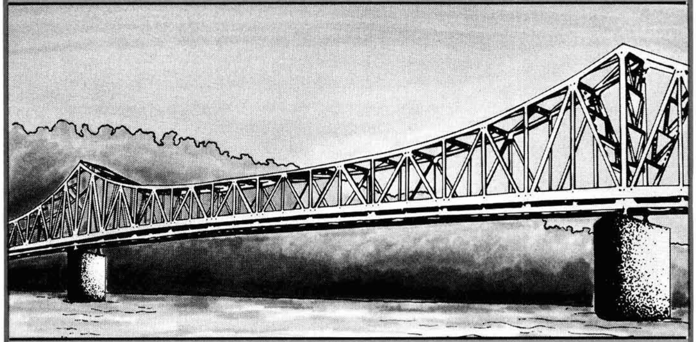
A four-page data sheet describes the performance features of a new line of high-speed dissolvers. The dissolvers have applications in the processing of paints, printing inks, specialty chemicals, plastics, food products, pharmaceuticals, magnetic media, and mineral slurries. For copies, write to Netzsch Incorporated, Grinding Department, 119 Pickering Way, Exton, PA 19341-1393.

Zinc Dust

Recently published is a pamphlet entitled, "Zinc Dust and Powder: Existing and Potential Commercial Uses." The literature is arranged to provide product designers, operating engineers, chemists, and plastics compounders with an overview of the uses and properties of particulate zinc. For single copies of the free publication, write to "Dust and Powder," Zinc Institute Inc., 292 Madison Ave., New York, NY 10017.

Particulate Contaminants

A guide discussing the extraction of fibers and particles from paint films as well as techniques for collecting and quantifying air-borne particles has been published. Intended for technical workers and consultants who occasionally encounter the problem of paint finishes marred by dust, the guide offers techniques that require a minimum amount of sample manipulation under the microscope. For copies, contact Mr. Dip Dasgupta, Head of Information Dept., Paint Research Association, Waldegrave Rd., Teddington, Middlesex, TW11 8LD.



Book Review

ADVANCES IN LOW TEMPERATURE PLASMA CHEMISTRY, TECHNOLOGY, APPLICATIONS, VOL. 1

Edited by
Herman V. Boenig, Ph.D.

Published by
Technomic Publishing Company,
Lancaster, PA
380 pages, $55

Reviewed by
Michael E. Graham
Whirlpool Corp.
Benton Harbor, MI

The field of low temperature plasma chemistry has seen tremendous growth in the last few years, both in the number and variety of research projects undertaken. This book provides tangible evidence of the broad scope of this research, and in addition, performs one important task—Dr. Boenig uses this opportunity to demonstrate the international scope of the research efforts.

Dr. Boenig brings together a group of papers representative of the current research going on in several parts of the world, including Western and Eastern European, Middle Eastern, North American, and Far Eastern countries. In fact, the second half of the book consists mainly of papers which had been presented at the Sixth International Symposium on Plasma Chemistry held in Montreal, Canada in July, 1983.

The book begins with a short article by Dr. Boenig reviewing the growing number of applications areas, ranging from microelectronics, optoelectronics, optics, and solar cells to adhesion, membranes, metal surface treatment, and tribological thin films. This is followed by nine full length papers dealing with current research in the fabrication and properties of thin films. The topics include oxidation processes, metal doped polymer films, membranes for reverse osmosis, metal surface nitriding, moisture sensitive plasma-polymerized films, plasma-activated chemical vapor deposition, plasma-hydrogenation of silicon films, and cathode erosion in arc plasma devices. Two review papers on advances in plasma deposition of thin films, organic and inorganic, follow.

The remainder of the book is a compilation of a number (17) of short papers from the 1983 International Symposium plus an additional paper by Dr. Boenig which reviews plasma technology in integrated optics with an emphasis on optical wave guides and a research paper on the reaction of aromatic compounds with oxygen in a R.F. discharge. The symposium papers deal with plasma-polymerization of a variety of monomer species, R.F. and microwave environments, and a variety of substrate treatments.

The book should be of use primarily to those currently engaged in related research areas or to those with appropriate scientific backgrounds who are beginning work in related fields of research. It should also be useful to those interested in an up-to-date survey of current research and progress in the various aspects of low-temperature, low-pressure plasma chemistry. The review papers by Dr. Boenig are well written and well referenced and should be very beneficial to the researcher wishing to stay informed as to the current status of developments in plasma deposition of thin films.

CALL FOR PAPERS

Symposium on High Solids Coatings
Division of Polymeric Materials: Science and Engineering

American Chemical Society
Sept. 7-12 Anaheim, CA

At the 192nd National Meeting of the American Chemical Society, to be held on September 7-12, 1986 in Anaheim, CA, the Polymeric Materials: Science and Engineering Division will feature a Symposium on High Solids Coatings. Topics to be presented include liquid high solids, powders, radiation curable coatings, and polyurethanes. Papers relevant to all scientific and technological aspects of these various systems, including underlying scientific and engineering principles, will be considered for presentation. Publication of the proceedings in an ACS Symposium Series is planned. Appropriate topics include, but are not limited to the following subject areas:

Synthesis of oligomers and polymers
Telechelic oligomers
Newer types of coatings binders
Oligomer physical properties; viscosity
Oligomerization processes; control of molecular weight and functionality
Crosslinkers
Chemistry of crosslinking
Catalysis
Film structure; network theory
Film physical properties
Weatherability
Adhesion
Solvents
Reactive Diluents
Pigments
Additives
Dispersants
Powder coatings—chemistry, application, curing, properties
Radiation curable coatings—chemistry, application, curing, properties
Photoinitiators
Photopolymerization
Polyurethane chemistry
Corrosion protection
Application
Coatings rheology
Surface effects
Acrylic oligomers
Melamine, related crosslinkers
Oligoesters and alkyd resins
Polyurethane materials in high solids chemistry
Epoxy and phenolic materials
Other types of coatings binders

If interested in contributing a paper to this symposium, send a preliminary title to George R. Pilcher by November 1, 1985. Complete details, including manuscript requirements, are available from the Symposium Chairmen:

George R. Pilcher
Hanna Chemical Coatings Corp.
P.O. Box 147
Columbus, OH 43216

Frank N. Jones
North Dakota State University
Polymers & Coatings Dept.
Fargo, ND 58105

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact FSCT, 1315 Walnut St., Philadelphia, PA 19107 (215-545-1506).

(Oct. 7-9)—63rd Annual Meeting and 50th Paint Industries' Show. Convention Center, St. Louis, MO.

1986

(May 13-16)—Federation "Spring Week." Seminar on 13th and 14th; Society Officers on 15th; and Board of Directors on 16th. Sheraton Station Square, Pittsburgh, PA.

(Nov. 5-7)—64th Annual Meeting and 51st Paint Industries' Show. World Congress Center, Atlanta, GA.

SPECIAL SOCIETY MEETINGS

(Nov. 5-6)—Symco '85. 15th Annual Chicago Society Coatings Symposium, "The Right Stuff." Knickers Restaurant, Des Plaines, IL. (Lonnie U. Haynes, Chairman, Hercules, Incorporated, 300 E. Schuman Blvd., One Energy Center, Suite 260, Naperville, IL 60540).

1986

(Apr. 2-5)—Southern Society. Annual Meeting. DeSoto Hilton Hotel, Savannah, GA. (Ronald R. Brown, Union Chemicals Div., P.O. Box 26845, Charlotte, NC 28213).

(Apr. 9-11)—Southwestern Paint Convention of Dallas and Houston Societies. Wyndham Hotel, near Houston Intercontinental Airport, Houston, TX. (Mike Winters, Ribelin Distributors, Inc., 7766 Blankenship, Houston, TX 77055).

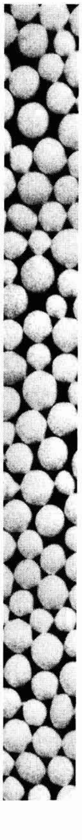
(May 1-3)—Pacific Northwest Society, Annual Symposium. Marriott Hotel, Portland, OR. (Gerald A. McKnight, Rodda Paint Co., 6932 S.W. Macadam Ave., Portland, OR 97219).

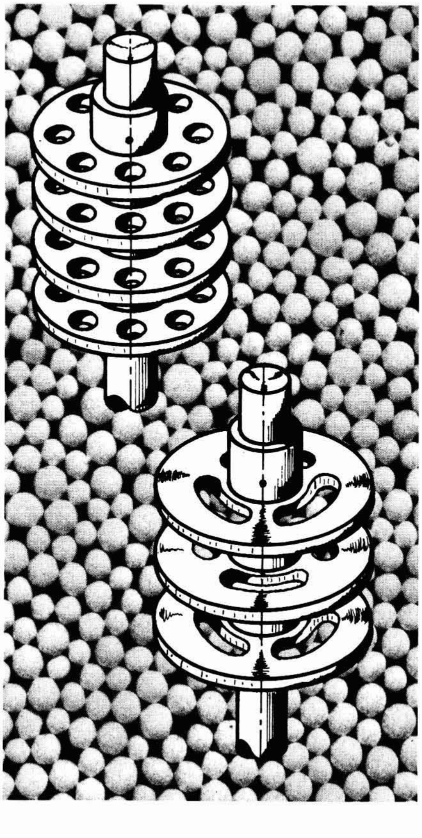
1987

(Feb. 23-25)—Western Coatings Societies' Symposium and Show, Monterey Convention Center, Monterey, CA. (Barry Adler, Royell, Inc., 1150 Hamilton Ct., Menlo Park, CA 94025).

OTHER ORGANIZATIONS

(July 23-26)—Short Course on "Fundamentals of Coatings Formulation for Increased Productivity." Sponsored by Eastern





Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Aug. 12-15)—Short Course on "Quality Assurance in Industrial Coatings." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Aug. 26-28)—Advanced Colorimetry Course. Munsell Color Science Laboratory, Rochester Institute of Technology campus, Rochester, NY. (Martha Pschirrer, Munsell Color Science Laboratory, RIT, P.O. Box 9887, Rochester, NY 14623).

(Sept. 2-4)—Federation of Scandinavian Paint and Varnish Technologists. 11th Congress. SAS Hotel Scandinavia, Oslo, Norway. (Paal Ivan, Nodest Industries A/S, Boks 500, N-3001 Drammen, Norway).

(Sept. 2-6)—Short Course on "Films and Coatings for Technology." Davos Congress Center, Switzerland. (Continuing Education Institute—Europe, Rörtorpsvägen 5, S-612 00 Finspang, Sweden).

(Sept. 9-12)—Short Course on "Introduction to Coatings Technology." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Sept. 9-13)—Short Course on "Nitride and Carbide Coatings." LSRH Research Center, Neuchatel, Switzerland. (Continuing Education Institute—Europe, Rörtorpsvägen 5, S-612 00 Finspang, Sweden).

(Sept. 16-19)—Fifth Finishing Conference and Exposition of the Association for Finishing Processes of the Society of Manufacturing Engineers. Cobo Hall, Detroit, MI. (Public Relations Dept., AFP/SME, One SME Dr., P.O. Box 930, Dearborn, MI 48121).

(Sept. 17-19)—FINISHING '85. Cobo Hall, Detroit, MI. (AFP/SME, P.O. Box 930, Dearborn, MI 48128).

(Sept. 21-24)—Canadian Paint and Coatings Assn. 73rd Annual Convention. Clevelands House, Minnett, Ont. (CPCA, 515 St. Catherine St. W., Montreal, Que., Canada H3B 1B4).

(Sept. 30-Oct. 2)—12th International Naval Stores Meeting. Westin Peachtree Plaza Hotel, Atlanta, GA. (Douglas E. Campbell, Executive Director, Pulp Chemicals Assn., 60 E. 42nd St., New York, NY).

(Oct. 8-11)—XVIth Congress of AFTPV (French Assn. of Paint and Varnish Technicians), Strasbourg, France. (Congress Secretary, B.P. 1036, 68050 Mulhouse Cedex, France).

(Oct. 14-18)—European Conference on Applications of Surface and Interface Analysis. Veldhoven, The Netherlands. (ECASIA Conference Bureau: QLT Convention Services, Keizersgracht 792, 1017 EC Amsterdam, The Netherlands).

(Oct. 15-17)—ASTM Committee B-8 on Metallic and Inorganic Coatings. ASTM Headquarters, Philadelphia, PA. (Teri Carroll, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Oct. 21-23)—Symposium on "New Chemistry for Product Diversification and Specialization in Coatings." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Oct. 27-30)—Fire Retardant Chemicals Association Fall Conference, Pinehurst Hotel, Pinehurst, NC. (James D. Innes, FRCA, 851 New Holland Ave., P.O. Box 3535, Lancaster, PA 17604).

(Nov. 4-6)—National Paint and Coatings Association. 98th Annual Meeting. Hilton Hotel, New Orleans, LA. (Karen Bradley, NPCA, 1500 Rhode Island Ave. N.W., Washington, DC 20005).

(Nov. 6-8)—National Coil Coaters Association Fall Technical Meeting. Hyatt Regency Dearborn, Dearborn, MI. (Tony Carroll, NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Nov. 15-17)—38th National Decorating Products Association Show. McCormick Place, Chicago, IL. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

(Nov. 18-19)—Seminar on "Fine Particles and Fillers—Overlooked Opportunities." Sheridan Park Conference Center, Mississauga, Ont., Canada. (H.G. McAdie, Ontario Research Foundation, Sheridan Park Research Community, Mississauga, Ont., Canada, L5K 1B3).

(Dec. 4-6)—Short Course on "Advanced Chemical Coatings for Technical Managers." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Dec. 9-10)—Short Course on "Introduction to Paint Job Estimating." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Dec. 11-13)—Short Course on "Update on Coatings for Painting Contractors." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

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(Apr. 14-15)—ASTM Symposium on "Testing of Metallic and Inorganic Coatings," Chicago, IL. (Teri Carroll, ASTM Standards Development Div., 1916 Race St., Philadelphia, PA 19103).

(Sept. 7-12)—Symposium on High Solids Coatings. Sponsored by the Division of Polymeric Materials: Science and Engineering, American Chemical Society. Anaheim, CA. (George R. Pilcher, Hanna Chemical Coatings Corp., P.O. Box 147, Columbus, OH 43216).

Advertisers Index

'Humbug' from Hillman

Maureen Lein has been awarded the unannounced, unpublicized, and unheralded *Humbug Honors Award.* The award is being given for her persistent, consistent, and unreasonable efforts in contributing most often to "Humbug from Hillman" over the past two years.

The citation reads—"For her frequent contributions to 'Humbug' and her courageous tenacity in the face of justifiable ridicule, Maureen Lein has been chosen by a select committee of one to be the Humbug Honors recipient for 1985."

Maureen, when she sent in the following nonsense from *Family Safety & Health* wondered, "if it doesn't seem strange that a slim chance and a fat chance mean the same thing?"

- In Salt Lake City, a rupture in a 16-inch water main was blamed on an implosion caused by a massive rush to bathrooms at halftime during the telecast of Super Bowl XVIII.
- When a California couple discovered their car had been stolen, they rented a car so that they could search for their own. The culprit who had taken their car ran a stop sign and broadsided another car. You guessed it—it was the car the couple had rented to use in their search.
- A Pittsburgh, PA, man parked his car on a street with a downhill grade and went to run an errand. When he returned, he found his car wedged between a loaded coal truck and another car that was snug up against his car's rear bumper. Being resourceful, the man figured he could release the coal truck's emergency brake and let the truck roll forward a few feet, giving him enough room to get his car out of its cramped parking space. He climbed into the truck's cab and was confronted by a variety of levers. He wasn't sure which was the brake, so he guessed—wrong! He grabbed the dump lever and instantly buried his car under five tons of coal.

Milt Glaser discovered what may be to you an amazing statistic. It seems that the average person drinks about 16,000 gallons of water during his lifetime. I could make several appropriate observations but better to leave them to your imagination.

- In the business world an executive knows something about everything; a technician knows everything about something; and the switchboard operator knows everything.
- If you want to see flying saucers, pinch a waitress. . . . The Lion

DEAR HUMBUG:

As one of your faithful readers and an occasional contributor, I have admired the wry humor reflected in many of the items you print. Often, even while I laugh, I think of that old phrase, "Tain't funny, McGee!" (For the benefit of your younger readers, this exclamation was popular in the days of electromagnetic communication by sound only, without pictures.)

Well, here's a communication of that funny-not-so-funny genre, for which I gratefully acknowledge *The Wall Street Journal*, and specifically, one James E. Sullivan, writing from Winter Springs, Florida:

"My wife and I, who are members of the Pearl Harbor generation, were speculating about what would have happened to us had the Japanese won the war.

"Remembering how they assigned conquered nations to a place in what they euphemistically termed the Greater East Asia Co-Prosperity Sphere, I concluded that we would have been relegated to a Third-World role of sending raw materials to Japan, while they systematically kept our manufactured goods out of their country and dominated our markets for finished goods. Jobs and wealth would thus be transferred from the vanquished to the victor.

"No sooner had I uttered these thoughts, than, as they do in the comic strips, the lights came on in both our heads and we cried in unison: 'We must have lost the war,' because, with the acquiescence of the Reagan administration, that is exactly what is taking place now."

—SID LAUREN

Just when you might have thought that you were safe and escaping from Bob Ahlfisms, along comes Tom Miranda with a whole new supply. We'll plague you with them from time to time. For example—

- To make a long story short, just have the boss walk in.
- More people take credit for the Mustang than for the Edsel.—Iacocca
- I'd like to tell you the truth but you'd just think I was arrogant.
- A Hershey bar weighs 1.125 ounces.—Eat one and you gain a pound.
- You CAN fight City Hall.—You can fight, but you can't win!

—Herb Hillman
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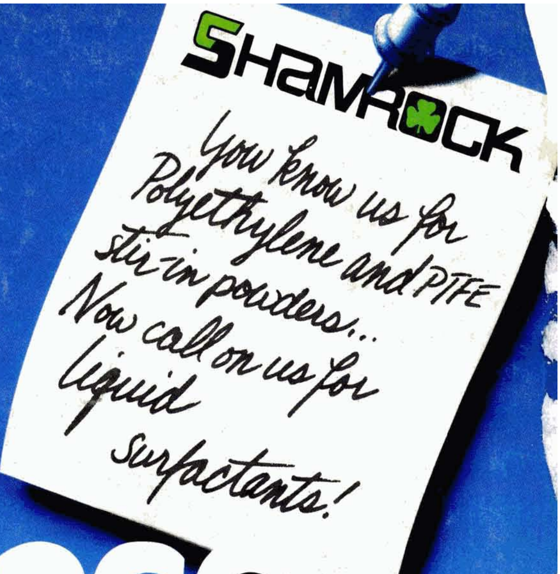

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