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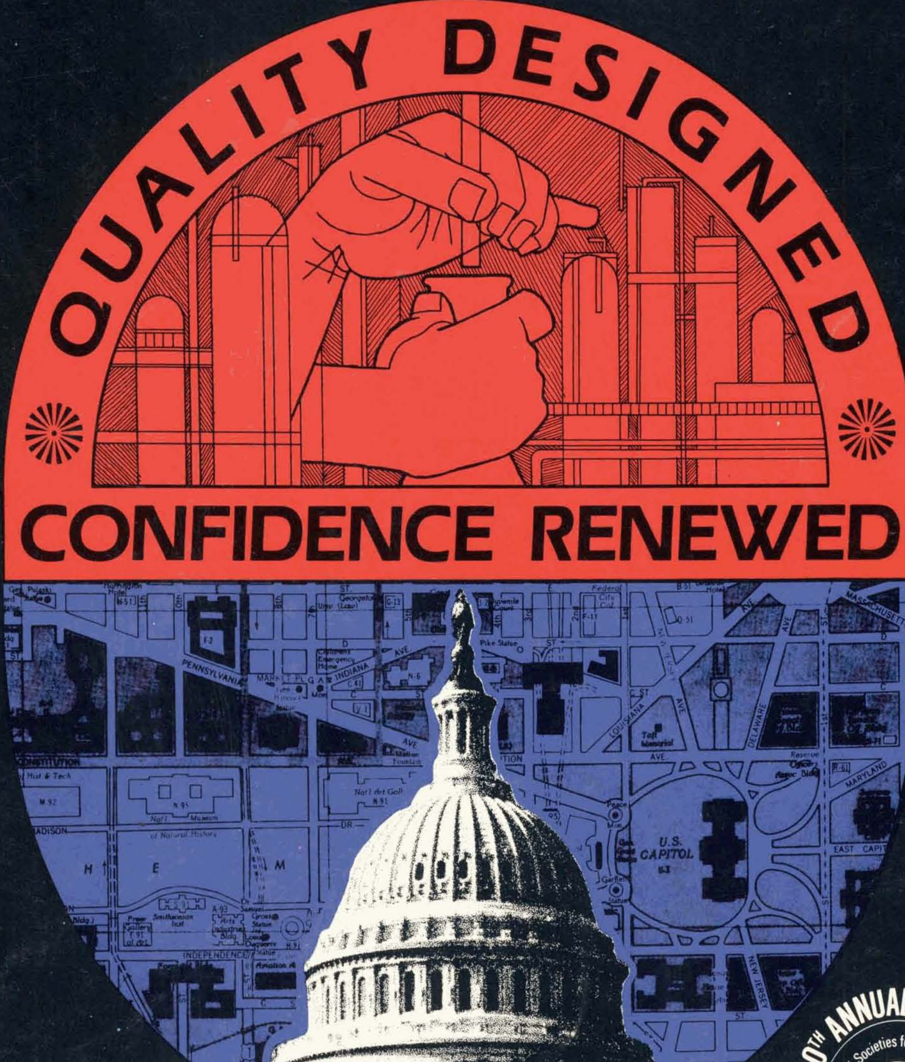
OCTOBER 1982



60TH ANNUAL MEETING
Federation of Societies for Coatings Technology
1922
1982
YE OLDE PAINT STONE 1737

ANNUAL MEETING & PAINT SHOW ISSUE


OLFSON
156

How to keep your latex paints in the thick of it.

60th ANNUAL MEETING
Federation of Societies for Coatings Technology
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VOLUME 54 NUMBER 693

Technical Articles

Federation News

Departments

BPA Membership Applied For May 1982

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1315 Walnut St., Phila., Pa. 19107

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Comment

With Its Head Above Water

With all the talk of deficits that one hears about these days in government, business, and even association circles, it is with pride that we report that the Federation continues to operate "in the black." The balanced budget for 1982 is about $1.3 million and the following outlines the sources of income and the areas of expense:

INCOME

39%—*Publications:* JCT advertising and non-member subscriptions; Series on Coatings Technology; Dictionary; Infrared Book; Pictorial Standards Manual, and others.

45%—*Annual Meeting and Paint Show:* Sale of exhibit space; Registration fees; Program Book Advertising.

8%—*Membership Dues:* About 6,600 members at $15.00 each.

2%—*Educational Activities:* Color-matching Aptitude Test Set; Audio/visual programs.

6%—*Miscellaneous:* Miscellaneous items; investment interest.

EXPENSE

35%—*Headquarters Administration:* Operation of the headquarters office and staff in Philadelphia; Communications activities; Staff travel.

30%—*Publications:* Production/promotion of all publications

16%—*Annual Meeting and Paint Show:* Management/promotion of these twin events.

10%—*Educational Activities:* Support of: Paint Research Institute; University scholarships; Educational Committee; Grants to industry organizations; Audio/visual programs; Color-matching Aptitude Test Set; Technical Advisor.

9%—*Officers, Board, and Committees:* Travel expenses for Officers; Transportation and meeting expenses for Board of Directors, Executive Committee; and national meetings of the Educational, Manufacturing, Technical Advisory, and other Committees.

The major sources of income are derived mostly from raw material and equipment manufacturers who advertise in Federation publications and exhibit in the Paint Show.

We thank them for their continued support which enables the Federation to carry on its research, educational, and publishing activities in and for the industry—with its head clearly above water.

Frank J Borrelle

Frank J. Borrelle
Executive Vice-President


BENTONE
SD-1
RHEOLOGICAL ADDITIVE
NL Chemicals

Abstracts of Papers in This Issue

ANTI-CORROSIVE PRIMERS BASED ON ZINC FLAKE—C.H. Hare and S.J. Wright

Journal of Coatings Technology, 54, No. 693, 65 (Oct. 1982)

An examination of the possibilities for the use of zinc flake in anti-corrosive coatings has revealed the material to produce films of significantly greater reactivity than zinc rich primers based on zinc dust. Attempts to reduce this reactivity by employing inhibitors and by the use of spacer pigments have led to the development of formulations utilizing tri-pigment systems based on zinc flake, zinc chromate and mica. These materials appear to offer value in their greater formulating versatility compared to modified organic zinc rich primers based on zinc dust.

MODIFICATION OF ACRYLIC POLYMERS FOR HIGH SOLIDS COATINGS—A.N. Theodore and M.S. Chattha

Journal of Coatings Technology, 54, No. 693, 77 (Oct. 1982)

A procedure has been developed for grafting ε-caprolactone onto a low molecular weight hydroxy acrylic polymer in the presence of dibutyltin oxide. High solids coatings formulations based on the graft polymer (cured with melamine resins) exhibit impact strength and flexibility superior to that obtained with either the starting acrylic polymer or a hydroxy acrylic polymer of equivalent glass transition temperature. At comparable solids levels, the viscosity of paints based on the graft copolymer is slightly higher than that of paints formulated from the parent acrylic polymer.

In accelerated weathering, the durability of coatings based on the graft polymer is intermediate to coatings obtained from the parent and low glass transition temperature acrylic polymers.

ROUTES TO LOW POLLUTION GLAMOUR METALLIC AUTOMOTIVE FINISHES—A.J. Backhouse

Journal of Coatings Technology, 54, No. 693, 83 (Oct. 1982)

As the application solids of spray applied paints rises, the change in viscosity due to solvent evaporation falls. In order to maintain flow control, the viscosity change can be augmented by the use of a paint with pseudoplastic rheology.

The degree of pseudoplasticity of a basecoat in a basecoat/clear process is not constrained by considerations of gloss to the same extent as it is in a finish.

Basecoats can be formulated, using polymer microgels, which can be sprayed at high solids. Although such basecoats are even in appearance, the highest solids are only achieved at the expense of aluminum orientation and loss of 'flop'.

A water–borne basecoat of pseudoplastic rheology achieves a high degree of aluminum orientation and flop, together with a low level of atmospheric pollution.

A MODEL FOR THE UPTAKE OF LINSEED OIL BY WOOD—M.H. Schneider and A.R. Sharp

Journal of Coatings Technology, 54, No. 693, 91 (Oct. 1982)

Direct gravimetric measurements of the along-the-grain uptake of linseed oil by white spruce sapwood are reported. The uptake vs time curve is characterized by three different time constants, (tens of days, days, hours) each with an associated equilibrium uptake. The interpretation is that the observed time constant of one to two days is associated with lumen capillarity in cells which are damaged by drying stresses or have partially open pits, and an uptake time constant an order of magnitude longer than this with lumen capillarity in less permeable cells. These time constants account for 60% and 30% to 40% of the observed uptake, respectively. About 5% to 10% of the total uptake proceeds with a time constant of a few hours. The mechanism for this is thought to be uptake along subvisible cracks in the wood.


Pfizer

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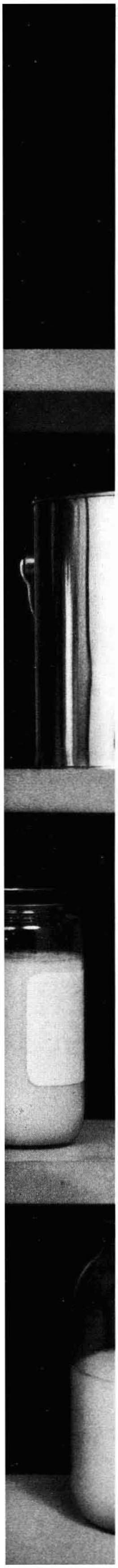

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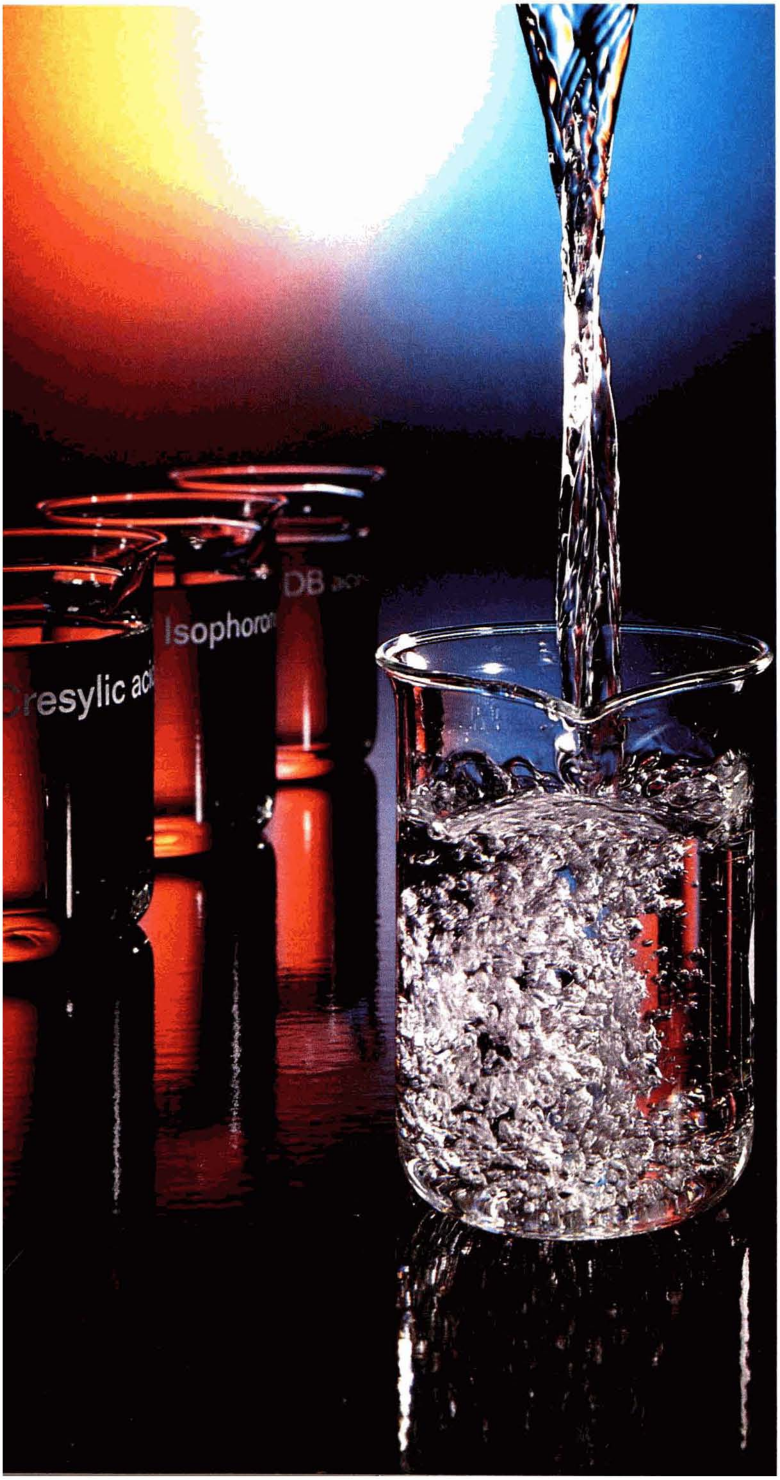

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PRI Paint Research Institute
OF THE FEDERATION OF SOCIETIES FOR PAINT TECHNOLOGY

IMPORTANT QUESTIONNAIRE

Concerning You and the Coatings Industry

THIS QUESTIONNAIRE FIRST APPEARED IN THE JULY 1982 JCT.
PLEASE COMPLETE ONLY IF YOU DID NOT RETURN THE INITIAL QUESTIONNAIRE.

QUESTIONNAIRE

At the January 1982 meeting, the Paint Research Institute Trustees discussed the report of the Ad Hoc Committee on PRI. This report related the comments of the many Federation members as well as other interested paint industry people, who were interviewed by the five-member Ad Hoc Committee.

The PRI Trustees are sympathetic to the many criticisms of past PRI performance. A reorganization and new 5-year plan is underway to change PRI. The President and Trustees of PRI are determined to make the research work of PRI relevant to the needs of the Paint and Coatings Industry. They will also convey research results to the Federation membership in a form which all can understand. It is planned that the results of research conducted by PRI should be helpful to the greatest number of companies possible.

In making your suggestions for future PRI research projects, please keep in mind that the Paint Research Institute is a tax-exempt organization. For this reason PRI cannot participate in proprietary or product development research.

Funds presently available to PRI are limited, so the number of projects to be undertaken must be limited. The PRI Trustees expect to prove that PRI research is of definite economic value to the industry and thus justify future funding at a higher level.

The attached brief questionnaire is an effort by the PRI Trustees to determine the type of research which *YOU* believe will be most helpful to the Paint and Coatings Industry. It is also an effort to give everyone associated with the industry an opportunity to contribute thoughts and ideas.

It is not necessary to sign your name to the completed questionnaire. However, to aid PRI in determining the type of research most needed by our industry, will you please check the appropriate boxes to describe your job, the size of your company, and the nature of your company's business.

Now is your chance. Won't you share your ideas with us?

Please complete and mail this questionnaire to:

Mr. Frank J. Borrelle
Executive Vice President
The Federation of Societies for Coatings Technology
1315 Walnut Street
Philadelphia, PA. 19107

SURVEY QUESTIONNAIRE
ON PRI PROJECT SELECTION

(1) If you could choose a research project for PRI work, what would it be?

First Choice ____

____

Second Choice ____

____

(2) Explain why you believe this project (s) will help industry if the research is successful.

____

____

(3) Will you please rate the following areas of research as you view their importance to the paint and coatings industry.

	Very Important	Moderately Valuable	Of Little Value
(a) Elimination of mildew growth on paint films	☐	☐	☐
(b) Prevention of steel corrosion	☐	☐	☐
(c) Waste treatment, recycling, and disposal	☐	☐	☐
(d) Coatings transfer efficiency improvement	☐	☐	☐
(e) Promotion of coatings adhesion	☐	☐	☐
(f) Waterborne coatings technology	☐	☐	☐
(g) High solids coatings technology	☐	☐	☐
(h) Better accelerated weathering testing	☐	☐	☐
(i) Improved pigment dispersion techniques	☐	☐	☐
(j) Improved test methods for evaluating coatings performance	☐	☐	☐
(k) Investigation of renewable natural raw materials	☐	☐	☐

(4) Please list other areas of research which you believe could be valuable to the paint and coatings industry.

____

____

(5) Can you suggest areas other than research, in which PRI could be helpful?

____

____

(6) *Your job:* ☐ Technical; ☐ Manufacturing; ☐ Sales; ☐ Management.
Company size: ☐ Large (over $80 million); ☐ Medium ($10 to $80 million);
☐ Small (under $10 million)
Type business: ☐ Paint mfg.; ☐ Raw Mat'l. Supplier;
☐ Equipment mfg.; ☐ Other ____________________.

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Stamp
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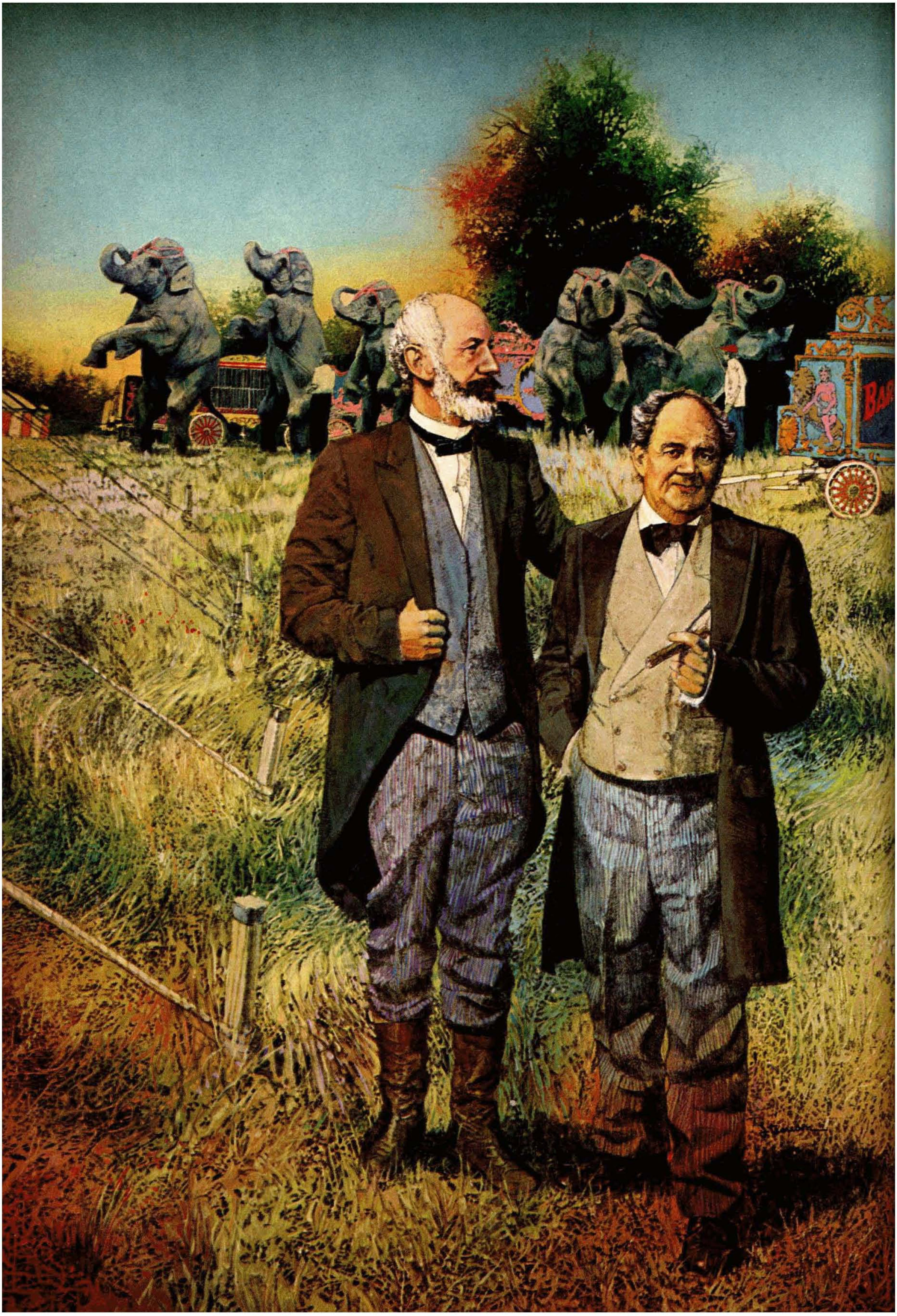
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EVEN IN OXYGENATED SOLVENTS, GOOD TEAMWORK CAN GET YOUR SHOW ON THE ROAD.

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In the same way, if you use oxygenated solvents, we can team up with you and help you make all the right moves in the years ahead.

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PROGRAM

60th ANNUAL MEETING

47th PAINT INDUSTRIES' SHOW

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NOVEMBER 3, 4, 5, 1982

60TH ANNUAL MEETING
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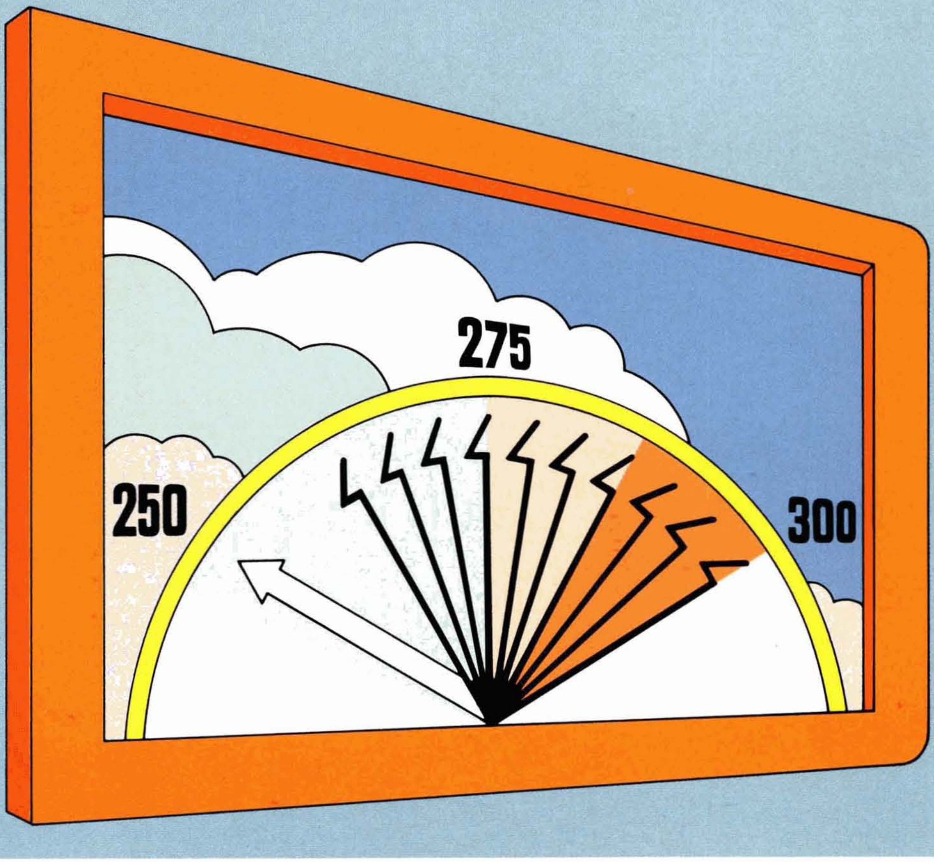
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Program

WEDNESDAY, NOVEMBER 3

OPENING SESSION
(10:00)

Sixtieth Annual Meeting of the Federation of Societies for Coatings Technology opened by President Howard Jerome.

Invocation and In Memoriam

Welcome: Donald Keegan, President of Baltimore Society for Coatings Technology

Gordon Allison, Chairman of the Host Committee

John C. Ballard, Chairman of the Program Committee

Deryk R. Pawsey, Chairman of the Paint Industries' Show Committee

Introduction of Distinguished Guests

Report of President Jerome

E.W. FASIG KEYNOTE ADDRESS
(10:30)

Keynote Address by Jules Bergman, Science Editor of ABC Network News.

INSURING QUALITY MANAGEMENT AND TECHNOLOGY THROUGH COMPUTER UTILIZATION
(2:00–5:00)

THE COATINGS INDUSTRY VS. DISCRETE MANUFACTURING—JUST HOW DIFFERENT IS IT?—John W. Kilgore, Wang Laboratories, Inc., Lowell, MA.

MICRO-COMPUTING OPENS NEW HORIZONS—Craig Larson, Chemical Specialties, Inc., Caledonia, MI.

EXPLOITING YOUR LABORATORY COMPUTER FOR YOU AND YOUR MANAGEMENT—Alan Brandau, DeSoto, Inc., Des Plaines, IL.

COMPUTER TECHNOLOGY IN COATINGS RESEARCH—Maynard Sherwin, Technical Center, Union Carbide Corp., South Charleston, WV.

The speakers will assemble as a panel for a 30-minute open-discussion period, then each will conduct workshop sessions to further explore their individual topics in more depth.

SYMPOSIUM ON POLYMER CHEMISTRY
(2:00–5:00)

INTER-RELATIONSHIPS BETWEEN PIGMENT SURFACE ENERGIES AND PIGMENT DISPERSIONS IN POLYMER SOLUTIONS—G. Dale Cheever and John C. Ulicny, General Motors Research Laboratories, Warren, MI. *(Roon Award-Winning Paper)*

STUDIES ON THE ESTERIFICATION OF TRIMELLITIC ANHYDRIDE—IMPLICATIONS FOR COATINGS POLYMERS—Wayne Riddick, Amoco Chemicals Corp., Naperville, IL.

FACTORIAL EXPERIMENTAL DESIGN: DETERMINATION OF HYDROXYL CONTENT IN POLYMERS—B. O. Demarest and L.E. Harper, DeSoto, Inc., Des Plaines, IL.

WATER-BORNE MARINE ANTIFOULANT COATINGS TOXICANT/RESIN COMPATIBILITY STUDIES—James Stoffer, John Gordon, Mike Beckman, and David Price, University of Missouri-Rolla, Rolla, MO.

STRUCTURE-PROPERTY RELATIONSHIPS FOR RADIATION CURABLE COATINGS—Aldo Priola, Fiorenzo Renzi, and Sebastiano Cesca, ASSORENI, Milan, Italy. (Presented on behalf of FATIPEC: Federation of Associations of Technicians in the Paint, Varnish, Lacquer, and Printing Ink Industries of Continental Europe.)

SYNTHESIS AND STRUCTURE-PROPERTIES RELATIONSHIPS OF OXAZOLIDONE RING-CONTAINING COATINGS—P. I. Kordomenos, Paint Plant, Ford Motor Co., Mt. Clemens, MI, and K.C. Frisch and J.E. Kresta, Polymer Institute, University of Detroit, Detroit, MI.

SYMPOSIUM ON FORMULATION—I
(2:00–4:30)

WATER-EXTENDIBLE HIGH SOLIDS ENAMELS—Frank N. Jones, Morris R. Olson, and Jim M. Larson, Cargill, Inc., Minneapolis, MN.

RHEOLOGY CONTROL OF HIGH SOLIDS COATINGS—Dennis G. Miller, William F. Moll, and Vaughn W. Taylor, Cabot Corp., Tuscola, IL.

THE CHEMISTRY OF HIGH SOLIDS, AIR DRY ALKYD/REACTIVE DILUENT COATINGS—Donald B. Larson and W.D. Emmons, Rohm and Haas Co., Spring House, PA.

VISCOSITY LOSSES IN LATEX PAINTS—Dallas Society for Coatings Technology. Presented by R. G. Gohman, Jones-Blair Co., Dallas, TX.

CHARACTERIZATION OF PIGMENT VOLUME CONCENTRATION EFFECTS IN LATEX PAINTS—D. T. Smith, W.J. Culhane, and C.P. Chiang, The Sherwin-Williams Co., Chicago, IL.

THURSDAY, NOVEMBER 4

MANUFACTURING COMMITTEE SEMINAR ON COMPUTERS IN THE COATINGS MANUFACTURING PROCESS

(9:00–12:00)

Moderator—Richard E. Max, Synkote Paint Co., Elmwood Park, NJ.

COMPUTERIZED PROCESS CONTROL—
J. Patrick Kennedy, Oil Systems Inc., San Leandro, CA
Robert W. McFee, Glidden Coatings & Resins, Div. of SCM Corp., Huron, OH.

COMPUTERIZED COLOR CONTROL—Wes Coppock, Applied Color Systems, Inc., Charlotte, NC.

COMPUTERS IN THE COATINGS MANUFACTURING BUSINESS
The Small Manufacturer Looks at a New Tool—the Micro-Computer—Colin D. Penny, Hampton Paint Mfg. Co., Hampton, VA.
Creative Use of Your Computer System—John Emmerling, Lenmar, Inc., Baltimore, MD.
Manufacturing Control with Time-Sharing Computers—Joseph B. Milgram, Jr., DeSantis Coatings Inc., Willoughby, OH.
Programming Computers—Martin Becker, Contact Paint & Chemical Corp., Baltimore, MD.

Moderator and speakers will assemble as a panel for a 45-minute open-discussion period to conclude seminar.

Presentation of the Morehouse Industries Golden Impeller Award will be made at this session.

SYMPOSIUM ON COATINGS DEFECTS

(9:00–11:30)

POPPING OF "WATER-SOLUBLE" BAKING ENAMELS—Zeno W. Wicks, Jr., Polymers & Coatings Dept., North Dakota State University, Fargo, ND, and Ben C. Watson, The Sherwin-Williams Co., Chicago, IL. *(Roon Award-Winning Paper)*

PRESENCE AND EFFECTS OF ANAEROBIC BACTERIA IN WATER-BASED PAINTS—Robert A. Oppermann, Cosan Chemical Corp., Carlstadt, NJ. *(Roon Award-Winning Paper)*

AN EXPERIMENTAL DESIGN APPROACH TO STUDYING THE YELLOWING EFFECTS OF PLASTICIZERS ON PAINTS—Robert D. Mate, Herbert L. Bullard, and Kenneth G. Roquemore, The Goodyear Tire & Rubber Co., Akron, OH.

PREDICTIVE MODEL FOR CRACKING OF LATEX PAINTS APPLIED TO EXTERIOR WOOD SURFACES—F. Louis Floyd, Glidden Coatings and Resins, Div. of SCM Corp., Strongsville, OH. *(Roon Award-Winning Paper)*

THE MECHANISM OF BLISTER FORMATION—Charles M. Hansen and Klaus Lampe, Scandinavian Paint & Printing Ink Institute, Horsholm, Denmark. (Presented on behalf of SLF: Federation of Scandinavian Paint and Varnish Technologists).

DESIGNING QUALITY THROUGH USE OF SCIENTIFIC INSTRUMENTATION—I

(9:00–12:00)

PARTICLE SIZE MEASUREMENT BY DISC CENTRIFUGE PHOTOSEDIMENTOMETRY—Theodore Provder, Glidden Coatings and Resins, Div. of SCM Corp., Strongsville, OH.

ELECTROCHEMICAL TECHNIQUES FOR STUDYING PROTECTIVE COATINGS—Henry Leidheiser, Jr., Center for Surface and Coatings Research, Lehigh University, Bethlehem, PA.

TORSIONAL BRAID ANALYSIS (TBA); TIME-TEMPERATURE-TRANSFORMATION (TTT) CURE DIAGRAMS OF THERMOSETTING EPOXY/AMINE SYSTEMS—John K. Gillham and John B. Enns, Dept. of Chemical Engineering, Princeton University, Princeton, NJ.

COMPARATIVE SOLVENT EVAPORATION MECHANISMS FOR CONVENTIONAL AND HIGH-SOLIDS COATINGS—William H. Ellis, Chevron Research Co., El Segundo, CA. *(Roon Award-Winning Paper)*

VISCOMETRY: MYTH AND REALITY—Los Angeles Society for Coatings Technology. Presented by Pat Shaw, Athey Technologies, Seal Beach, CA.

COMPUTERIZATION AND AUTOMATION IN A COATINGS ANALYTICAL CHEMISTRY LABORATORY—P. Kamarchik and G.P. Cunningham, PPG Industries, Inc., Research Center, Springdale, PA.

SYMPOSIUM ON FORMULATION—II

(2:00–5:00)

THE INFLUENCE OF CO-SOLVENTS ON THE STABILITY AND FILM PROPERTIES OF WATER-SOLUBLE ALKYDS—Toronto Society for Coatings Technology. Presented by Andrew J. Jones, Degussa Canada Ltd., Burlington, Ontario, Canada.

REACTIVE SILANE MODIFIED PIGMENTS II: A DESIGNED EXPERIMENT IN SILANIZED TALC/LATEX FORMULATIONS—Los Angeles Society for Coatings Technology. Presented by Robert D. Athey, Athey Technologies, Seal Beach, CA.

THE DESIGN OF WATER-BORNE COATINGS FOR THE CORROSION PROTECTION OF STEEL. PART III: THE EFFECT OF SURFACTANTS IN AN AQUEOUS AIR-DRY COATING—New England Society for Coatings Technology. Presented by Cynthia Leavy, General Electric Co., Louisville, KY.

THE EFFECT OF MOLECULAR WEIGHT ON PERFORMANCE OF CELLULOSIC THICKENERS IN LATEX PAINTS—D. M. Blake, Dow Chemical Co., Midland, MI.

THE EFFECT OF CATALYSTS ON KINETICS AND MECHANISM OF URETHANE FILM FORMATION—David Ihms and James Stoffer, University of Missouri-Rolla, Rolla, MO., and Daniel Schneider and Cheryl McClain, Carboline Co., St. Louis, MO.

QUALITY AND CONSISTENCY FROM AN EASIER DISPERSING RHEOLOGICAL ADDITIVE—Armand J. Stolte, Judy Hahn, and Michael E. Masterson, NL Chemicals/NL Industries, Inc., Hightstown, NJ.

TECHNICAL INFORMATION SOURCES AND SERVICES FOR THE COATINGS INDUSTRY—AN UPDATE

(2:00–4:30)

Moderator—Helen Skowronska, Chairperson, Technical Information Systems Committee.

COATINGS INFORMATION FROM CHEMICAL ABSTRACTS SERVICE—Paul F. Herbeck and Elizabeth M. Langstaff, Chemical Abstracts Service, Columbus, OH.

PARTICIPATION—THE FOURTH "P", AFTER PEOPLE, POLITICS, AND PUBLICATIONS—John C. Weaver, Consultant, Shaker Heights, OH.

INFORMATION SERVICES AT PUBLIC AND COLLEGE LIBRARIES—Helen Lamrey, PPG Industries, Inc., R&D Center, Allison Park, PA.

INFORMATION SERVICES—AN OVERVIEW—Robert M. Vance, The Sherwin-Williams Co., Research Center, Chicago, IL.

THE EMERGING ELECTRONIC LIBRARY—IMPLICATIONS FOR CORPORATE SCIENTISTS AND ENGINEERS—Clifford Tierney, Whirlpool Corp., R&D Center, Benton Harbor, MI.

PRI SYMPOSIUM HONORING DR. RAYMOND R. MYERS

(2:00–5:00)

Introductory comments by Peter V. Robinson, Glidden Coatings and Resins, Div. of SCM Corp., Strongsville, OH, President of Paint Research Institute.

MILDEWCIDE TESTING ON GROWTH AND ULTRASTRUCTURAL RESPONSES OF THE FUNGUS *AUREOBASIDIUM PULLULANS*—Richard E. Crang, Dept. of Botany, University of Illinois at Urbana-Champaign, Urbana, IL.

NONDESTRUCTIVE EVALUATION OF POLYMER SURFACES, INTERFACES AND FILMS VIA ULTRASONICS—D. L. Hunston and J.A. Koutski, U.S. Dept. of Commerce, National Bureau of Standards, Polymer Div., Washington, DC.

CHARACTERIZATION OF ORGANIC COATINGS BY DIELECTRIC AND DYNAMIC MECHANICAL RELAXATION TECHNIQUES—K. Varadarajan, Technical Center, American Can Co., Barrington, IL.

THERMOSETTING COATINGS—ANALYTICAL AND PREDICTIVE CAPABILITY BY CHEMORHEOLOGY—Richard R. Eley, Glidden Coatings and Resins, Div. of SCM Corp., Strongsville, OH.

Concluding portion of symposium will feature Federation Officers and PRI Trustees expressing appreciation to Dr. Myers for his many years of service as Research Director.

DESIGNING QUALITY THROUGH USE OF SCIENTIFIC INSTRUMENTATION—II

(2:00–5:00)

CHARACTERIZATION OF THE VARIABILITY IN CORROSION RESISTANCE OF STEEL USING ELECTROCHEMICAL TECHNIQUES—R.G. Groseclose, C.M. Frey, and F. Louis Floyd, Glidden Coatings and Resins, Div. of SCM Corp., Strongsville, OH.

EVAPORATION DURING SPRAYOUT OF A TYPICAL WATER REDUCIBLE PAINT AT VARIOUS HUMIDITIES—Albert L. Rocklin, Shell Development Co., Houston, TX.

USE OF THE BROOKFIELD VISCOMETER TO PREDICT RHEOLOGICAL PERFORMANCE OF COATINGS—Luigi Cutrone, Tioxide Canada Inc., Sorel, Quebec, Canada.

ASSESSMENT OF WEATHERING IN TWO-COAT AUTOMOTIVE FINISHING SYSTEMS—Joseph Puglisi and Fred Vigeant, CIBA-GEIGY Corp., Hawthorne, NY.

COMPUTER-DESIGN OF LATEX FLATS TO MEET A REQUIRED FILM INTEGRITY AND PAINT COST—Dallas Society for Coatings Technology. Presented by Ray C. Pierrehumbert, Union Carbide Corp., Garland, TX.

COLOR CHANGE WITH CHANGE OF VIEWING ANGLE—Los Angeles Society for Coatings Technology. Presented by V.C. Jenkins, Ellis Paint Co., Los Angeles, CA.

WASHINGTON MONUMENT—By law, the tallest building in the nation's capital, at 555 ft, it is also the tallest masonry structure in the world

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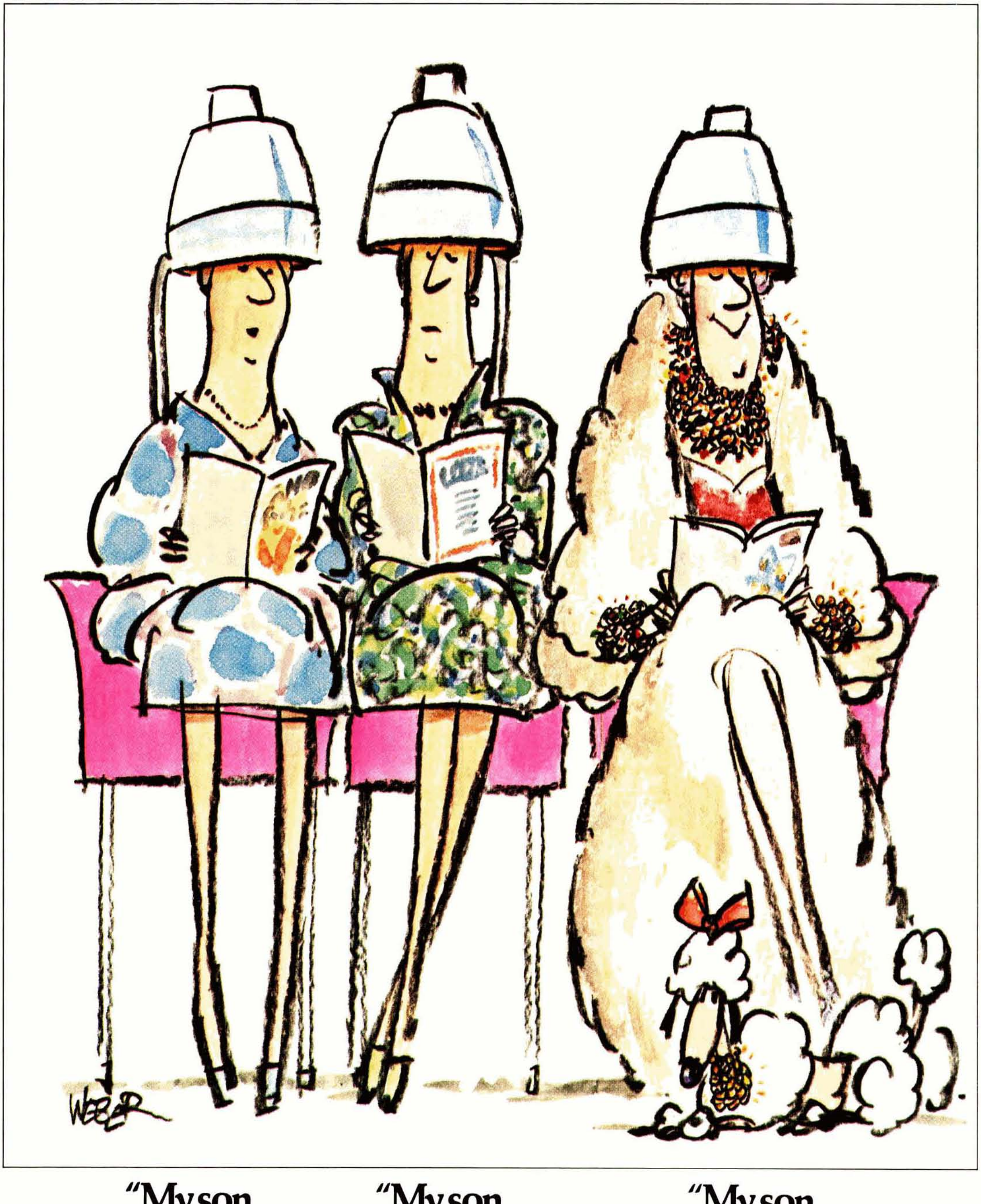

"My son
is a doctor."

"My son
is a lawyer."

"My son
makes paint
with UCAR Acrylics."

FRIDAY, NOVEMBER 5

EDUCATIONAL COMMITTEE PRESENTATION ON COATINGS SCIENCE AS A CAREER
(9:00–10:30)

Moderator—John A. Gordon, Dept. of Chemistry, University of Missouri-Rolla, Rolla, MO.

HOW TO PREPARE FOR A CAREER IN COATINGS—Zeno Wicks, Jr., Polymers & Coatings Dept., North Dakota State University, Fargo, ND.

THE ROLE OF THE TECHNICAL PERSON IN COATINGS—John J. Oberle, Benjamin Moore & Co., Newark, NJ.

THE TECHNICAL PERSON IN MANAGEMENT—Robert S. Bailey, Lilly Industrial Coatings, Indianapolis, IN.

DON'T THINK IT ENDS WHEN YOU GRADUATE!—John A. Gordon, Dept. of Chemistry, University of Missouri-Rolla, Rolla, MO.

COLOR, PROCESS, AND WASTE CONTROL
(9:00–10:30)

A MAJOR EXTENSION IN THE USE OF COLOR—BASE COAT/CLEAR COAT—Sol Panush, Inmont Corp., Hamtramck, MI.

FACTORS AFFECTING WEAR IN SMALL MEDIA PIGMENT GRINDING MILLS—Toronto Society for Coatings Technology. Presented by Jan Grodzinski, S. C. Johnson & Son Ltd., Brantford, Ontario, Canada.

LEACH STABILITY OF SOLID WASTES FROM A COATINGS WASTE TREATMENT PROCESS BASED ON PYROLYSIS—Louisville Society for Coatings Technology. Presented by Dean Harper, University of Louisville, Louisville, KY.

REGISTRATION HOURS

Tuesday, November 2	12:00 p.m. to 5:00 p.m.
Wednesday, November 3	8:00 a.m. to 5:30 p.m.
Thursday, November 4	8:00 a.m. to 5:00 p.m.
Friday, November 5	8:00 a.m. to 4:00 p.m.

PAINT SHOW HOURS

Wednesday, November 3	12:00 p.m. to 5:30 p.m.
Thursday, November 4	9:30 a.m. to 5:00 p.m.
Friday, November 5	9:30 a.m. to 4:00 p.m.

MATTIELLO LECTURE
(10:30–11:45)

BUNTE SALTS AS CROSS-LINKING AGENTS IN THERMOSETTING WATER-BORNE POLYMERS—Dr. Shelby F. Thames, Vice-President for Administration and Regional Campuses at the University of Southern Mississippi, Hattiesburg, MS.

FEDERATION LUNCHEON
(11:45)

Presentation of the George Baugh Heckel Award, Union Carbide Award, and Paint Show Awards.

Winners of the other Federation awards to be announced.

Featured Speaker: Mark Russell, political humorist.

CORROSION COMMITTEE PANEL DISCUSSION ON PERFORMANCE OF NON-LEAD, NON-CHROME PIGMENTS IN AQUEOUS AND SOLVENT-BASED COATINGS
(2:00–4:00)

Discussions will focus on presentations by representatives of each of six producers of non-lead, non-chrome pigments. An open-forum period for audience participation will follow.

Moderator—Fred Lafferman, The Enterprise Cos., Chicago, IL.

Kenneth A. Haagenson, Buckman Laboratories, Inc., Memphis, TN.

Milton Kaplan, Mineral Pigments Corp., Beltsville, MD.

Andrew Panozzo, Pigments, Div., BASF Wyandotte Corp., Holland, MI.

Jay Austin, Halox Pigments, Hammond, IN.

David B. Lewis, Sherwin-Williams Chemicals, Coffeyville, KS.

Alan Smith, NL Chemicals/NL Industries, Inc., Hightstown, NJ.

ANNUAL BUSINESS MEETING
(4:00–5:00)

Annual Business Meeting of the Federation.

Presentation of these awards: Roon Foundation . . . American Paint & Coatings Journal/A.F. Voss . . . Materials Marketing Associates . . . Program Committee . . . Armin J. Bruning . . . Ernest T. Trigg.

Installation of Officers, 1982–83.

OTHER CONVENTION INFORMATION

PAINT INDUSTRIES' SHOW

The 47th Annual Paint Industries' Show will run concurrently with the Annual Meeting at the Sheraton Washington Hotel. The only national exposition of materials and equipment used in the formulation, testing, and manufacture of coatings, the Show will be open from Noon to 5:30 p.m. on Wednesday, November 3; 9:30 a.m. to 5:00 p.m. on Thursday, November 4; and 9:30 a.m. to 4:00 p.m. on Friday, November 5.

Participating supplier companies will have their top technical representatives on hand to discuss the latest developments with registrants at this year's event. Over ninety per cent of the companies featured in last year's Paint Show will be in attendance in Washington.

REGISTRATION

Registration fees for the Annual Meeting and Paint Show are on a Federation member and nonmember basis:

	Member	Nonmember	Spouses
Advance*	$40	$55	$25
In Washington	$50	$65	$35
One-Day	$30	$40	—

*Special registration fee for retired members and their spouses—advance only—is $20 each.

Registration form has been mailed to all members.

Note: Purchase of luncheon tickets is optional for both advance and on-site registration.

LUNCHEON

The Annual Federation Luncheon will be held on Friday, November 5, at the Sheraton Washington.

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 1982 Paint Industries' Show), and the Union Carbide Coatings Technology Award (for extraordinary achievement in coatings technology).

Featured speaker will be Mark Russell, well-known political satirist, who stars in his own show on the PBS television network and is regularly featured on NBC's "Real People."

SPOUSES' PROGRAM

A schedule of activities has been planned each day for spouses attending the Annual Meeting, and a Hospitality Suite will be maintained at the Sheraton Washington Hotel.

A get-acquainted Wine and Cheese Social is scheduled for Wednesday afternoon.

On Thursday, a continental breakfast will precede an all-day tour of Annapolis.

Continental breakfast will be available again on Friday morning.

Registration fees for the Spouses' Activities are $25 in advance and $35 on-site.

HEADQUARTERS HOTEL

The Sheraton Washington Hotel will serve as headquarters for the Annual Meeting and Paint Show. Other hotels with blocks of rooms set aside for the event are the Shoreham, Washington Hilton, DuPont Plaza, Gramercy Inn, Embassy Row, Highland, Holiday Inn, and Normandy Inn.

ROOM RESERVATIONS

All requests for room and suites must be made on the official housing form which was mailed to all members. Additional housing forms are available from the Federation headquarters office.

BOARD MEETING

The Fall Board of Directors Meeting of the Federation will be held at the Sheraton Washington Hotel on Tuesday, November 2.

SPEAKERS' BREAKFAST

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

PUBLICATION OF PAPERS

No *Proceedings* is offered of papers presented at the Annual Meeting, nor are preprints of presentations available. The JOURNAL OF COATINGS TECHNOLOGY has prior rights to the publication of all papers presented at the Annual Meeting.

NPCA MEETS SAME WEEK

The National Paint and Coatings Association will hold its annual meeting from November 1–3 at the Washington Hilton Hotel.

NPCA registration badges will be honored for admission to the Federation Annual Meeting and Paint Show on Wednesday, November 3, only.

PROGRAM STEERING COMMITTEE

Chairman—John C. Ballard, of Kurfees Coatings, Inc., Louisville, KY; *Vice-Chairman*—Peter Hiscocks, of CIL Paints Inc., Toronto; Steven Crouse, of Kwal Paints, Denver; Loren W. Hill, of Monsanto Co., Indian Orchard, MA; Gus W. Leep, of Seymour of Sycamore, Sycamore, IL; Robert G. Modrak, of Benjamin Moore & Co., Milford, MA; Tom Ruland, of Cook Paint & Varnish Co., Houston; and Gary Van de Streek, of Wyandotte Paint Products Co., Troy, MI.

Mr. Hiscocks will be Chairman of the Program Committee for the October 12–14, 1983 Annual Meeting and Paint Show in Montreal, Que., Canada.

HOST COMMITTEE

Members of the Baltimore Society are serving on the Host Committee under General Chairman Gordon Allison, of McCormick Paint Works. Assisting him are: Mitchell Dudnikov, of Genstar Stone Products; James A. McCormick, of Inland Leidy; Thomas Mitchell, of Tenneco Chemicals, Inc., and Joseph Giusto, of Lenmar, Inc.

Mrs. Gordon (Margaret) Allison is serving as Spouses' Program Chairman.

HALOX REPORT: TR14

Successfully formulating corrosion-inhibitive emulsion system coatings

Performance—or stability: The great dilemma in formulating non-toxic, corrosion-inhibitive water-based coatings. Use an inhibitive pigment with too low a water solubility, and you may lose performance. Use a more soluble pigment, and risk instability.

Preventing irreversible phase separation, hockey pucks, high viscosity, and cottage cheese.

Instability can take any of these forms in water-thinnable coatings. In one approach, HALOX® Pigments chose, from among many, two representative resin systems to work with: A typical styrenated acrylic emulsion similar to that in coatings now being evaluated by the State of California, and a straight acrylic resin known for generally good performance against corrosion.

Working with these resin systems, we elected to evaluate two classes of pigments: *borosilicates* (HALOX CW2230, 17% B_2O_3, and CW221, 10% B_2O_3), which provide good performance but may present stability problems in water-thinnable coatings, and *phosphosilicates* (HALOX BW191), which offer excellent stability because of comparatively lower solubility parameters. HALOX BW191 was favored over our BW111 because of lower water and vehicle demand.

Pigment selection naturally follows your resin system selection. From there, successful formulations depend on a vast number of variables: pigment solubility... pigment vehicle demand... water demand... and many more, including surfactant and wetting agent choice, order of addition, and dispersion parameters and techniques. To name just a few.

		Oil Absorption	Solubility constant gm/100ml H_2O
CW221	Calcium borosilicate (10% B_2O_3)	35	0.35
CW2230	Calcium borosilicate (17% B_2O_3)	42	0.40
BW191	Barium phosphosilicate	25	0.06

Formulating practice for stable high performance

Styrenated Acrylic Paints—
All three styrenated acrylic paints, regardless of pigment, proved to be stable up to one month when carefully made, but the high boron pigment tended toward irreversible phase separation and seeding, believed to be due to soluble cation presence.

The borosilicate pigmented paint tended to foam and froth, so in accelerated corrosion testing there was some rust failure in a "measles" pattern in single-coat. This was not seen in multiple-coat applications because the additional coverage filled in broken bubble craters. The phosphosilicate paint generally retained less air, hence foaming and frothing less, giving better single-coat corrosion test results.

A good formula incorporating the phosphosilicates in this vehicle is:

WHITE LATEX METAL PRIMER (H-81-10)

Initial Grind: Disperse the following, in order, on a high-speed dispersion mill to a 5 n.s.u. grind:

	lb.	gal.
Water	133.28	16.00
Igepol CO-630 (GAF Corp)	2.80	0.32
Cellulosic Thickener[1]	1.50	0.13
Tamol 731 (Rohm & Haas Corp)	9.20	1.00
Defoamer[2]	1.00	0.13
Surfynol 104E (Air Products Inc.)	2.10	0.25
Ethylene Glycol	9.31	1.00
Titanium Dioxide[3]	100.00	2.90
HALOX BW191	125.00	5.25
Wollastonite (NYCO, Inc.)	50.00	2.07
Then let down with: (at low speed)		
Styrenated Acrylic Emulsion[4]	581.85	66.00
Water	24.77	2.95
Dalpad A (Dow Chemical)	13.75	1.50
Surfynol 104E	4.15	0.50
Total:	1058.71	100.00

Premix the Dalpad A with water, then slowly add this premixture to the emulsion under agitation.

PVC = 24.97
Viscosity = 70-80 Ku @ 75°F
V.O.C. = 89 g/l (0.74#/gal.)
Salt fog expectations: 2 coats at 1.5 mils d.f.t. each—2500 hours.

[1] Cellusize QP-4400—Union Carbide Corp. Ethylene Glycol
[2] Troykyd 999 or equivalent—Troy Chemical
[3] Ti-Pure R-900—E.I. du Pont de Nemours & Co.
[4] Styrenated Acrylic Emulsion Arolon 820—Spencer-Kellogg Division, Textron

With the styrenated acrylic vehicle, HALOX Pigments found that the best surfactant-wetting aid combination in our systems is Tamol 731 and Surfynol 104E. Also, to improve stability and performance, the coalescing agent should be pre-mixed with the latex resin and then added very quickly to the pigment grind, so the coalescent is absorbed onto the vehicle, not the pigmentation. An extender pigment of high pH was chosen to provide a buffer effect, and flash and early rust resistance.

Straight Acrylic Latex Primer—

A good formula incorporating the phosphosilicates in this vehicle is:

WHITE LATEX METAL PRIMER (H-81-07)

Initial Grind: Disperse the following, in order, on a high-speed dispersion mill to a 5 n.s.u. grind:

	lb.	gal.
Water	83.30	10.00
Cellulosic Thickener[5]	0.75	0.04
NH_4OH	1.00	0.14
Methyl Carbitol (Union Carbide Corp.)	50.00	5.79
QR-681M Dispersant[6]	18.14	2.00
Igepol CO-630 (GAF Corp)	2.70	0.31
Surfynol 104E (Air Products, Inc.)	4.10	0.49
Titanium Dioxide[7]	50.00	1.46
Calcium Carbonate[8]	50.00	2.20
HALOX BW191	60.00	2.54
Zinc Oxide[9]	5.00	0.11
Then let down with: (at low speed)		
Acrylic Emulsion[6]	526.35	60.00
Texanol[10]	5.50	0.70
*Aroplaz 1271 & Driers[11]	58.00	6.94
Defoamer[12]	1.00	0.13
Preservative	2.00	0.23
QR-708 Thickener	15.00	1.67
Water	43.73	5.25
Total:	976.57	100.00

*Premix the driers with the Aroplaz 1271, then slowly add this mixture to the let-down phase under agitation.

Drier combination:	Aroplaz 1271	93.4%
	Zirconium Drier 6%	5.6%
	Cobalt Drier 6%	0.5%
	Manganese Drier 6%	0.5%
		100.0%

PVC = 16.30
Viscosity = 130 Ku @ 75°F
V.O.C. = 170g/l (1.42#/gal.)
Salt fog expectations: 2 coats at 1.5 d.f.t. each—1200 hours.

[5] Natrosol 250MR or equivalent—Hercules, Inc.
[6] QR-681 Dispersant—Rohm and Haas Co.
Acrylic Emulsion Rhoplex MV-23
Skane M-8 Preservative
QR-708 Thickener
[7] Ti-Pure R-900 or equivalent—E.I. du Pont de Nemours & Co.
[8] Atomite Calcium Carbonate or equivalent—Thompson, Weinman & Co.
[9] Kadox 515 or equivalent—New Jersey Zinc Co.
[10] Texanol Coalescent—Eastman Chemical Products, Inc.
[11] Aroplaz 1271 Alkyd—Spencer-Kellogg Division, Textron; Driers—Mooney Chemical
[12] Foamaster VL or equivalent—Diamond Shamrock Chemical Co.

For maximum performance, stability, viscosity control and easy dispersion in the straight acrylic emulsion, it was found necessary to use the resin manufacturer's suggested dispersants, surfactants, and thickeners. We further suggest that the levels of cellulosic thickener be kept at 0.70 to 1.0 lb/gal, and the PVC be held between 16 and 22 per cent. Accelerated testing performance is also improved by the use of French process zinc oxide, alkyd modification, and a fast-release freeze/thaw stabilizer such as diethylene glycol monomethyl ether. Proprietary QR-708 rheological modifier improves flow, leveling, and brushing properties. Reduced levels of QR-708, or use of a post-addition of diethylene glycol monobutyl ether, will provide a lower apparent viscosity if desired. It has also been our formulating experience that a pigment level of 0.5 to 1.0 lb/gal exhibits better performance and stability. Phosphosilicate pigments were selected because of lower solubility parameters at this loading level, and because phosphosilicates tend to foam less than borosilicates in this resin system.

From our data and in our opinion, non-toxic water-based corrosion-inhibitive coatings can in fact be formulated successfully to achieve good stability—*and* high performance.

If you would like our suggestions on additional starting formulations, please request them on your letterhead. Full data on coatings performance in application and under accelerated testing will be forthcoming in future reports.

See us during the Annual Meetings of the Association and the Federation, and at Booth 1224-1226 of the 47th Paint Industries Show.

HALOX ®

HALOX PIGMENTS

Manor Oak One, 1910 Cochran Road
Pittsburgh, PA 15220 (412) 344-5811

A DIVISION OF HAMMOND LEAD PRODUCTS, INC.

ABSTRACTS OF PAPERS

MICRO-COMPUTING OPENS NEW HORIZONS

Craig W. Larson, Chemical Specialties, Inc.

Computers have been utilized for some time in the paint industry for inventory control, batch sheet processing, bulking, costing, and a multitude of other tasks. The cost of these systems, however, placed their use out of the reach of the smaller coatings manufacturers. The advent of the micro- or mini-computer has opened new horizons for the smaller company and has also created new applications independent of the large main frame computers within large corporations.

A number of these applications are discussed. Computers still have certain limitations and hidden costs which will cause the user undue hardship if he is unaware of these pitfalls. Limitations and hidden costs are presented, as well as a suggested approach to the successful installation of a micro-computer system, including employee training. Suggestions are made with regard to software development, since software is a crucial part of an operating system.

EXPLOITING YOUR LABORATORY COMPUTER FOR YOU AND YOUR MANAGEMENT

Alan Brandau, De Soto, Inc.

Computers are generally leased or purchased by laboratories to solve complex mathematical problems and simplify technical number crunching. Once having acquired either micro- or time-sharing computers, there are many equally useful nontechnical applications that will provide important information for bench chemists as well as management. This paper discusses examples of such applications that can, with little effort, increase individual productivity, maximize research management effectiveness, and provide reports and graphic records not previously considered economically feasible.

The following are discussed: (1) report generation; (2) word processing; (3) project management (i.e., time reports, pert diagrams, etc); (4) budget preparation; (5) personal record keeping and retrieval; (6) communications; and (7) chart and graph plotting.

COMPUTER TECHNOLOGY IN COATINGS RESEARCH

Maynard Sherwin, Union Carbide Corp.

A main frame computer network is used to greatly increase the productivity of a large research and engineering technical center. Network subsystems consisting of dedicated mini-computers are used in specific areas such as analytical chemistry, polymer properties, and coatings exterior testing. The computer system used to support a trade paint exterior exposure program is illustrative of the many problems and benefits that arise.

Specific examples are presented of storage and retrieval of weathering data, customer service functions, and polymer research.

INTERRELATIONSHIPS BETWEEN PIGMENT SURFACE ENERGIES AND PIGMENT DISPERSIONS IN POLYMER SOLUTIONS

G. Dale Cheever and John C. Ulicny, General Motors Research Laboratories

In the manufacture of paints, plastics, elastomers, and adhesives, good dispersion of pigments and other fillers is essential in producing a quality product. Although many theoretical examples exist in the literature describing the factors required for dispersion, a practical method is needed to measure these pigment and solution properties and relate them to dispersion.

The critical surface tension of wetting (γ_C) of 18 commercial pigments representing hiding, extender, colored, white, organic, and inorganic types were measured with a capillary flow technique. A relationship was found between pigment dispersion and the γ_C values of eight representative pigments and the surface tension of an aqueous polyvinyl alcohol solution.

STUDIES ON THE ESTERFICATION OF TRIMELLITIC ANHYDRIDE: IMPLICATIONS FOR COATINGS POLYMERS

Wayne Riddick, Amoco Chemicals Corp.

The esterification of trimellitic anhydride (TMA) with hydroxyl-functional reactants was observed at various reaction temperatures. Results show that TMA monoester is formed initially, and during the remainder of the reaction, all the carboxyl groups of the monoester and diester species have approximately equal reactivity. As a result, TMA diester and triester species begin forming immediately as the reaction progresses beyond the monoester stage. The resulting distributions of TMA monoester, diester, and triester were found to be independent of reaction temperature and dependent only on extent of TMA reaction. Practical implications of the results pertaining to coatings polymers are explored.

FACTORIAL EXPERIMENTAL DESIGN: DETERMINATION OF HYDROXYL CONTENT IN POLYMERS

B. O. Demarest and L. E. Harper, DeSoto, Inc.

A statistical method for experimentation facilitated investigation of the following methods for determining hydroxyl content in polymers: an imidazole catalyzed esterification with pyromellitic dianhydride; two acid catalyzed acetylations utilizing perchloric and p-toluenesulfonic acids as catalysts; and a dibutyltin dilaurate catalyzed urethane formation with phenyl isocyanate. The statistical method involved a factorial experimental design where three independent variables were evaluated at two levels (two level three factorial design). This approach facilitated comparison of the methods for determination of hydroxyl content in polymers by efficiently optimizing reaction parameters.

WATER-BORNE MARINE ANTIFOULANT COATINGS TOXICANT/RESIN COMPATIBILITY STUDIES

James Stoffer, John Gordon, Mike Beckmann, and David Price, University of Missouri-Rolla

Compatibility studies were performed on four experimental toxicants to determine their applicability for incorporation into four commercially available water-borne resins for possible use by the U.S. Navy as marine antifoulant coatings. The resins studied were an epoxy polyamide, an epoxy acrylic, a polyurethane, and an alkyd. The toxicants employed were Nopcocide N-96, cuprous oxide, p-toluene sulfonamide, and a styrene-maleic anhydride copolymer esterified with tri-butyl tin.

The following parameters were examined as a function of toxicant loading: wet grind, drying time, film hardness, and enamel holdout (a measure of film integrity). A sample of each resin/toxicant system was prepared and used to coat fiberglass panels for evaluation by immersion testing by the U.S. Navy.

STRUCTURE-PROPERTY RELATIONSHIPS FOR RADIATION-CURABLE COATINGS

A. Priola, F. Renzi, S. Cesca, ASSORENI, Milan, Italy

The main technological properties of UV-cured coatings were studied as a function of the oligomer structure, reactive diluent and the possibility of modifying the network structure. An oligomer system based on bisphenol-A-acrylated-epoxy resins was used. The addition of reactive monomers to the system was found to modify the properties of the coating depending on the type of monomer and its acrylic functionality.

The structure of the oligomer was changed by introducing flexible chain segments (polyethylene-oxide, aliphatic polycarbonates) in the molecule, thus increasing flexibility and impact resistance. Finally, a modification of the network structure was obtained by introducing chain transfer agents into the system, which control the acrylic chain length. The resulting properties of the coatings were evaluated and are discussed.


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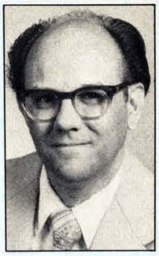
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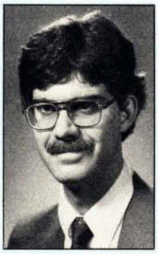
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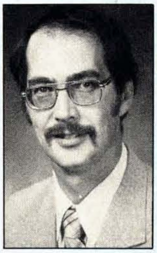
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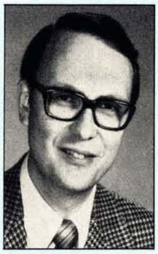
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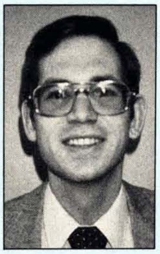
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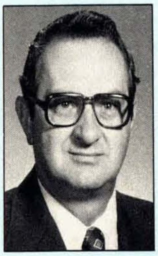
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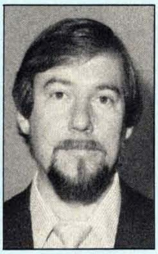
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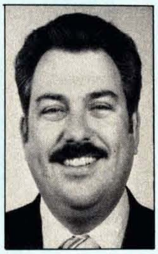
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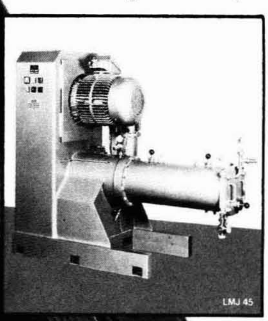
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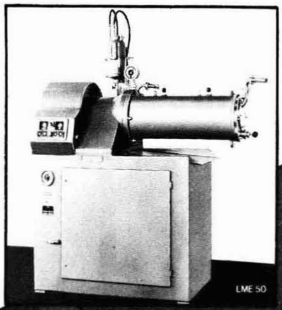
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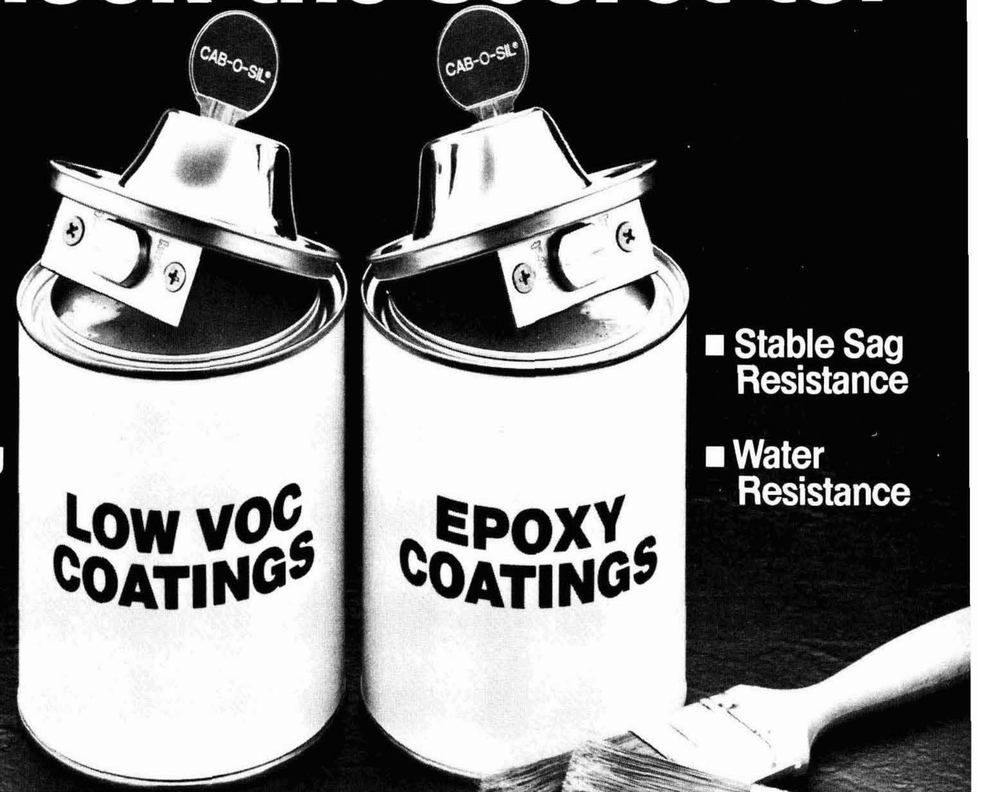

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SYNTHESIS AND STRUCTURE-PROPERTIES RELATIONSHIPS OF OXAZOLIDONE RING-CONTAINING COATINGS

P.I. Kordomenos, Ford Motor Co. and K.C. Frisch and J.E. Kresta, University of Detroit

The catalysis of the oxazolidone-forming reaction was studied using isocyanate and epoxy functional model compounds. It was found that the concentration of the NCO group decreased during the reaction faster than the concentration of the epoxy group. Several side reactions were investigated in order to explain this phenomenon. The synthesis and properties of oxazolidone ring-containing polymers such as polyoxazolidones, poly(oxazolidone-isocyanurates), poly(oxazolidone-epoxides), and poly(oxazolisone-urethane-isocyanurates) were investigated. It was found that the thermal stability of these polymers increased with increasing concentration of the oxazolidone rings and increasing crosslinking density.

WATER-EXTENDABLE HIGH SOLIDS ENAMELS

Frank N. Jones, Morris R. Olson, and Jim M. Larson, Cargill, Inc.

The potential usefulness of a new approach to formulation of low-VOC industrial enamels was explored. In this approach, combinations of high hydroxyl value resins, water miscible solvents and standard crosslinkers are formulated to high solids enamels which can be thinned to spray viscosity with water. Polyester, alkyd, and acrylic resins can be used. Polyesters are especially well suited. Prototype water-extendible high solids enamels were formulated and tested. VOC's were within EPA guidelines. Film physical properties were generally good, better in some respects than those of conventional water-reducible enamels.

RHEOLOGY CONTROL OF HIGH SOLIDS COATINGS

Dennis G. Miller, William F. Moll, and Vaughn W. Taylor, Cabot Corp.

The coatings industry is in a state of change to meet the Federally mandated reduction in organic solvent emissions. The production of high solids coatings to meet these requirements has been growing rapidly and this trend is expected to continue in the future.

High solids coatings are based on low molecular weight resins. This results in two rheology related problems: (1) sagging during the heat cure cycle and (2) pigment settling on aging. In this study we have evaluated several anti-sag/anti-settling agents to try to solve these problems in a typical high solids coating. Rheological studies made with both the Ferranti Shirley viscometer and a simple yield point tensiometer showed that yield point and not thixotropy controls the sag resistance of the coatings tested. The results showed that fumed silica was the best anti-sag/anti-settling agent tested.

CHEMISTRY OF HIGH SOLIDS, AIR DRY ALKYD/REACTIVE DILUENT COATINGS

D. B. Larson and W. D. Emmons, Rohm and Haas Co.

Pressures have increased in recent years to reduce both solvent emissions and thermal curing requirements for organic coatings. A practical response is a system based on oil modified alkyds formulated with methacrylate reactive diluents which function initially as solvents but then convert to binder. Basic requirements of a reactive diluent include low volatility, toxicity, and odor, with good compatibility and stability. Another is rapid conversion during film formation, a process strongly opposed in thin films by oxygen inhibition of free radical polymerization.

Proper coating design controls the oxygen content in the film by rapidly increasing film viscosities to slow oxygen diffusion rates and by efficiently scavenging oxygen using alkyd unsaturation. Keeping reactive diluent levels in the 15–30% range is a key part of the design. Fully complying high solids systems are achieved by further constraining the system to use lower molecular weight alkyds. Model systems and practical high solids alkyd/reactive diluent coatings illustrate design principles and rationalize observed coating properties.

VISCOSITY LOSSES IN LATEX PAINTS

Dallas Society for Coatings Technology

A summary of a questionnaire on viscosity losses in latex paints is presented, and suggestions offered for reduction of losses associated with viscosity problems, including a procedure for detecting excess oxidant in the latex emulsion. A method for the qualitative detection of the presence of enzymes is referenced.

Emphasis is placed on the importance of good housekeeping. The paper describes an "in-house" program for checking the sterility of raw materials, process equipment, and packaged paint.

CHARACTERIZATION OF PIGMENT VOLUME CONCENTRATION EFFECTS IN LATEX PAINTS

W.J. Culhane, D.T. Smith, and C.P. Chiang, The Sherwin-Williams Co.

The relationship of the pigment volume concentration to the critical pigment volume concentration in latex paint films is characterized by traditional and new methods. Calculated and empirical critical pigment volume concentration determinations are shown to yield consistent results. Gloss, scrub resistance, staining, and observed T_g of the films are correlated with scanning electron microscope observations for samples formulated over an extreme range of pigment volume concentrations. New insights into the role of the pigment/latex ratio are provided.

COMPUTERIZED PROCESS CONTROL

J. Patrick Kennedy, Oil Systems, Inc. and Robert W. McFee, Glidden Coatings and Resins Div. of SCM Corp.

All formula-based manufacturing processes have potentially very large payouts from consistency, quality, throughput, and elimination of errors. Although the techniques have been proven, the analysis and investment can be significant; but automated production also has large returns. The practical task of reducing this technology to practice and profits is dealt with.

MANUFACTURING CONTROL WITH TIME-SHARING COMPUTERS

Joseph B. Milgram, Jr., DeSantis Coatings, Inc.

A coatings business management system that provides, through the use of a time-sharing computer service, timely manufacturing, marketing, and financial data is described. Inventory control, formula cost, and selected other management reports are illustrated.

POPPING OF WATER-SOLUBLE BAKING ENAMELS

Ben C. Watson, The Sherwin-Williams Co. and
Zeno W. Wicks, Jr., North Dakota State University

The tendency of water-soluble industrial baking enamels to show popping is a factor which significantly limits their commercial use in some applications. A test to determine the maximum film thickness of coating which can be applied and cured under standardized conditions without popping was developed to compare various coatings.

Glass transition temperature of the acrylic copolymer was found to correlate with popping. Critical film thickness decreased as glass transition temperature increased. The same trends were observed in solvent-reduced and water-reduced coatings. The critical film thickness was much thinner for water-reduced coatings. It was found that after initial losses, rate of volatile loss in a TGA furnace at 150° C was decreased as T_g increased and was slower from water-reduced coatings than from 2-butoxyethanol-reduced coatings. Rate of temperature increase of the TGA samples from water-reduced coatings was slower than with 2-butoxyethanol-reduced coatings. The greater heat requirement to evaporate water may be a factor in the greater sensitivity to popping of the water-induced coatings. Other factors which may affect popping are also discussed.

PRESENCE AND EFFECTS OF ANAEROBIC BACTERIA IN WATER-BASED PAINTS

Robert A. Oppermann, Cosan Chemical Corp.

Water-based paints are subject to microbial invasion resulting in spoilage. Analysis of such spoiled paints frequently results in no known chemical or biological cause. Bacteria growing in the absence of oxygen (anaerobically) could cause some of the deterioration, but would not be found in the aerobic culture methods normally used. Accordingly, many paint and paint raw material samples, some of which were spoiled, were cultured under anaerobic conditions. Anaerobic bacteria were found which reduce viscosity and cause malodors and discoloration. The quantity, identification, degradative activity, biocide sensitivity, and prevention of the bacteria found are discussed.

AN EXPERIMENTAL DESIGN APPROACH TO STUDYING THE YELLOWING EFFECTS OF PLASTICIZERS ON PAINTS

Herbert L. Bullard, Robert D. Mate and
Kenneth G. Roquemore
The Goodyear Tire & Rubber Co.

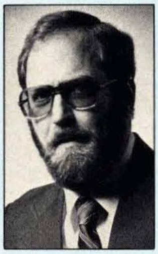
A fundamental understanding of the effects of various materials on certain performance properties is a requirement for the development of better coatings. In this work, an experimental computer design study was used to evaluate the effects of 20 commercially available chlorinated plasticizers on the ultraviolet aging properties of a water-proofing sealer paint. Areas of concern were plasticizer type and content, stabilizer content and paint make-up temperature.


H. Leidheiser


W.H. Ellis


P. Shaw


R.D. Athey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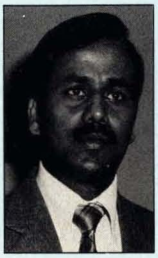
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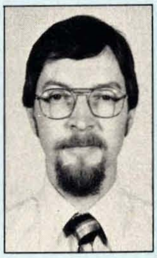
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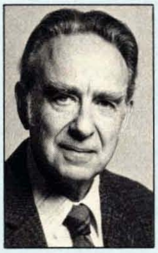
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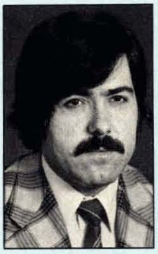
L. Cutrone


J. Puglisi

The study successfully demonstrated that the concentrations of various ingredients and the conditions under which paints are made do indeed affect the yellowing characteristics of paints. It also helped to rank the performance of the various plasticizers, as well as identify the optimum vehicle ratios of resin binder and plasticizer for each formulation, and establish the influence of paint mixing conditions.

PREDICTIVE MODEL FOR CRACKING OF LATEX PAINTS APPLIED TO EXTERIOR WOOD SURFACES

F. Louis Floyd, Glidden Coatings and Resins Div. of SCM Corp.

While it is well-known that paints applied to exterior wood substrates will eventually develop cracks, and may, if their adhesion is deficient, subsequently peel or flake off, attempts to explain this phenomenon on the basis of tensile properties have been unsuccessful to date. The present work shows that a two-parameter model, employing fracture energy (energy required to propagate a crack through a paint film) and liquid water permeability, successfully accounts for cracking behavior over a wide range of compositional variables. From these observations, a mechanism for the cracking behavior of latex paint films applied to exterior wood surfaces is proposed.

MECHANISM OF BLISTER FORMATION

Charles M. Hansen, Scandinavian Paint and Printing Ink Institute

Blistering is shown to occur at or near the water-saturation point in four primer/topcoat systems. A temperature decrease in nearly water-saturated coatings also caused blistering in several cases, since this is accompanied by reduced water solubility. The excess water simply phase separates into regions or clusters which we call blisters. These can then grow by one mechanism or another.

In each case tested, primers had higher water uptakes than topcoats. It would appear that practical experience led to this relationship. The topcoat can be saturated and blistering presumably avoided for a time by transferring water to the primer which acts as a reservoir. When the reservoir is filled, blisters are unavoidable in such adverse conditions as water immersion with temperature variations. Blistering at the substrate was found only when the primer was near the saturation point with water. Otherwise, the blistering occurred in the topcoat or near the interface between the topcoat and primer.

Systematic studies of the type described here should lead to better products. The effect of individual materials on a film's absolute water-uptake, rate, and temperature dependence can be studied by the method described. It appears a proper goal is to strive for little or no variation in the equilibrium water uptake at various temperatures.

PARTICLE SIZE MEASUREMENT BY DISC CENTRIFUGE PHOTOSEDIMENTOMETRY

Theodore Provder, Glidden Coatings and Resins Div. of SCM Corp.

Centrifugal photosedimentometry produces an apparant weight differential particle size distribution directly and rapidly. The requirements necessary for obtaining absolute particle size distributions are related to: (1) the optimization of operational variables (spin fluid viscosity, density difference between the particle and spin fluid, centrifugation speed [RPM], and the spin fluid volume) through Stokes' Law particle diameter-time curve; (2) accurate calibration of disc cavity dimensions; and (3) the photodetector response factor curve.

Various experimental procedures (homogeneous, two layer, buffer-line start, externally generated gradient methods) are discussed in the context of the above requirements and the separation mechanism is illustrated by a 35-mm film for the buffer-line start method. Instrumentation is discussed, including an Improved Variable Speed Disc Centrifuge (U.S. Patent No. 4,311,039). Mathematical methods are presented for transforming the raw photosedimentometer trace into absolute particle size distributions. Coatings applications discussed include blending of latex, guide to latex synthesis and coatings formulation, quality control of supplier materials, and evaluation of emulsion stability.

ELECTROCHEMICAL TECHNIQUES FOR STUDYING PROTECTIVE COATINGS

Henry Leidheiser, Jr., Lehigh University

The applicability of impedance measurements to the determination of the following properties of polymeric coatings on metallic substrates are described: rate of water uptake by the coating; presence of conductive pathways in the coating; and homogeneity of the coating. Electrochemical measurements are also useful in designing coating systems that are capable of tolerating aggressive environments without complete loss of protective quality. Such measurements may have applicability in the screening of inhibitors, for example.

TORSIONAL BRAID ANALYSIS (TBA): TIME-TEMPERATURE-TRANSFORMATION (TTT) CURE DIAGRAMS OF THERMOSETTING EPOXY/AMINE SYSTEMS

John K. Gillham and John B. Enns, Princeton University

The conversion of liquid resin to solid thermoset during the process of cure can be monitored using a substrate coated with the reactive system as the specimen in a torsion pendulum experiment (TBA). Measurement of times to gelation and vitrification at a series of temperatures results in an isothermal time-temperature-transformation (TTT) cure diagram which can be used for comparing different systems. In this report, molecular and macroscopic TTT cure diagrams are considered: it is demonstrated that TBA is a convenient method for generating macroscopic TTT cure diagrams. The influence of chemical structure on the kinetics and macroscopic properties was investigated by comparing aliphatic and aromatic tetrafunctional amines with diepoxides of varying molecular weights. Also described is automation of the TBA instrument using a desk-top calculator.

COMPARATIVE SOLVENT EVAPORATION MECHANISMS FOR CONVENTIONAL AND HIGH-SOLIDS COATINGS

W. H. Ellis, Chevron Research Co.

Solvent volatility has traditionally been used to control initial flow and resulting qualities of a conventional coating. As evaporation progresses, the rate limiting factor changes from volatility to diffusion. We have developed a precise method for determining the transition point. Comparison of laboratory

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data with typical formulas demonstrates that conventional alkyd coatings are formulated at resin concentrations below the transition point, high-solids polyester coatings above. Thus, diffusion limits the total evaporation process in high-solids coating; and solvent volatility cannot be used to control setting and other initial flow properties.

VISCOMETRY: MYTH AND REALITY

Los Angeles Society for Coatings Technology

The practice of viscometry is often at odds with its theoretical base. The differences are accommodated by making certain assumptions about viscometry. They are: (1) Flow behavior does not affect the results of viscosity measurements; (2) The choice of a viscometric method is based on good practice; (3) The precision of a viscosity value is better than ±5 per cent; and (4) Viscosity measurements made by one method can be correlated with measurements made by another.

The Los Angeles Society's Technical Committee investigated the validity of those assumptions. The study is based on the viscometric evaluation of six samples by 16 laboratories.

COMPUTERIZATION AND AUTOMATION IN A COATINGS ANALYTICAL CHEMISTRY LABORATORY

P. Kamarchik and G. P. Cunningham, PPG Industries, Inc.

In order to meet the challenges of an ever-increasing sample load and the desire for enhanced productivity, a program emphasizing the use of computers and automated equipment was undertaken. This program of automation has been applied to many aspects of classical coatings analyses. In particular, the automation of gravimetric, titrimetric, spectroscopic, and chromatographic determinations is described. Computerization has also been integral to the introduction of scanning electron microscopy and x-ray diffraction to our laboratory.

In addition to the above applications, laboratory management and chemical inventory computerized systems have been developed. These systems provide status reports of progress of analyses and chemical inventories, respectively, as well as generate certain analytical reports.

This coordinated approach has resulted in increased productivity, more timely results, and an improvement in the quality of results reported.

INFLUENCE OF CO-SOLVENTS ON THE STABILITY AND FILM PROPERTIES OF WATER-SOLUBLE ALKYDS

Toronto Society for Coatings Technology

The dry retention and pH stability of a water-soluble alkyd resin carried in butyl cellosolve and water was studied for nine months utilizing a variety of driers and methods of addition. Though some loss in tack free time and film hardness was observed, the most significant observation was that the loss in pH was not a continuous phenomenon. It followed a two stage process, falling rapidly over the first three months, stabilizing for three months, and then continuing to fall from six to nine months.

Solutions of various glycol ethers in water demonstrate a loss in pH both in the presence or absence of amines in under three months. This suggests an explanation for the observed discontinuity in pH loss behavior.

REACTIVE SILANE MODIFIED PIGMENTS II: DESIGNED EXPERIMENT IN SILANIZED TALC/LATEX FORMULATIONS

Los Angeles Society for Coatings Technology

The earlier presentation in this series described a variety of silanes as talc treatments for use in latex formulations. The best candidates were identified from a list of seven commercially available silanes, noting there were problems observed, such as: wettability of the treated talcs by water; dispersibility of pigment in "standard" coating formulation; flash rusting; and obnoxious odors. However, positive aspects were noted, such as apparent corrosion inhibition by some of the treated talcs. Accordingly, further studies were initiated.

In the previous presentation it was hypothesized that the reactive silane treated talcs might: add to the hydrophobicity of the total system; compatibilize the polar talc with the relatively nonpolar binder (e.g., to improve strength or reduce moisture permeation); and aid in corrosion protection (perhaps by some inhibition phenomenon).

The first item was not clearly shown in the previous presentation, so alternative evaluation schemes were proposed. The second point was not dealt with at all until this study. The last item was deemed a possibility from the previous report, and received the major emphasis.

Current work has been a statistically designed experiment in four variables: type of talc treatment; type of latex; type of formulations (e.g., which coalescents were used to aid film formulation); and amount of talc treatment.

DESIGN OF WATER-BORNE COATINGS FOR CORROSION PROTECTION OF STEEL, PART III: EFFECT OF SURFACTANTS IN AN AQUEOUS AIR DRY COATING

New England Society for Coatings Technology

A great deal of research effort has gone into the development of latex industrial coatings over the past 10 years, making present-day products far superior to those available in the 1960's. In the area of industrial coatings, acrylic latex systems have been employed as industrial maintenance coatings for approximately 10 years. This application requires the coating system to protect the metal substrate from mild atmospheric corrosion degradation.

With acrylic latex systems, formulators have developed considerable experience in industrial maintenance coatings and have demonstrated their effectiveness in protecting metal surfaces from corrosion, for allowing application over less thoroughly cleaned surfaces, and for the reduction of toxic and flammable materials. However, much remains to be done to develop better corrosion resistant water-borne coatings. The scope of this work includes the evaluation of surfactants in an acrylic latex coating system, and the application of this system onto a metal substrate.

EFFECT OF MOLECULAR WEIGHT ON PERFORMANCE OF CELLULOSIC THICKENERS IN LATEX PAINTS

D.M. Blake, Dow Chemical U.S.A.

A latex paint was formulated in five versions, each thickened with hydroxypropyl methylcellulose of a different molecular weight. The five were brought to essentially equal viscosity for comparison of thickener efficiencies. To determine and compare other effects of thickener molecular weight variation, the five were evaluated for: rheology at low-shear and high-shear rates; flow and leveling characteristics; spatter resistance; foaming tendency; scrub resistance; and color acceptance.

Thickener molecular weight was found to affect the paint's high-shear rheology, spatter resistance, and foaming tendency; it has no effect on low-shear rheology, scrub resistance, or color acceptance. The color acceptance testing indicated shortcomings in the commonly-used hand rubup test procedure.

EFFECT OF CATALYSTS ON KINETICS AND MECHANISM OF URETHANE FILM FORMATION

David Ihms and James Stouffer, University of Missouri-Rolla, and Daniel Schneider and Cheryl McClain, Carboline Co.

The literature describing polyurethane reactions and curing mechanisms is very extensive. Unfortunately, much of the work has been very detailed investigations upon idealized chemical systems such as phenyl isocyanate. This work represents investigation of industrial materials and processes on a detailed basis, using materials such as difunctional isocyanate. The isocyanate-water reaction has been reported to be a very complex reaction at ambient temperature conditions.

Described here is the investigation of the carbon dioxide evolution from the isocyanate-water reaction conducted in diglyme solvent, using tolulene diisocyanate, water, and several catalysts. This study of carbon dioxide evolution from catalyzed reactant systems in diglyme solvent has given rates and volumes of carbon dioxide production from the water-isocyanate reaction, shown the strength of several selected catalysts as a function of the solvent media, and shown a tenatative first-order relation between the expected loss of water and the evolution of carbon dioxide.

QUALITY AND CONSISTENCY FROM AN EASIER DISPERSING RHEOLOGICAL ADDITIVE

Armand J. Stolte, Judy A. Hahn, and Michael E. Masterson, NL Chemicals/NL Industries, Inc.

Paint manufacturers seeking greater plant efficiency and lower manufacturing costs have adopted equipment with faster throughput rates and lower shear. This has required the development of raw materials with inherently better dispersibility, including easier dispersing rheological additives.

Organoclays are the most common rheological additives used to impart viscosity, sag and pigment settling control, and application properties to solvent-based paints. High levels of shear, often not attainable with the newer equipment, and chemical activation are required to consistently develop the full efficiency and performance of conventional organoclays.

A new type of super dispersible organoclay has been discovered, which requires only minimal shear and no chemical activation for the development of full rheological properties. Such easy dispersion allows, for the first time, the rheological additive to be added at any point in the manufacturing process, including post addition to the letdown, and ensures consistent development of rheological properties.

A variety of evaluations in aliphatic solvent-based coatings is reviewed, including performance under a range of manufacturing conditions, and application, film property, storage and durability effects.

COATINGS INFORMATION FROM CHEMICAL ABSTRACTS SERVICE

Paul F. Herbeck and Elizabeth M. Langstaff, Chemical Abstracts Service

A great deal of information on coating materials and technology is included in *Chemical Abstracts* (CA), which provides worldwide coverage of the chemical and chemical engineering literature, including patents. The documents covered in CA are indexed by a wide variety of both natural language and controlled-vocabulary terms, and subscribers can take advantage of this to do highly specific searches on various aspects of coating materials and technology in either printed indexes or computer-readable files.

Abstracts for most of the coatings-related documents appear in Section 42, "Coatings, Inks, and Related Products." In addition to appearing in the CA weekly abstract issue, this section is also available in two smaller, less expensive information packages. These are the CA Macromolecular Sections, which include all abstracts published in the group of CA Sections relating to polymers and plastics, and a CA SELECTS publication, "Coatings, Inks, and Related Products," which includes just those abstracts published in Section 42.

For users with more narrowly defined coatings information needs, the Individual Search Service (ISS) may be the solution. With this service, individually tailored search profiles are run biweekly against the computer file of information for the documents whose abstracts are being published in that two-week period, and the results are printed and mailed to ISS subscribers.

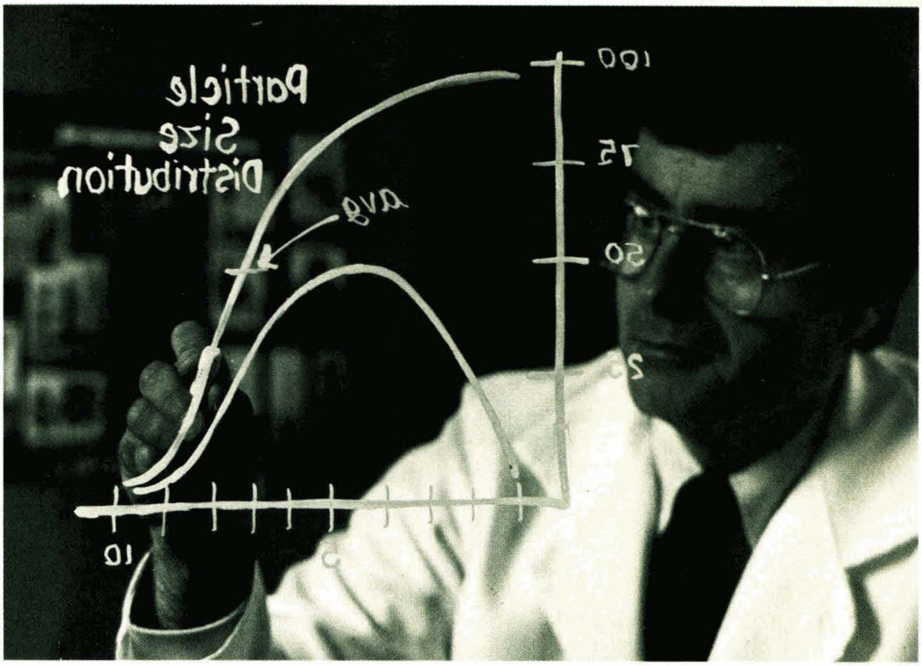
PARTICIPATION—THE FOURTH "P", AFTER PEOPLE, POLITICS, AND PUBLICATIONS

John C. Weaver, Consultant

Technical information systems mushroom and challenge us to use both computers and printed hard copy in the race to keep up with science pouring from academia and industry. Sputnik I panicked our people and our politicians into dramatic increases in government grants for science and defense. Literature in science and technology proliferates. In the Federation, Sputnik I coincided with (1) the formation of the Paint Research Institute, (2) fewer Society technical projects and Society papers, and (3) growing imbalance in our several publications services.

PRI can evolve its own new federalism by using TISCO and the Technical Advisory Committee (TAC) toward a broader overview of coatings science and technology and guidance of regional couplings of academia with the coatings industry. While our Society and Federation officers rotate annually their considerable short-term administrative burdens, the new metamorphosis in PRI can be joined and supported by TISCO for long-term management of coatings literature surveillance and its interpretive services to members for formation of more and better technical committees.

Reviews which are comprehensive, critical, and even prophetic of the entire coatings-related literature can be strategized and operated with computerized search resources under the aegis of PRI with TISCO and TAC. Upon this publishable base via TISCO, PRI can oversee the science-technology matrixes of various academia/industry interfaces toward federalized graduate level consortiums and undergraduate projects.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Distribution
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INFORMATION SERVICES AT PUBLIC AND COLLEGE LIBRARIES

Helen Lamrey, PPG Industries, Inc.

Coatings technologists with limited or no access to a technical library or information center need not go without library service. Public, college, and university libraries throughout the country can provide necessary technical assistance by mail or telephone. Many of the larger libraries collect materials in the coatings, plastics, and polymer fields. Some of them are depository libraries for government documents, and are a good source for obtaining copies of Federal and state legislation, government regulations, patents, etc. These libraries provide services such as answering reference questions, loaning books, supplying photocopies of journal articles, and conducting literature searches, including online searches of computerized data bases. Charges for these services vary, depending on the nature of the service and type of library providing the service.

INFORMATION SERVICES—AN OVERVIEW

Robert M. Vance, The Sherwin-Williams Co.

Professional workers in scientific fields must deal with a rising tide of information, rolling in through more and more specialized journals, abstracting services, computerized databases, technical meetings, and symposia. Time and know-how are required to make effective use of the many resources available.

At the Sherwin-Williams Research Center, the Information Services Department has been established to assist technical staff members in satisfying their information needs. Library services, current awareness capabilities and resources, and use of computerized databases relevant to the coatings field are reviewed.

THE EMERGING ELECTRONIC LIBRARY—IMPLICATIONS FOR CORPORATE SCIENTISTS AND ENGINEERS

Clifford Tierney, Whirlpool Corp.

This presentation reviews the technological and economic factors contributing to the rapid development of the electronic library, and examines the implication this holds for corporate scientists and engineers. Some of the processes that are changing the way in which technical information is communicated within a corporate environment include: on-line searching and surveillance; electronic journals; document delivery service; on-line interlibrary loan transactions, on-line indexing; and cataloging and networking.

By changing some traditional information searching patterns, the corporate scientist and engineer can enhance his local access to world literature, and greatly improve the precision and effectiveness of information, surveillance, and synthesis. But he also could lose that helpful creativity factor—serendipity.

MILDEWCIDE TESTING ON GROWTH AND ULTRASTRUCTURAL RESPONSES OF THE FUNGUS *AUREOBASIDIUM PULLULANS*

Richard E. Crang, University of Illinois at Urbana-Champaign

Four nonheavy metal containing mildewcides which have been shown to be effective in test situations are evaluated on the basis of cell responses in the defacing fungus, *Aureobasidium pullulans*. Specifically, cell growth, melanization, and cell ultrastructural effects are demonstrated from laboratory-maintained cultures. Although all inhibitors are effective in restricting growth and pigmentation at concentrations above 10^{-4} molar, lower levels of the agents promote greater melanization. Since the black pigment of *Aureobasidium* and related fungi are of great significance in coatings defacement, the pigment has been characterized using techniques in electron microscopy and electron spin resonance.

The utilization of high-resolution electron microscopic techniques promises to reveal target sites of mildewcide action. Data are presented to relate the varying effects of the four commercially-developed mildewcides to biological responses.

NONDESTRUCTIVE EVALUATION OF POLYMER SURFACES, INTERFACES, AND FILMS VIA ULTRASONICS

D. L. Hunston and J. A. Koutsky, National Bureau of Standards

Films, surfaces, and interfaces play an important role in a wide variety of polymer applications ranging from paints and protective coatings to adhesives and composites. Although the mechanical properties of the polymer layer are often critical to their success, measuring these properties, particularly in a nondestructive way, is extremely difficult and measurements performed on bulk samples of the polymer are often poor indicators for the behavior of thin films. One method that has proven useful in attacking this problem is ultrasonic shear wave measurements. This technique can nondestructively examine the mechanical properties of thin films ranging from liquids to soft solids. The method is sensitive to both contact area and the interface between the substrate and the sample so that these features of a system can also be examined. This paper briefly reviews the technique and discusses a number of applications such as materials characterization, monitoring of curing and drying, and surface properties evaluation.

CHARACTERIZATION OF ORGANIC COATINGS BY DIELECTRIC AND DYNAMIC MECHANICAL RELAXATION TECHNIQUES

K. Varadarajan, American Can Co.

The complimentary techniques of dielectric relaxation and dynamic mechanical relaxation experiments provide valuable information on the performance of coatings. In a dielectric relaxation experiment, a periodic electrical potential is applied to the sample between two electrodes and the dielectric constant, ϵ', and the dissipation factor, $\tan \delta = \epsilon''/\epsilon'$, are measured as a function of frequency and temperature. The minimum film forming temperature (MFT), adhesion, corrosion resistance, aging, end use, water sorption, film defects, and curing of organic coatings have been characterized by dielectric relaxation measurements. In a dynamic mechanical experiment, the viscoelastic properties of coatings are characterized by the application of a cyclic stress and measurement of their strain response. A review of the successful application of the dynamic mechanical methods in characterizing the glass transition temperature, adhesion, aging, water uptake, kinetics of curing, and crack resistance of coatings is also presented.

THERMOSETTING COATINGS—ANALYTICAL AND PREDICTIVE CAPABILITY BY CHEMORHEOLOGY

Richard R. Eley, Glidden Coatings and Resins Div. of SCM Corp.

Many final film properties of a thermosetting coating are influenced by the detailed viscosity-time path followed by the material during the cure process. These include leveling, gloss, gas release, oven sag, surface defects, particle sintering, etc. Typical industrial tests of the cure characteristics of a coating, however, are "single-point" data, and do not give any information on the actual viscosity-time profile followed during cure. Such data are often inadequate to pinpoint the cause of important performance problems.

The viscosity-time curves of thermosetting coatings, prior to the gelation point (the region where flow-controlled properties are determined), have been measured on an automated Ferranti-Shirley cone and plate viscometer. Such cure curves can then be analyzed in a variety of ways to obtain data relating cure rheology, and ultimately composition variables, to performance. In particular, an empirical approach due to Roller has been used to derive physical and chemical activation parameters and predict cure performance under selected conditions simulating those of actual use.

CHARACTERIZATION OF VARIABILITY IN CORROSION RESISTANCE OF STEEL USING ELECTROCHEMICAL TECHNIQUES

R. G. Groseclose, C. M. Frey, and F. L. Floyd, Glidden Coatings and Resins Div. of SCM Corp.

In testing paints for corrosion resistance, coating companies have had to cope with the variability of the metal test substrate. Previous methods in the literature to quantify steel quality and variability are time consuming and expensive. A novel and quick electrochemical technique has been developed using anodic polarization of metal test specimens in a mildly corrosive electrolyte. This had lead to an electrochemical profile of the uncoated steel that can predict the relative salt spray performance of the coated panel. The variability of cold rolled steel test panels has also been quantified. Additional characterization was carried out on abrasively polished and sandblasted steel. Such mechanical cleaning was shown to dramatically reduce the variability of the steel.

EVAPORATION DURING SPRAYOUT OF A TYPICAL WATER-REDUCIBLE PAINT AT VARIOUS HUMIDITIES

Albert L. Rocklin, Shell Development Corp.

Solvent balance during sprayout of a water-reducible paint at various humidities and spraygun settings is close to that of a corresponding model system composed of neat solvent blend thickened to the same viscosity as the paint. Using measured degree of evaporation from the model, paint solvent balance can be estimated with a previously developed computer program that predicts evaporation of water and cosolvents at any humidity. During sprayout, the concentration of 2-butoxyethanol cosolvent is relatively insensitive to evaporation conditions. Tert-butanol cosolvent is affected less than expected because humidity has opposite effects on evaporation rate and on depletion of volatile cosolvents.

USE OF THE BROOKFIELD VISCOMETER TO PREDICT RHEOLOGICAL PERFORMANCE OF COATINGS

Luigi Cutrone, Tioxide Canada, Inc.

The rheology of gloss latex paints was studied using a Brookfield Viscometer and computer processing of the viscosity readings in order to establish a practical correlation between viscosity data and paint performance without resorting to sophisticated rheological methods. The Casson Equation is employed to analyze the data and the constants (yield value and infinite shear viscosity) obtained are used to describe rheological behavior such as: flow, levelling, settling, sagging, brushability, film build, and stability. The method can be used for quality control as well as development work.

ASSESSMENT OF WEATHERING IN TWO-COAT AUTOMOTIVE FINISHING SYSTEMS

Joe Puglisi and Fred Vigeant, CIBA-GEIGY Corp.

Evidence indicates that ASTM method E430 (developed for appearance classification of metal surfaces) is a suitable reflectance measurement in comparing the appearance of two-coat finished automotive coating systems. Weathered panels possessing equivalent specular gloss readings were to exhibit visible appearance differences. The ranking according to the ASTM E430 method of measurement corresponded to the observed differences. The method may also be effective in determining levels of weathering in two-coat systems.

COMPUTER DESIGN OF LATEX FLATS TO MEET A REQUIRED FILM-INTEGRITY AND PAINT COST

Dallas Society for Coatings Technology

A 1.9 K BASIC software package was designed for low-cost TRS-80 PC-1 portable microcomputer which will calculate the weight of a dry-hide type fine extender #3 (4th pigment) to meet a latex-paint cost and PVC/CPVC ratio, after inputing an initial weight of titanium dioxide plus two fixed levels of extender pigments. The program essentially utilizes two FOR--NEXT loops; the first to compute the third extender #3 weight and the second to adjust the titanium dioxide and wet latex levels, if necessary to meet the formulator's requirements.

Within 3½ minutes time, one obtains a printout of 12 significant characteristics. The computer program's utility was demonstrated by the design of 12 flat latex paints using four different pigment combinations at PVC/CPVC ratios of 1.00, 1.20 and 1.35. Paint test results confirmed good integrity correlation between the PVC/CPVC ratio's and ASTM-Scrub-Cycle rate-of-wear plots. Other paint characteristics, however, varied widely, dependent upon the pigment-surface geometry.

The computer proved to be a valuable time-saving tool for the design and selection of appropriate pigmentations for problem-solvers to evaluate in the laboratory.

COLOR CHANGE WITH CHANGE OF VIEWING ANGLE

Los Angeles Society for Coatings Technology

Most paint and coatings industry personnel have observed an experienced color-matcher go through the motions of comparing the standard panel to the batch panel. First he (or she) looks at it in the "face," with the panels held side-by-side in a vertical position at the same level as the eyes. If the illumination is from a 45-degree angle over the back of the color-matcher, this most closely represents the standard ASTM 45-degree/0-degree specification.

However, the color-matcher next begins turning the panels to observe how the color of the batch will "follow" the standard panel, colorwise, as the viewing angle and illumination angles are changed. With more and more companies resorting to colorimeters to solve their color matching problems, the inability of the colorimeter to determine if the batch color "follows" the standard color could result in some unpleasant surprises for either the paint manufacturer or user when the ultimate customer rejects the job as being off-color due to an unexamined color angle.

An instrument has been designed for viewing the panels at different angles. But the incident light angle cannot be varied independently of the viewing angle; also, it is not a colorimeter and does not give unbiased electronic readout. It is, however, very useful in showing the observer how color changes can take place with change in viewing angle.

ROLE OF THE TECHNICAL PERSON IN COATINGS

John J. Oberle, Benjamin Moore & Co.

The coatings industry offers a range of products diverse in both composition and application. Whether for service or appearance, most manufactured goods utilize coatings directly or are packaged in coated containers. Advances in technology, environmental or competitive pressures, legislative regulations, and economic factors combine to influence formulation priorities. This generates an environment having a strong continual demand for competent technical personnel; it offers challenge, a variety of opportunities, and reward for innovative ability.

A MAJOR EXTENSION IN USE OF COLOR—BASE COAT/CLEAR COAT

Sol Panush, Inmont Corp.

The use of color to attract is as old as creation. Automotive coatings manufacturers use color and appearance to snare the automobile buyer, to stimulate his interest and ego through unusual effects and stimuli relative to initial showroom appearance and the retention of that appearance after many years of outdoor exposure. In the last 60 years there have been definitive pigment, resin, and innovative coatings breakthroughs, beginning with the introduction of nitrocellulose lacquers in 1922 and culminating with the current base coat/clear coat—a major extension in the use of color.

FACTORS AFFECTING WEAR IN SMALL-MEDIA PIGMENT GRINDING MILLS

Jan Grodzinski, S.C. Johnson & Son Ltd.

A study was undertaken to determine factors affecting the rate of wear on both mill components and grinding elements. A test method was devised, and a special grinding chamber constructed, to compile data on: (1) wear rate of various metal alloys that could be considered as mill construction materials; (2) effect of vehicle types on wear rate of mill parts and/or grinding elements; and (3) effect of grinding media type on wear rate of mill parts. Supplemental worksheets are included in the presentation, for further investigation by anyone interested in developing additional data.

LEACH STABILITY OF SOLID WASTES FROM A COATINGS WASTES TREATMENT PROCESS BASED ON PYROLYSIS

Louisville Society for Coatings Technology

Previous research subjected an industrial sales coating waste to a treatment process which (i) recovered solvent for re-use as a material resource, (ii) pyrolyzed the remaining polymer solution to a fuel-like liquid for utilization as an energy resource, (iii) produced noncondensable off-gases which were rejected to the atmosphere, and (iv) produced a solid waste char which is believed to consist of the pigment/additive portion of the original waste plus solids generated by the pyrolysis step. This experimental study yielded 18 samples of each category from a 2 × 3 × 3 factorial design of pyrolysis conditions (two pressures, three temperatures, and three residence times).

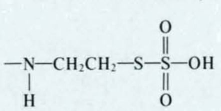
The solvent samples were subjected to analyses comparable to those for virgin material to ascertain their suitability for re-use. The pyrolysis liquid samples were analyzed as if they were fuel oils to determine their value as energy resources. The solid waste samples were treated according to ASTM D 3987-81, "Shake Extraction of Solid Waste with Water." The aqueous extracts were analyzed for the presence of leachable cations via atomic absorption.

With knowledge of the heating required for the distillation and pyrolysis steps, and the heating value of the pyrolysis liquids produced, one can estimate an energy efficiency for the process. Given the dollar values of the reclaimed solvent and the fuel substitute produced, one can make an economic evaluation of the process.

BUNTE SALTS AS CROSSLINKING AGENTS IN THERMOSETTING WATER-BORNE POLYMERS

Shelby F. Thames, University of Southern Mississippi

Substituted aminoethanethiosulfuric acids, or bunte salts **(I)**,

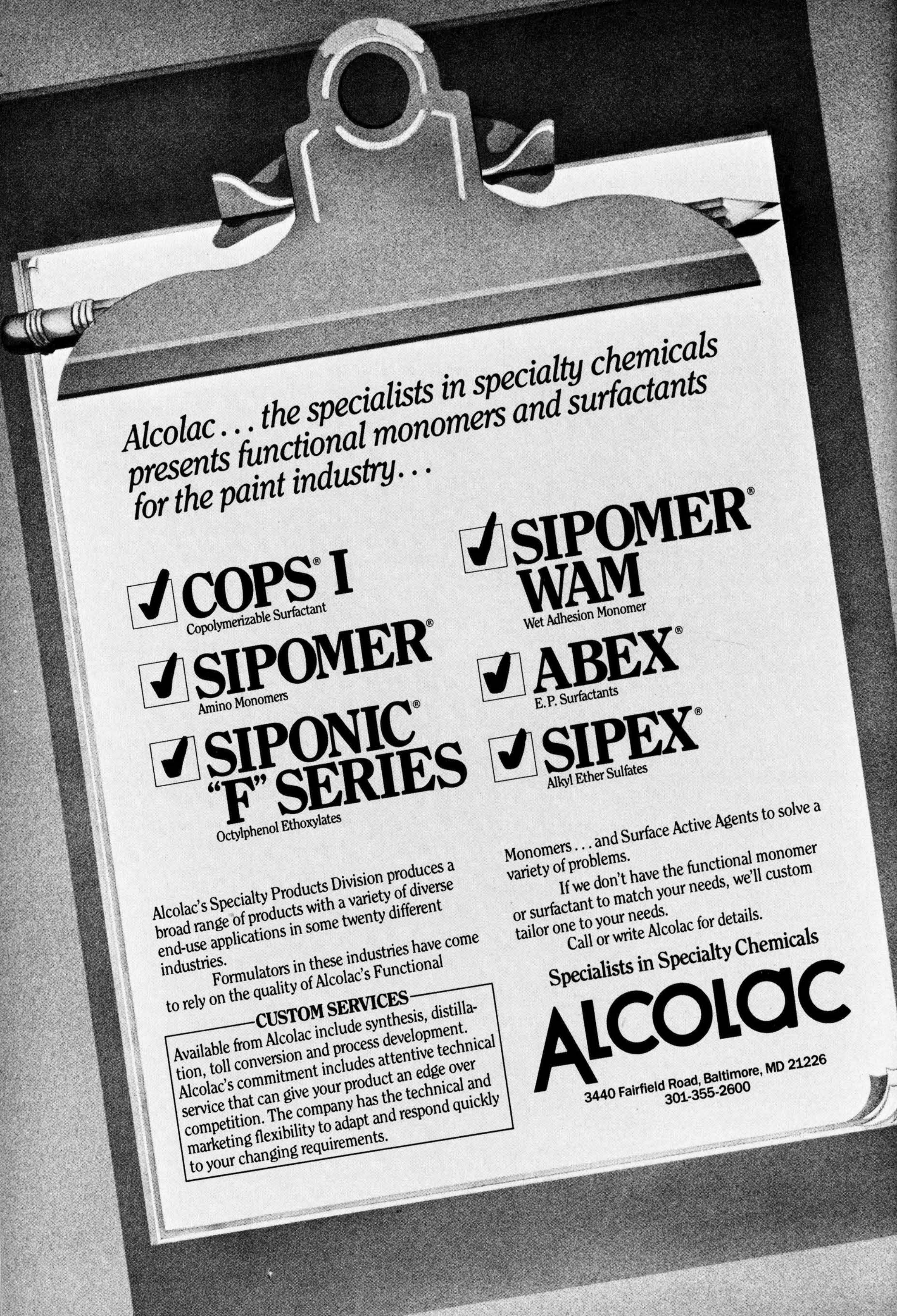


$$-\underset{\underset{\displaystyle H}{|}}{N}-CH_2CH_2-S-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}}-OH$$

(I)

have been incorporated into the structure of preformed thermoplastic polymers soluble only, prior to bunte salt incorporation, in organic solvents. However, inclusion of the bunte salt group as part of the polymer structure renders the polymer water soluble. It likewise provides a moiety capable of thermal disproportionation and subsequent crosslinking.

It has been shown previously that the S-S bond of the bunte salt is labile toward ionizing radiation, acid hydrolysis, reducing agents and oxidizing agents. Thus, the availability of bunte salt functionality as part of a polymer structure provides crosslinking capability, as well as rendering the polymer water sensitive prior to curing and water insensitive subsequent to curing. It has been shown that the bunte salt moiety will crosslink polymers at temperatures as low as 123° C. Much of the characterization of the polymers synthesized during this research effort is discussed, as well as mechanical properties of the thermoset species.



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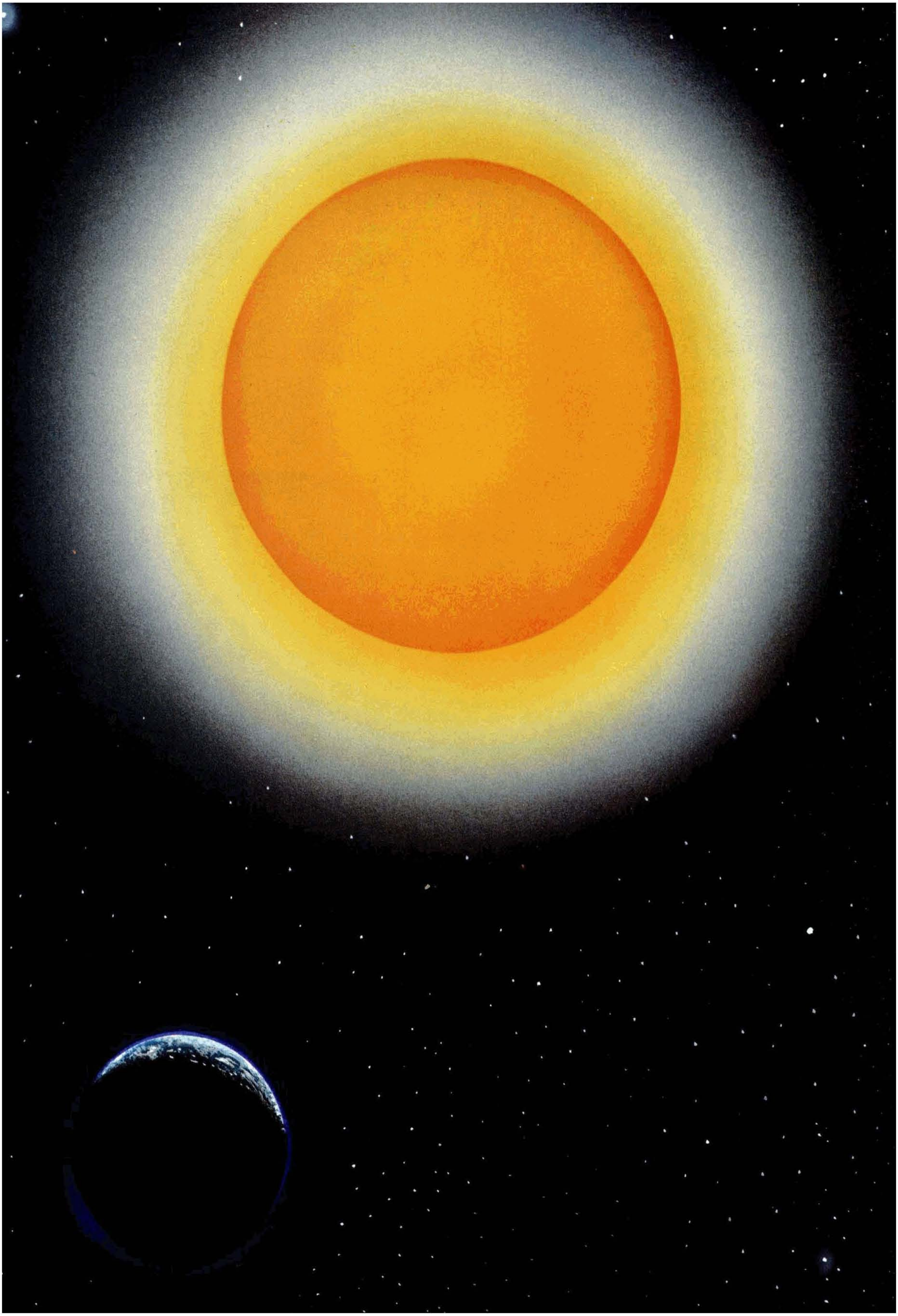

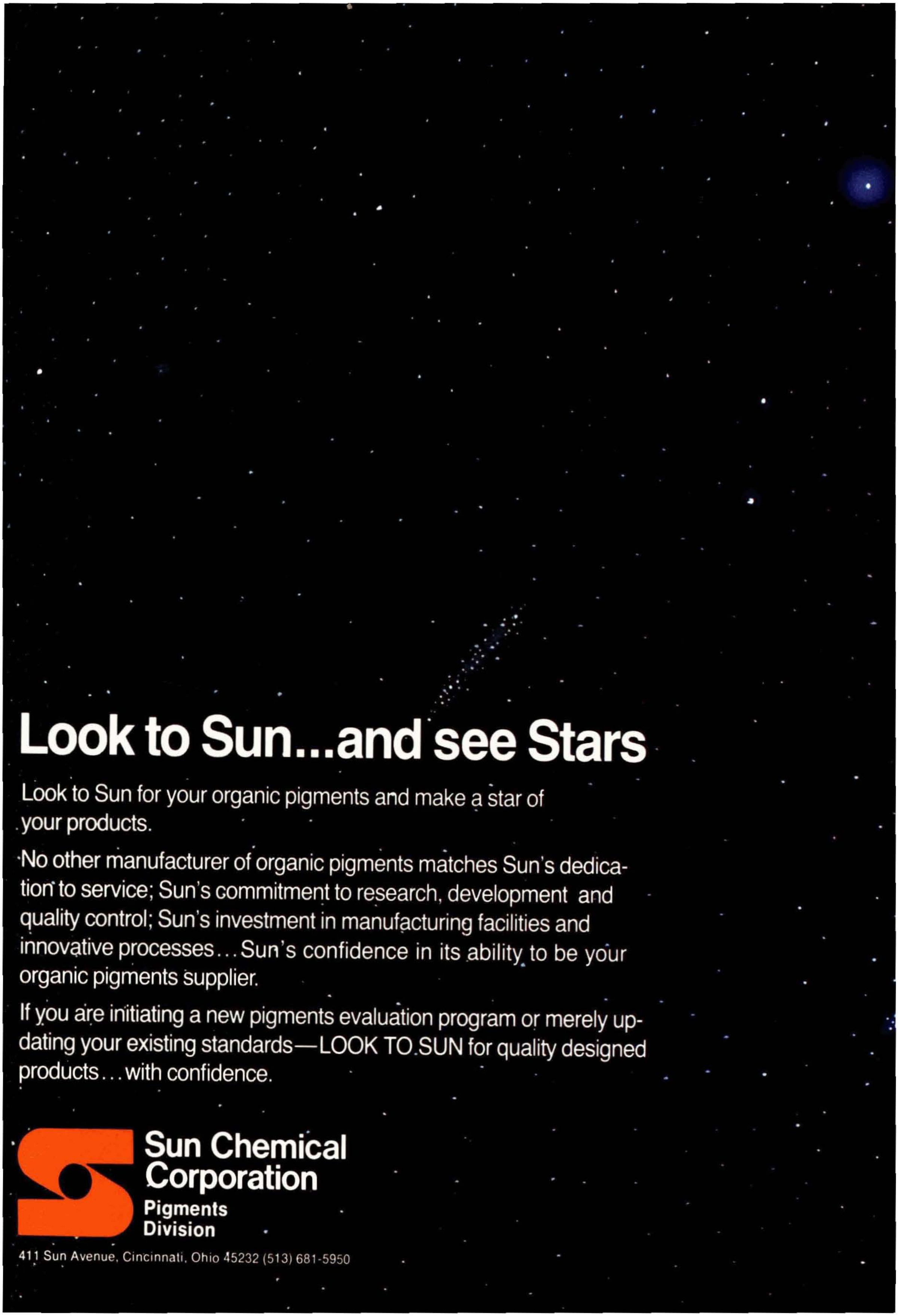

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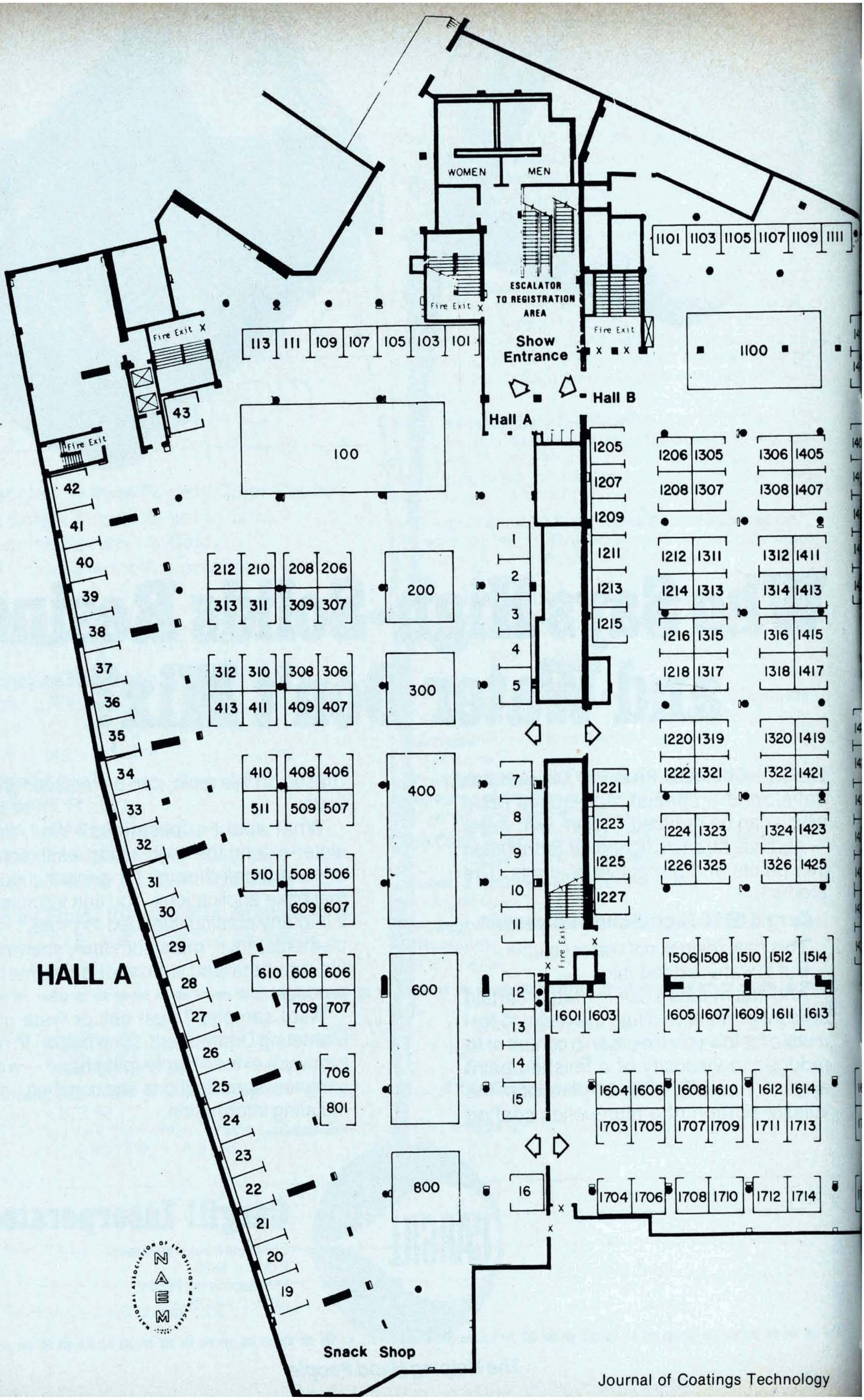
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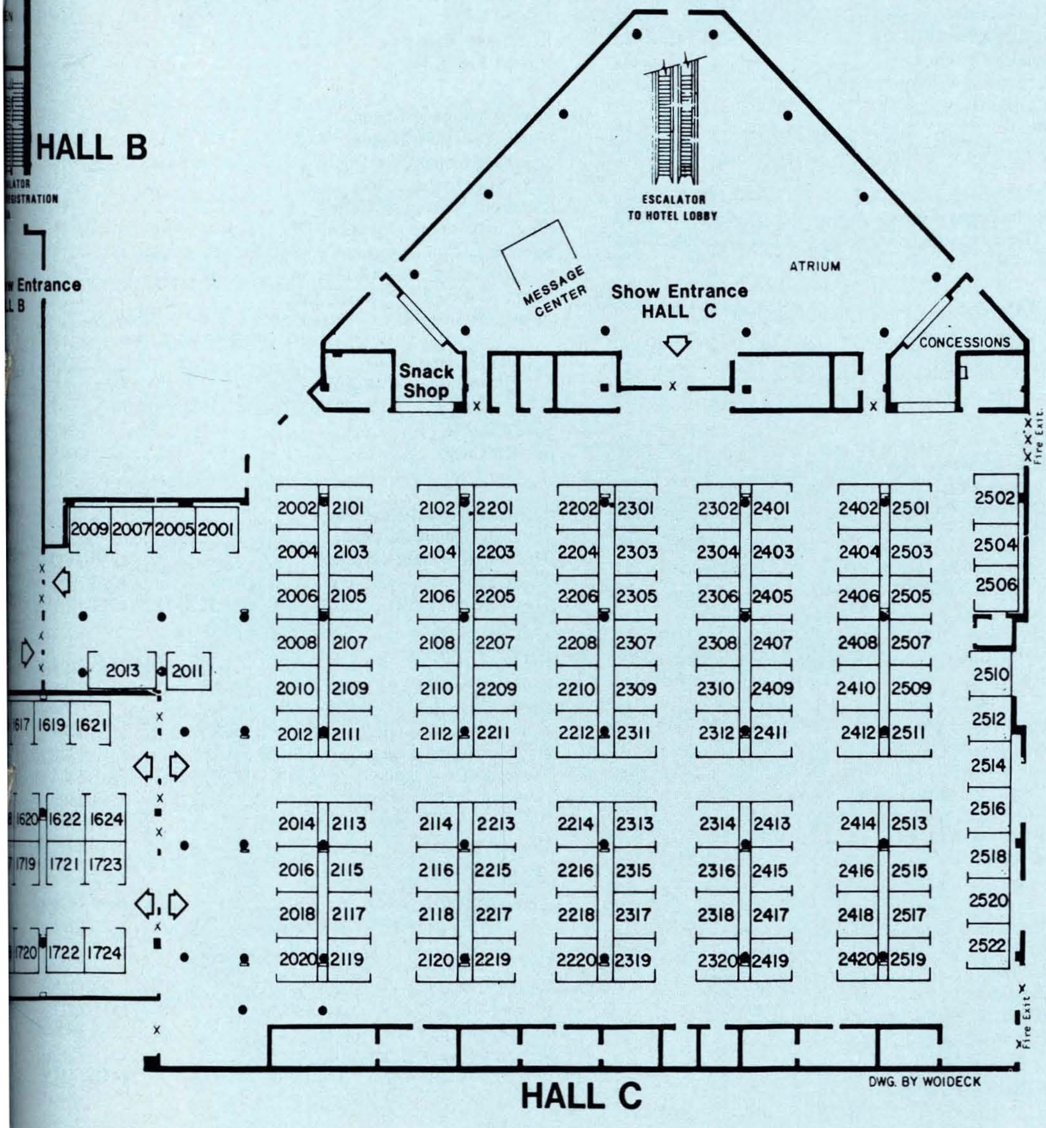

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Cordova Chemical Co. of Michigan
Cosan Chemical Corp.
Custom Chemical Co.
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Degussa Corp.
Diamond Shamrock Corp.
Drew Chemical Corp.
Engelhard Corp., Minerals & Chemicals Div.
GAF Corp.
W.R. Grace & Co.
ICI Americas, Inc.
Interstab Chemicals, Inc.
Kenrich Petrochemicals, Inc.
Laporte (United States) Inc.
3M Co.
Manchem, Inc.
Merck & Co., Inc.
Nalco Chemical Co.
NL Chemical/NL Industries, Inc.
OMYA, Inc.
PPG Industries, Inc.
Rohm and Haas Co.
Sandoz Colors & Chemicals
Sanyo-Kokusaku Pulp Co. Ltd.
Shamrock Chemicals Corp.
Tenneco Chemicals, Inc.
Troy Chemical Corp.
Union Chemicals Div. Union Oil Co. of Calif.
United Catalysts, Inc.
United States Movidyn Corp.
R.T. Vanderbilt Co., Inc.
Wacker Chemical Co.

Chemical Intermediates

Berol Chemicals, Inc.
Buckman Laboratories, Inc.
Chemische Werke Huls AG
Cordova Chemical Co. of Michigan

Colorants

CDI Dispersions
Color Corp. of America
Columbian Chemicals Co.
Custom Chemical Co.
Daniel Products Co.
EM Chemicals
Hilton-Davis Chemical Group
Laporte (United States) Inc.
Penn Color, Inc.
Sandoz Colors & Chemicals
Tenneco Chemicals, Inc.
Universal Color Dispersions

Extenders

Burgess Pigment Co.
Chemische Werke Huls AG
Engelhard Corp., Minerals & Chemicals Div.
Georgia Kaolin Co.
Manville Products Corp.
MiniFIBERS, Inc.
NYCO, Div, PMI
OMYA, Inc.
Ottawa Silica Co.
Pennsylvania Glass Sand Corp.
PPG Industries, Inc.
R.T. Vanderbilt Co., Inc.
Zeelan Industries, Inc.

Latices and Emulsions

Celanese Chemical Co., Inc.
Chemische Werke Huls AG
GAF Corp.
Goodyear Tire & Rubber Co.
Rohm and Haas Co.
Thibaut & Walker Co., Inc.
Union Chemicals Div., Union Oil Co. of Calif.
Wacker Chemical Co.
Witco Chemical Corp.

Oils (Drying / Non-Drying)

Chemische Werke Huls AG
Spencer Kellogg Div. of Textron, Inc.

Pigments, Inorganic

Aceto Chemical Co., Inc.
Buckman Laboratories, Inc.
Degussa Corp.
Dominion Colour Co. Ltd.
EM Chemicals
Georgia Kaolin Co.
Halox Pigments, Div. Hammond Lead Products
Harshaw Chemical Co.
Dr. Hans Heubach Gmbh & Co. KG
Hooker Chemicals & Plastics Corp.
J.M. Huber Corp.
ISC Alloys Ltd.
Laporte (United States) Inc.
Manchem, Inc.
Meadowbrook Corp.
Mearl Corp.
Mineral Pigments Corp.
NL Chemicals/NL Industries, Inc.
Pennsylvania Glass Sand Corp.
Pfizer, Inc., MPM Div.
PPG Industries, Inc.
Reichard-Coulston, Inc.
United Catalysts, Inc.

Pigments, Organic

Dominion Colour Co. Ltd.
Ebonex Corp.
Harshaw Chemical Co.
Laporte (United States) Inc.
Sandoz Colors & Chemicals
Southern Clay Products, Inc.
Sun Chemical Corp., Pigments Div.

Pigments, Metallic

Aluminum Company of America
Meadowbrook Corp.
Silberline Mfg. Co., Inc.

Resins

Cargill, Inc., Chem. Products Div.
Chemische Werke Huls AG
Eastman Chemical Products
EM Chemicals
Goodyear Tire & Rubber Co.
Henkel Corp.
Hercules Incorporated
ICI Americas, Inc.
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Union Camp Corp.
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Aceto Chemical Company, Inc.
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Ashland Chemical Co., Industrial Chemical & Solvent Div.
Chemische Werke Huls AG
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Eastman Chemical Products
Union Chemicals Div., Union Oil Co. of Calif.

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FRYMA, Inc.
Graco, Inc.
Hockmeyer Equipment Corp.
Matter Mixers, Inc.
Miller Paint Equipment, Inc.
Morehouse Industries, Inc.
Myers Engineering
Netzsch, Inc.
Premier Mill Corp.
Reynolds Industries, Inc.
Schold Machine Co.
Semi-Bulk Systems, Inc.
Union Process, Inc.

Pumping / Metering

Blackmer Pump Div., Dover Corp.
Liquid Controls Corp.
Netzsch, Inc.
Warren Rupp Co.
Wilden Pump & Engineering Co.

Safety / Fire Protection

Neutronics, Inc.

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DSET Laboratories, Inc.
Elektro-Physik, Inc.
KTA-Tator, Inc.

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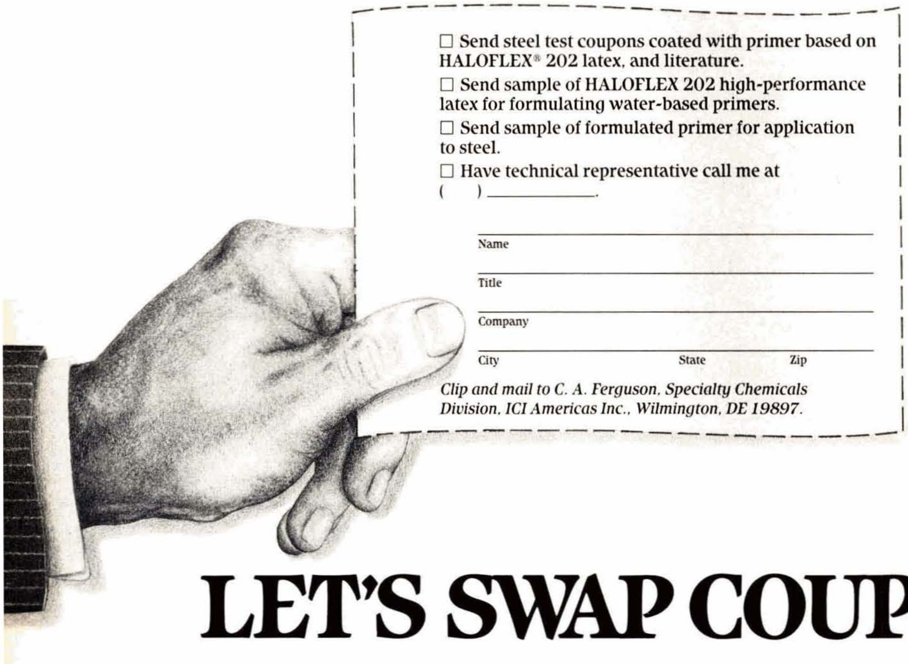
The new Sheraton Washington Hotel & Exhibit Hall with co-headquarters Shoreham Hotel in background



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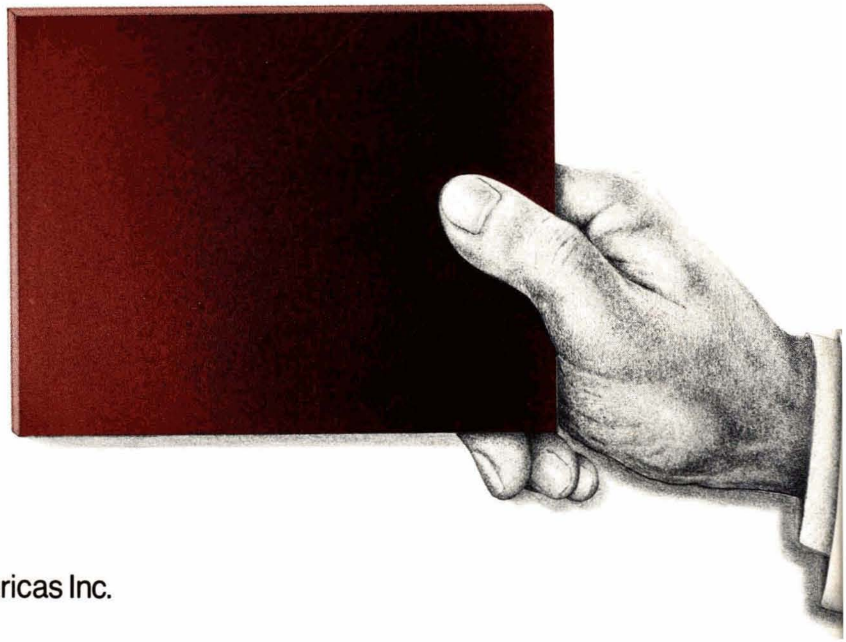

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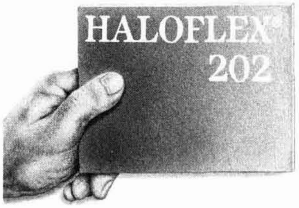

Government and Industry

CARB Proposes VOC Limits for Exempt Products

The California Air Resources Board (CARB) and the South Coast and Bay Area Air Quality Management Districts are seeking industry input on CARB's recommendations that certain products now exempt from architectural coatings rules until September of this year or next year (depending on the district) be removed from the exempt list and be subject to a volatile organic compound (VOC) limit. CARB is recommending a one-year extension of the exempt status of those products to allow time for technical review and rulemaking.

The following specialty coatings are presently exempt from the rules: varnish, lacquer or shellac; semi-transparent stain; opaque stain on bare redwood, cedar, mahogany and douglas fir; primer, sealer or undercoater; wood preserative; fire retardant coating; tile-like glaze coating; waterproofing coating, except bituminous pavement sealers; industrial maintenance finish; metallic pigmented coatings; swimming pool coatings; graphic arts coatings; multi-colored coatings; mastic coatings; and traffic coatings on public streets and highways. CARB is proposing to expand and redefine these categories ". . . in order to more specifically describe coatings types and applications," according to its recent notice.

CARB is proposing to set solvent limits and a September 1983 compliance schedule for: clears, semi-transparent stains, opaque stains, general primers and mastic texture coatings. CARB, SCAQMD and the BAAQMD held consultation meetings in mid June to discuss limits for those products. Later in the year consultation meetings will be held to consider limits for wood preservatives, roof coatings, waterproof sealers, industrial maintenance primers and topcoats, traffic coatings and aerosols. An extension to 1985 was recommended by CARB for all other exemptions.

Additionally, CARB is recommending that the sales of coatings in one-liter or smaller containers be permanently exempt and that the use of the "less water" method of calculating coatings VOC be retained.

For further information on these proposed changes, contact: Chuck Beddow, CARB, (916) 322-8277.

CARB has also announced completion of the final D/L Laboratories Report "Evaluation of Architectural Coatings II, Part B, Exempt Architectural Coatings," which it sponsored. The report is an evaluation of low solvent coatings, including high solids and water-borne coatings, and conventional solvent thinned coatings, among the 14 classes of products now exempt from its architectural coating rules. The report can be obtained from Chuck Beddow at CARB. [NPCA Coatings]

Study Predicts Five-Year Increase in Coatings Market

The industrial coatings industry, which represents an estimated 487 million gallons a year in volume, will increase to 495 million gallons a year in volume by 1986, forecasts a recent study, *Industrial Coatings: New Trends, Markets,* by Business Communications Co., Stamford, CT.

On a dry solids basis, predictions indicate a increase from 195 million gallons in 1981 to 223 million gallons in 1986—a 2.8% average annual increase for dry gallons over the next five years.

The study differs considerably from the *Kline Guide to the Paint Industry* (see April JCT, p 14) which forecasts little or no growth through 1986.

Analyzing the field by catagory, the current study predicts:

- Total solvent systems (conventional and conforming) consumption will remain almost flat;
- High solids and powder coatings show highest growth potential;
- Water-borne systems are next in terms of growth;
- Powder coatings will not reach the large total some analysts have been foretelling.

In analyzing the survivability of coatings manufacturers in the coming years, the study states, "the number of companies that survive the changes and the shake-out will depend on how closely the smaller and medium size companies follow developments which are often tied to the degree of cooperation with raw material suppliers."

"As a general rule, whenever there is turmoil within the framework of an industry, we ultimately see fewer companies, less fragmentation and more specialization. There isn't much total integration in the coatings industry and that aspect isn't likely to markedly change in the next five years."

When you're formulating industrial coatings, you can always count on PPG Lo-Vel® flatting agents to leave you flat. Our highly efficient Lo-Vel flatting agents are designed to reduce the gloss of all surface coatings when needed. And do it economically.

PPG makes a variety of Lo-Vel flatting agents which can be used to reduce gloss on coil coatings, varnishes, lacquers, extrusion coatings, and even micro-texture finishes. They are easy to wet and disperse so they lend themselves well to a wide range of mixing techniques. Unlike silica gels, PPG Lo-Vel flatting agents have no tendency to produce white specks. So you never have to worry about the time and cost of remilling. What's more, the easy dispersion of Lo-Vel flatting agents helps produce more flexible finishes. That can be a big advantage in applications such as coil or extrusion coatings.

PPG Lo-Vel flatting agents exhibit excellent suspension in pigmented finishes and many clears. They are also easily resuspended in clear finishes by the addition of small amounts of polar solvents. Their high efficiency often permits low loading and substantial raw materials cost savings. Many Lo-Vel flatting agents need only two-thirds of the loading required with hydrogel silicas to achieve comparable finishes. And with a Mohs' hardness of 0, PPG Lo-Vel flatting agents will not abrade spray guns or equipment.

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Anti-Corrosive Primers Based on Zinc Flake

Clive H. Hare and Stephen J. Wright
Clive H. Hare, Incorporated*

An examination of the possibilities for the use of zinc flake in anti-corrosive coatings has revealed the material to produce films of significantly greater reactivity than zinc rich primers based on zinc dust. Attempts to reduce this reactivity by employing inhibitors and by the use of spacer pigments have led to the development of formulations utilizing tri-pigment systems based on zinc flake, zinc chromate, and mica. These materials appear to offer value in their greater formulating versatility compared to modified organic zinc rich primers based on zinc dust.

INTRODUCTION

The use of zinc in the control of the corrosion of iron and steel dates back to the early 19th Century when it was discovered that metals having a more active electrochemical potential (compared to steel) could be employed to maintain electrically contiguous steel (of more noble potential) cathodic and thereby, protect it in the presence of a continuous electrolyte.[1,2,3] Such cathodic protection is the underlying principle of all zinc rich coatings wherein the zinc anode is in the form of finely dispersed zinc particles which pigment a suitable coating vehicle. Since the early work of Evans and Mayne[4,5,6] in England and Nightingall[7,8] in Australia, zinc rich coatings of this type have gradually assumed a very considerable proportion of the total metal primer market.

Zinc rich protection is perhaps the surest method of corrosion control yet devised by the coatings industry. Inhibitive pigment based systems are all, to some extent, subject to chloride and sulfate ion depassivation. Paints based on inhibitive pigmentation tend to suffer from osmotic and electroendosmotic blistering failure under immersion conditions.[9] Barrier type coatings such as asphaltics, coal tar epoxies, etc. require high film builds, and often present aesthetic drawbacks.

In zinc rich systems, however, as long as there is sufficient electrical conduction within the continuum of the film and across the interface, the steel must remain protected as long as zinc is available for corrosion. The life of the system will then depend on the rate of the zinc corrosion in any particular environment. Ideally, this should be controlled so that just enough current is generated to maintain the entire steel surface cathodic. Beyond this level, the anode is unnecessarily wasted.

Electrical continuity can be a demanding requirement in organic paint systems where the wetting of the zinc pigment and substrate by the organic vehicle inevitably involves some encapsulation. To date, the almost universally employed form of zinc in coatings has been zinc dust. This pigment is prepared by the shock cooling of vaporized zinc dross and scrap, and is naturally spherical in shape.[10] Thus, electrical current transfer can only be accomplished tangentially between any two adjacent particles of zinc dust, and contact availability is, therefore, limited. In inorganic systems, where the vehicle chemically reacts with atoms of zinc on the surface of the zinc particle (and probably iron atoms on the substrate as well) encapsulation is essentially negligible. In organic systems, judicious formulation at or near the critical pigment volume concentration (CPVC) is required to ensure close packing of pigment (in a typical rhombohedral array) with minimum encapsulation, but with vehicle content sufficient to ensure good substrate wetting and reasonable physicals of the film. Inevitably, these high pigment volume concentration (PVC) requirements translate to extremely high weight loadings of the high density zinc dust particles, and this, in turn, means high costs.

Since zinc dust is a heavy pigment and tends to settle and pack in the can, incomplete homogenization of even a perfectly formulated organic zinc rich product can

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*Two Mear Rd., Holbrook, MA 02343.

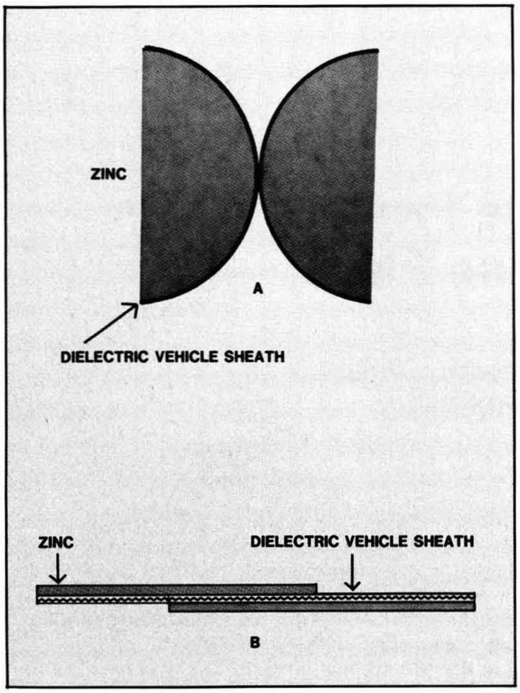

Figure 1—Relative contact areas for electrical conduction across zinc dust (A) and zinc flake (B) films

result in considerable heterogeneity in the applied film.[11] In such cases, some areas of the painted structure will inevitably bear underbound films of high PVC:CPVC ratio (having poor physicals and being overly porous), while films in adjacent areas will be so overly bound that the current transfer across the film continuum will be virtually eliminated. In the latter case, of course, the zinc rich primer is useless and offers no protection to the steel.

Even in properly formulated products, and particularly in the inorganics which are by their very nature much more open than their organic counterparts, porosity can be a significant problem. Such a condition may result in a cohesively weakened continuum which can, in turn, lead to lateral fracture and sheeting delamination phenomena in completed paint systems that bear thick continuous topcoats of high cohesive strength. Also, porous films will often result in serious top coating problems during application. Overly porous coatings contain by definition many air filled voids. When recoated, particularly with high solids, and high build lacquers, solvents penetrate such porous primers and displace air from these internal voids. Unless these finish coats are based on exceptionally slow solvent systems, or are formulated at relatively high PVC's, there will be a tendency for the upper layers of the finish to skin over before all the occluded air is released from the primer. After such finish coat "skinning," the air that is displaced from the primer rises partially through the finish in a large bubble which becomes entrapped in the finish. Some such bubbles may break, but, unless there remains sufficient flow in the finish, this action will leave a large pin-hole or cavity exposing the primer.

Such bubbling problems have haunted zinc rich applications, and many remedies have been tried to resolve this problem. These include the application of mist coats, low solids, "zot" (solvent-thinned) coats (which more easily penetrate the primer and so release the occluded air more rapidly), wash primers, and even solvent coats prior to the application of the finish.[12] All involve a costly additional application step, and do not necessarily resolve the problem entirely.

An additional problem can occur in many types of zinc dust coatings, particularly those formulated in single package form. Zinc is a highly reactive metal and in manufacture, in storage, and/or during coating manufacture, can absorb water from the air. In the presence of water, particularly at low pH, zinc reactivity can result in the evolution and concentration of hydrogen gas in the can, producing can deformation and even explosions. In acidic vehicles, such as epoxy esters, the problem can be more severe, as it also can be in vehicles such as chlorinated rubber, which may undergo dehydrochlorination in the presence of water and zinc metal. Hydrolysable solvents and other ingredients can also cause difficulties. The problems of gassing and settling, in fact, force many manufacturers to prepare zinc rich coatings in two packages (some chemically reacting thermosetting systems are even packaged in three cans), where the zinc dust is added to the vehicle immediately prior to application.

As noted above, theoretically, steel protection will be maintained until zinc availability is exhausted. In practice this is compromised because of the polarizing effects of zinc corrosion products. In the macro sense, the corrosion products forming on the primer surface as the zinc is consumed may prolong the primer life. In coating the primer surface, the corrosion products tend to fill up the intersticial voids between the pigment particles near the surface of the film and thereby, reduce access of water to the lower film sections and to the substrate itself. Thus, the film actually assumes properties more akin to barrier finishes. However, as with all films of thicknesses much less than 250 microns, enough water will still reach the metal to ensure the possibility that the driving cathode reaction at the steel surface will continue, albeit at a reduced level. In environments where the corrosion product is soluble, or is stripped mechanically from the film, such surface polarization is continually prevented and the resulting rate of zinc corrosion becomes more linear, forshortening the active service or life of the coating.

In the micro sense, the build-up of corrosion product on the surface of the zinc spheres may not only reduce current transfer but may actually prevent full effective utilization of the zinc volume in the core of the pigment. Once the corrosion build-up between particles of zinc dust raises the film's resistance enough so that current transfer is eliminated, further zinc core corrosion is local and does nothing for the electrically isolated steel.

It would appear necessary, therefore, that the upper sections of the film are well sealed with insoluble and inaccessible zinc corrosion product before the lower sections. Fortunately, this is the case in most environments.

ALTERNATE ZINC FORMS

Problems such as cost, porosity, recoating difficulties, and package stability (settling and gassing) were instrumental in the decision to evaluate other forms of zinc in anti-corrosive coatings for steel. It was reasoned that in this respect a flat platey zinc particle might show some promise, as a greater contact area of lamella particles might allow lower PVC's, and thus improved coating strength (*Figure* 1). In addition, this particle shape should reduce settling and possible top coat bubbling. There should be more efficient usage (less zinc core wastage) with these higher surface area pigments than with zinc dust, and, as the average flake thickness is about 10 times the diameter of the average dust particle, additional benefits in thin films.

Unfortunately, few commercial renderings of the metal in flake form were available, and most of these were in the form of pastes in aliphatic hydrocarbons (not at all a universal solvent for typical zinc rich vehicles). One pigment, however, Zinc Flake Ecka® 31129/G seemed an ideal candidate for this study, being both easily dispersable in typical zinc rich vehicles and available in a dry form without solvents. The pigment was developed for the Dacromet® Primers used in the highly successful Zincromet® process.

While the primary thrust of the study was toward the utilization of zinc flake in sacrificial protective systems, the more basic objective of corrosion control, irrespective of mechanism, remained much more important.

Initially, an evaluation of the zinc flake as the sole pigment was made in a high molecular weight epoxy (Phenoxy®) based formulation utilizing a series of primers ranging in PVC from 21.2% to 66.4%. Volume solids were monitored at 25% throughout, generally being limited by the molecular weight of the Phenoxy resin, and in the higher PVC compositions by the oil absorption of the zinc flake. The thixotrope system was based on a high molecular weight polyolefin, and the solvent system was a Cellosolve® acetate/2-nitropropane mix in volume ratios of approximately 12:1. The compositions of the primers are outlined in *Table* 1. These primers were evaluated in both 5% salt spray (ASTM-B-117) and in a modified form of the bullet hole test, in which a steel panel having two zinc coated strips on either side of a strip of bare steel was immersed in 3% salt water (see *Figure* 2). The zinc to steel (anode to cathode) area on these panels is therefore in the ratio of 3:1, which is less favorable than conventional bullet hole tests. This second test examines galvanic activity, and evaluations are made on the duration of protection of the bare steel by the adjacent zinc.

All films were cast via doctor blade, using the Testape™ technique[13] on MEK washed, unblasted, ground steel Q-Panels® (in efforts to slightly accelerate results). Film thicknesses, measured after complete drying prior to exposure, were all between 0.9 and 1.3 dry mils (23-33 microns).

Figure 2—Typical arrangement for the 3% NaCl bullet hole immersion test. Each test vessel holds one panel only. Test solution is renewed after each seven days.

The results (see *Table* 2) of the first tests were both disappointing and revealing; their most startling aspect being the rapid corrosion of the zinc, especially at higher PVC's (59% and greater). On these films, copious amounts of white zinc corrosion product were noted in the salt fog tests. Within less than 200 salt fog hours, such panels had begun to show red rust and had deteriorated rapidly thereafter. Blister resistance was again very poor, being most acceptable at PVC's in the 50% to 55% range. In the bullet hole studies, the protection of the bare steel seemed to improve as the PVC increased, being almost nonexistent at PVC's below 40% and maximized above 60%. Again, blistering resistance was poor, particularly in the middle order PVC's.

Such data seemed to indicate that the zinc flake provided an anode too available at normal PVC's (with reference to zinc dust primers) to give any long term protection, although, quite clearly over the short term, the flake behaved very favorably. Undoubtedly, this was related to the topology of the primer's surface, which was more akin to hot dip galvanized surfaces than to conventional zinc rich primer surfaces. As stated elsewhere,[14] smooth zinc surfaces would not be as conducive to long term salt fog protection as would the more uneven surface of a conventional zinc dust primer. More generally, the test method itself may not be entirely appropriate for this type of coating.[15,16,17]

The possibility of unduly weakened films of too high

Table 1—Formulation Design for the Unmodified Zinc Flake Primers

lbs. (U.S. gallons)

Ingredients	Source	Primer A	Primer B	Primer C	Primer D	Primer E	Primer F	Primer G
PKHH (Phenoxy)	Union Carbide	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)
Cellosolve Acetate	Union Carbide	607.4 (75.0)	572.0 (70.6)	536.5 (66.2)	341.1 (61.9)	465.6 (57.5)	430.2 (53.1)	394.7 (48.7)
MPA-X-1078	N.L. Ind.	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)
Zinc Flake Ecka 31129/G	Eckart-Werke	800.0 (18.5)	730.9 (16.9)	661.8 (15.3)	592.7 (13.7)	523.6 (12.1)	454.4 (10.5)	385.4 (8.9)
2-Nitropropane	IMC	55.7 (6.8)	52.1 (6.4)	48.6 (5.9)	45.1 (5.5)	41.5 (5.1)	38.0 (4.6)	34.4 (4.2)
% Pigment Volume Concentration		66.4	64.4	62.1	59.4	56.4	52.9	48.8

Ingredients	Source	Primer H	Primer I	Primer J	Primer K
PKHH (Phenoxy)	Union Carbide	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)	80.0 (8.14)
Cellosolve Acetate	Union Carbide	359.3 (44.4)	323.9 (40.0)	288.4 (35.6)	353.0 (31.2)
MPA-X-1078	N.L. Ind.	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)	24.0 (3.24)
Zinc Flake Ecka 31129/G	Eckart-Werke	316.0 (7.3)	276.4 (6.4)	207.0 (4.8)	109.0 (2.5)
2-Nitropropane	IMC	30.9 (3.8)	27.3 (3.3)	23.8 (2.9)	20.2 (2.5)
% Pigment Volume Concentration		43.9	40.6	33.8	21.2

Volume Solids Remain Constant at 25.0%

Table 2—Performance Profiles of the Unmodified Zinc Flake/Phenoxy Primers In 5% Salt Spray and 3% NaCl Bullet Hole Immersion

	5% Salt Spray								3% NaCl Bullet Hole Immersion	
Primer	Zinc Corrosion (Salt Formation)		Ferric Corrosion At Scribe Line		Ferric Corrosion Of General Panel		Blistering Resistance		Days to Bullet Corrosion	Blistering Resistance
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)		
A	H.	H.	6	5	3	1	2/6	2/5	20	8/6
B	H.	H.	7	6	4	2	2/6	2/5	23	8/6
C	H.	H.	6	5	4	1	2/6	3/5	15	8/5
D	M.-H.	H.	8	8	6	4	5/5	5/5	13	6/7
E	M.	M.	9	9	8-9	7	6/6	5/5	17	7/5
F	M.-L.	M.-L.	9	8-9	9	8	6/6	5/5	20	3/5
G	M.	H.	9	8-9	8	5	2/5	1/4	14	3/5
H	M.	M.	9-10	8-9	10	6-7	4/4	1/3	17	3/4
I	M.	M.	10	8	9-10	6-7	2/2	1/2	13	4/4
J	M.	M.	9-10	6	10	8	2/2	1/2	4	10/10
K	M.-L.	L.	7-8	6	10	9-10	2/5	9/9	1	10/10

KEY
Duration in salt spray
(a) 168 hrs.
(b) 550 hrs.

Zinc Corrosion
H.—Heavy Copious White Corrosion
M.—Moderate White Corrosion
L.—Light Irregular Whitening of Primer Surface.

Degree of Blistering
10—No Blisters
9—Few Isolated Blisters
1—Extreme Blistering
0—Total Delamination

Size of Blisters
10—No Blisters
9—Pinpoint Blisters
1—Very Large Blisters

Scribe and General Panel Ferric Corrosion
10—No Corrosion
0—Totally Corroded Face

Blistering Resistance
(—/—)—Degree of Blistering/Size of Blisters)

a PVC:CPVC ratio that break up under test conditions was also very real, however. Zinc flake (as tested), unlike zinc dust, is processed with a long chain carboxylic acid derivative used as a surface lubricant to facilitate its manufacture. Difficulties in wetting low energy surfaces might well reduce cohesion of zinc flake films, particularly at high PVC:CPVC ratios, and thereby foster film breakup and/or blistering as water penetrates into the coating.

The other data were more positive. As predicted, the zinc flake primers were not prone to hard sedimentation, and the paints could be readily used even after several months storage with very little stirring. There was no apparent settlement during the period of application, and it was found that in-pot mixers would hardly be necessary to maintain homogeneity once the primer was initially mixed.

The apparent reduction in effective PVC was also predictable. In both bullet hole and salt fog studies, levels in the 50% to 55% range seemed optimum, and are judged to be near the CPVC (the CPVC of these coatings is significantly lower than the CPVC range normally found in unmodified dust primers—which is usually near 65%) because of the higher oil absorption of zinc flake—15 as compared to 7 for zinc dust. Oil absorptions were measured using the Spatula Rub-Out technique (ASTM-D281).

Thus, it appeared that if the reactivity of the zinc in the flake form could be controlled, and if the blistering tendency (to which all zinc flake films seemed prone) could be eliminated, some advantages might be gained from the use of the zinc flake.

INHIBITING ZINC REACTIVITY

In attempts to resolve these inadequacies, two separate directions of research were conducted. In the first, the use of an inhibitor (zinc potassium chromate) was employed with zinc flake to reduce its reactivity. Levels between 3% and 15% zinc potassium chromate based on the total pigment volume were used. Aside from the pigmentary composition, these inhibitive zinc flake coatings were based on formulations of the same type as those employed in the earlier tests. Again, ranges of PVC's were evaluated, although in this case, the range was restricted to between 39% and 58% PVC, (see *Table* 3). As in the first experiments, nonblasted Q-Panels were used as substrates, and films of between 0.9 and 1.3 dry mils (23–33 microns) were tested in both salt spray and bullet hole immersion.

Data (see *Table* 3) showed that in salt spray the chromate decreased the apparent rate of zinc dissolution (reducing the amount of white corrosion), and increased the performance of the flake in providing protection to the scribe and to the general panel. Furthermore, the inclusion of the chromate, while generally improving the blister resistance, gave radical improvements in the blister resistance of those formulations at and above what was believed to be the CPVC (calculated from the oil absorptions of the pigment mixes). This optimum PVC level seemed to decrease (from approximately 54% to 48%) as zinc chromate content increased from 0% to 15%. If viewed in terms of the increased oil absorption of the total pigment mix that the inclusion of the zinc chromate might cause; this makes sense. A 15% volume replacement of zinc flake with zinc chromate raised the oil adsorption of the pigment mix from 15 to 21. Optimum levels of zinc chromate were judged at or above the 9% level (volume of zinc potassium chromate on total pigment volume).

Bullet hole test data on this series of primers showed similar improvements. Increasing chromate improved both the duration of bright steel at the bullet hole, and the general panel corrosion resistance. Again, above or near the CPVC, blistering resistance was improved, although below this level there was little improvement. As before, the effects of increasing chromate content on the optimum PVC, could be interpreted in terms of the decreasing CPVC caused by the increasing oil absorption of the pigment mix.

Interestingly, the addition of zinc potassium chromate to zinc flake inorganic systems seemed to have a less positive effect on performance. In inorganic systems, unmodified zinc flake was found to have surprisingly excellent performance (when compared to the organic system described above). On sandblasted steel at 2.0 dry mils applied by airspray techniques, as many as 2600 hours in the salt fog chamber were found necessary to produce even the slightest amount of red rust at the scribe (with no undercutting). These results have been discussed more fully elsewhere.[18]

When similar chromate inorganic zinc flake systems were evaluated, they gave much poorer salt fog results. Unfortunately, film thicknesses of the chromated primers were significantly lower (1.0 ± 0.2 dry mils or 20 – 30 microns) than their nonchromated counterparts, and this fact alone may have had an overriding effect on the experiment. Certainly, the performance of the unmodified inorganics gives much impetus for more work with modified formulations of this type.

MICA MODIFICATION

A second direction of research involved experiments based on the use of mica in combination with the zinc flake. Many zinc rich paint manufacturers employ this pigment as a means of reducing CPVC and, consequently, (when PVC/CPVC ratios equal unity) the PVC of their zinc rich primers. The effectiveness of mica replacement in such systems has been discussed by Eickhoff.[19] The technique gives significant cost reduction in such systems and may slightly reduce both the tendency of the formulation to settle and to pin-hole when top coated. In zinc dust formulations, however, because of the limited tangential contact between zinc particles, the amount of mica that can be employed must inevitably be limited if cathodic protection is to be maintained. In zinc flake systems, contact is lamella and electrical resistance is lower. Measurements were made of the electrical resistances of unmodified films of equal PVC:CPVC ratios (1.06:1) applied over glass and aged two days in a nondessicated atmosphere. Zinc dust films were measured at 890 K ohms, and the zinc flake film at 4,350 K ohms. Consequently, since zinc consumption is more

Table 3a—Performance of Chromated Zinc Flake Primers in 5% Salt Spray and 3% NaCl Bullet Immersion

			5% Salt Spray						3% NaCl Bullet Hole Immersion	
Primer	Z.F./ Z.P.C.	% PVC	Scribe Corrosion		Gen. Panel Corrosion		Blistering Resistance		Days to Bullet Hole Corrosion	Blistering Resistance
			(a)	(b)	(a)	(b)	(a)	(b)		
2848A	100/0	58.1	9	8-9	7	5	5/7	3/7	17	10/10
2848B	"	56.7	8-9	8	7	5	3/5	2/4	17	10/10
2848C	"	55.3	8-9	8	6-7	5	6/6	4/5	17	9/8
2848D	"	53.7	9-10	9-10	10	8	5/6	2/4	14	8/7
2848E	"	52.1	9	8-9	9-10	7	3/5	2/4	14	8/7
2848F	"	50.3	8-9	7	8	4	3/5	2/3	17	5/4
2848G	"	48.4	9	7	8	4-5	2/2	2/2	18	3/2
2848H	"	46.4	9	8	8	5	2/2	1/2	17	3/3
2848I	"	44.2	9-10	7	9	5	2/2	1/1	14	3/3
2848J	"	41.8	9-10	6	8	4	2/2	1/1	12	2/3
2848K	"	39.1	9-10	6	8	5	2/2	1/1	11	2/3
2849A	97/3	58.1	9-10	8	9-10	8	10/10	6/6	17	10/10
2849B	"	56.7	9-10	8	9-10	7	8/6	3/6	17	10/10
2849C	"	55.3	7	7	7	5	8/7	6/3	13	10/10
2849D	"	53.7	8-9	7-8	9-10	6	9/5	4/5	17	10/10
2849E	"	52.1	7-8	6-7	9	5	10/10	6/2	17	10/10
2849F	"	50.3	10	7	10	8	5/5	5/4	31	10/10
2849G	"	48.4	10	7-8	10	6	4/6	2/4	55	2/7
2849H	"	46.4	10	7-8	10	6	4/6	2/4	38	2/5
2849I	"	44.2	10	7-8	10	6	3/6	2/4	31	2/4
2849J	"	41.8	10	7	10	5	2/6	2/4	25	3/3
2849K	"	39.1	10	7	10	5	2/6	2/4	25	3/3

KEY
Salt Fog Durations
(a) 190 hrs
(b) 622 hrs
Z.F./Z.P.C.—Ratio by volume of Zinc Flake to Zinc Potassium Chromate.
For other abbreviations, etc., see *Table* 2.

rapid, greater quantities of mica might be employed as "spacers" to reduce the extent of lamella contact between overlapping zinc flakes. The concept was interesting not only technically, but also because of the cost reductions that the replacement of larger amounts of zinc flake with mica could bring.

To investigate this concept, three series of zinc flake primers utilizing different grades of mica (ranging from a 10 micron sized pigment to a coarse 100 micron pigment) were evaluated. Each series involved six sets of paints where volumetric replacements of zinc flake with mica (ranging from 15% mica/85% zinc flake to 70% mica/30% zinc flake) were examined in salt fog and in bullet hole immersion. For each different zinc level, with each different mica type, a full PVC ladder ranging from 37.3% to 58.1% was formulated. Primers were based on the same type of formulation system as was used in the unmodified and chromate modified studies being bound by the Phenoxy vehicle and carried in a Cellosolve acetate/2-nitropropane solvent mix. Volume solids were again normalized at 25%. Primers were applied on Q-Panels by doctor blade at 1.0 ± 0.2 dry mils (20 to 30 microns).

Data from the 1,000 hour salt fog exposures of these mica modified series shows that the coarsest mica extender, Mica #279, gave the best performance profiles. While all micas demonstrated their effectiveness at blistering reduction, the best all around data was secured with this pigment. The finer extenders gave shorter lived protection of bare steel in the bullet hole studies, and generally poorer corrosion resistance in salt spray.

Results of the #279 mica series are shown in *Table* 4. In salt spray, replacement levels of up to 70% mica were found possible, while PVC's seemed optimized between 33% and 44%. Bullet hole data of these formulations, however, seem to indicate the excellent salt fog performance at lower zinc content might be as much related to barrier protection (via lamella platlets) as cathodic protection. In apparent contradiction of this, the scribe lines of even the 60% mica modified systems in salt spray showed intensified white zinc corrosion, coupled with the absence of ferric corrosion, indicating some sacrificial protection was taking place in these systems, and that this was partially responsible for the high performance. Optimum results in the bullet hole tests were found at higher PVC's than in salt fog, and somewhat lower levels of mica gave the longest protection. The 15% to 30% levels of mica, at PVC's as high as 49% to 54%, gave the best cathodic protection, with bare steel remaining uncorroded for periods of up to 50 days. While such low mica, high PVC panels tended to exhibit blistering in salt spray, they did not do so in salt water.

High mica formulations showing excellent salt fog performance gave shorter protection of the exposed steel in the bullet hole test, with the bare steel corroding in 5 to 10 days at all PVC levels when mica levels ranged between 50% and 70% of the pigment volume. As mica levels decreased, the degree of cathodic protection

Table 3b—Performance of Chromated Zinc Flake Primers In 5% Salt Spray and 3% NaCl Bullet Immersion

			5% Salt Spray						3% NaCl Bullet Hole Immersion	
Primer	Z.F./ Z.P.C.	% PVC	Scribe Corrosion		Gen. Panel Corrosion		Blistering Resistance		Days to Bullet Hole Corrosion	Blistering Resistance
			(a)	(b)	(a)	(b)	(a)	(b)		
2850A	91/9	58.1	10	7–8	10	4–5	10/10	6/5	28	8/2
2850B	"	56.7	10	8–9	10	4–5	10/10	5/5	27	8/2
2850C	"	55.3	10	7–8	10	5	10/10	7/5	23	6/3
2850D	"	53.7	10	8	10	5	10/10	5/6	23	7/3
2850E	"	52.1	10	8	10	4–5	10/10	2/7	13	10/10
2850F	"	50.3	10	10	10	10	10/10	8/9	13	10/10
2850G	"	48.4	10	7–8	10	8	8/6	3/3	13	2/8
2850H	"	46.4	10	7	10	7	3/4	2/3	18	5/5
2850I	"	44.2	10	7	10	8	3/4	2/2	18	2/4
2850J	"	41.8	10	7	10	9	3/4	3/4	18	2/2
2850K	"	39.1	10	7	10	10	3/4	2/3	12	2/5
2851A	85/15	58.1	10	9	10	6–7	10/10	7/4	23	6/5
2851B	"	56.7	10	9–10	10	7	10/10	7/4	38	4/5
2851C	"	55.3	10	9	10	6	10/10	6/4	31	6/5
2851D	"	53.7	10	8–9	10	5	10/10	4/5	47	10/10
2851E	"	52.1	10	8–9	10	5	10/10	4/6	66	8/8
2851F	"	50.3	10	8–9	10	6	10/10	6/6	59	9/8
2851G	"	48.4	10	8	10	8	10/10	5/3	47	2/2
2851H	"	46.4	10	7–8	10	8	4/6	2/4	18	2/4
2851I	"	44.2	10	7	10	8–9	3/6	2/4	23	2/3
2851J	"	41.8	10	7	10	8	3/6	2/6	23	2/4
2851K	"	39.1	10	7	10	8–9	3/6	2/5	31	2/5

KEY
Salt Fog Durations
(a) 190 hrs
(b) 622 hrs
Z.F./Z.P.C.—Ratio by volume of Zinc Flake to Zinc Potassium Chromate.
For other abbreviations, etc., see *Table* 2.

increased. Perhaps the best compromise between the data of the two tests was realized at approximately 40% mica/60% zinc flake, at PVC's between 40% and 45%.

The discrepancy between salt fog and bullet hole results revealed in these tests is possibly explained in terms of the aggressiveness of the salt fog medium towards zinc metal. In this particular test method, high zinc flake/high PVC systems, the zinc is consumed too rapidly for long service life. On the other hand, electrical resistances increase with mica content or decreasing PVC, and the zinc availability is more controlled and the primers lived longer. This might tend to encourage the formulation of less reactive systems with lower zinc availability (high mica/low PVC systems) for salt spray. On the other hand, the sheer size of the cathode in the bullet hole tests would require the greater zinc availability that low mica/high zinc/high PVC coatings would provide.

For optimized performance, therefore, in many respects it would seem that such primers should be suited to the severity of the test environment. One might ask, at this point, whether bullet hole or salt fog data are truly meaningful measures for the performance of these systems in real environments, or merely convenient guides to formulating trends? What, indeed, should be the best mica/zinc flake combination for normal exterior exposure in low chloride ion environments? What should optimized PVC's be?

What this data does indicate, however, is that the zinc flake/mica systems are far more versatile and less critically limited by PVC/CPVC ratio considerations than are conventional zinc dust organic systems.

The remarkable improvement in the performance of zinc flake primers utilizing either inhibitive pigments or mica, compared to primers based on the unmodified flake, clearly verified the theoretical basis for both concepts and gave authority for further study. Inevitably, such studies lead to a combination of the two techniques—as tri-pigment systems utilizing zinc flake, mica, and zinc chromate.

TRI-PIGMENT SYSTEMS

In these experiments, zinc potassium chromate volume levels of 5%, 10%, and 15% on the total pigment volume were evaluated with the zinc flake contents ranging from 34.0% to 66.5% of the pigment volume. Consequent mica contents ranged from 28.5% to 51.0%. The vehicle, thixatrope, and solvent system in these experiments were identical to the earlier evaluations, and the total volume solids were again adjusted to 25%. For each of the 12 separate pigment combinations evaluated, a PVC ladder of six separate primers was made. Pigment volume concentrations were identical from pigment combination to pigment combination, although differences in the CPVC were inevitable. PVC levels studied were 52.2% (A primers), 50.0% (B primers), 47.3% (C primers), 44.2% (D primers), 41.0% (E primers), and 37.3% (F primers). CPVC values could be expected to be reduced somewhat

Table 4a—Performance of Mica Modified Zinc Flake Primers In 5% Salt Spray and 3% NaCl Bullet Immersion

			5% Salt Spray						3% NaCl Bullet Hole Immersion	
Primer	Z.F./ Mica	% PVC	Scribe Corrosion		Gen. Panel Corrosion		Blistering Resistance		Days to Bullet Hole Corrosion	Blistering Resistance
			(a)	(b)	(a)	(b)	(a)	(b)		
5838A	100/0	58.1	9–10	8	10	2	10/10	2/7	12	10/10
5838B	"	54.0	10	10	10	8–9	10/10	2/7	11	2/5
5838C	"	49.7	9–10	8	10	7–6	6/6	2/6	26	2/4
5838D	"	44.2	9–10	8	10	7	7/6	2/5	14	2/2
5838E	"	40.1	10	8–9	10	8	6/6	2/4	12	2/2
5838F	"	37.3	9–10	8–9	10	8	6/7	2/3	11	2/2
5853A	85/15	58.1	10	8	8	4	5/6	4/7	49	10/10
5853B	"	54.0	9–10	8	8–9	3	10/10	2/6	41	7/8
5853C	"	49.7	10	10	10	10	6/6	6/6	50	3/4
5853D	"	44.2	10	10	10	10	5/5	4/4	35	2/2
5853E	"	40.1	10	10	10	10	8/6	4/4	32	2/2
5853F	"	37.3	10	10	10	10	7/7	4/3	15	2/2
5854B	70/30	54.0	10	9	9	7	10/10	8/6	23	10/10
5854C	"	49.7	10	8	10	6	10/10	5/8	19	10/10
5854D	"	44.2	10	10	10	8	7/8	4/7	19	2/4
5854E	"	40.1	10	10	10	10	6/6	5/3	12	2/2
5854F	"	37.3	10	10	10	10	8/8	5/2	7	2/4
5854G	"	33.1	10	10	10	10	8/8	8/3	5	2/1
5855B	60/40	54.0	9–10	5	7–8	3	8/8	3/7	10	10/10
5855C	"	49.7	10	8	8	4	10/10	4/7	14	10/10
5855D	"	44.2	10	10	10	8	10/10	10/10	14	6/7
5855E	"	40.1	10	10	10	8	7/6	4/6	8	2/4
5855F	"	37.3	10	10	10	9	10/10	4/6	6	2/2
5855G	"	33.1	10	10	10	10	8/8	5/7	5	2/3

KEY
Salt Fog Durations
(a) 168 hrs.
(b) 504 hrs.
Z.F./Mica — Ratio by volume of Zinc Flake in #279 Mica ex. W.C.D.
For other abbreviations, etc., see *Table* 2.

Table 4b—Performance of Mica Modified Zinc Flake Primers In 5% Salt Spray and 3% NaCl Bullet Immersion

			5% Salt Spray						3% NaCl Bullet Hole Immersion	
Primer	Z.F./ Mica	% PVC	Scribe Corrosion		Gen. Panel Corrosion		Blistering Resistance		Days to Bullet Hole Corrosion	Blistering Resistance
			(a)	(b)	(a)	(b)	(a)	(b)		
5856B	50/50	54.0	10–9	8	8	3	10/10	10/10	7	10/10
5856C	"	49.7	10	10	8–9	5–6	10/10	10/10	7	10/10
5856D	"	44.2	10	10	10	8	10/10	10/10	5	10/10
5856E	"	40.1	10	10	10	8	10/10	10/10	5	10/10
5856F	"	37.3	10	10	10	9	10/10	10/10	4	2/6
5856G	"	33.1	10	10	10	9	10/10	10/10	4	2/6
5857B	40/60	54.0	9	4	5	2	10/10	10/10	4	10/10
5857C	"	49.7	10	9–10	6	4	10/10	10/10	4	10/10
5857D	"	44.2	9–10	9	8–9	8	10/10	10/10	4	10/10
5857E	"	40.1	10	9	9–10	9	10/10	10/10	3	8/8
5857F	"	37.3	9	9	10	8	10/10	10/10	3	2/4
5857G	"	33.1	10	10	10	9–10	10/10	10/10	2	2/3
5858B	30/70	54.0	9	9	6	5	10/10	10/10	1	10/10
5858C	"	49.7	10	10	7–8	7–8	10/10	10/10	1	10/10
5858D	"	44.2	10	10	10	9	10/10	10/10	1	10/10
5858E	"	40.1	10	9	10	8–9	10/10	10/10	1	10/10
5858F	"	37.3	10	9–10	10	9–10	10/10	10/10	1	6/7
5858G	"	33.1	10	10	10	9–10	10/10	10/10	1	3/6

KEY
Salt Fog Durations
(a) 168 hrs.
(b) 504 hrs.
Z.F./Mica — Ratio by volume of Zinc Flake to #279 Mica ex. W.C.D.
For other abbreviations, etc., see *Table* 2.

Table 5a—Composition and Performance Profile Of the Tri-Pigment (Zinc Flake/Mica/Zinc Potassium Chromate) Systems

Notebook Reference	Percent Volume Composition			5% Salt Spray									3% NaCl Bullet Hole Immersion	
	Z.F./Mica/Z.P.C.			Scribe Corrosion			Corrosion of the General Panel			Blistering (Degree/Size)			Days to Bullet Corrosion	Blistering (Degree Size)
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)		
7212A	57	38	5	9-10	8-9	4-5	7-8	7-8	4-5	10/10	7/8	5/7	27	10/10
7212B	"	"	"	9	8	5	7-8	7-8	5	10/10	9/8	5/7	25	10/10
7212C	"	"	"	9	8	6	9	8	6	10/10	9/8	5/7	20	10/10
7212D	"	"	"	8-9	8	7	8	8	7	10/10	9/8	6/8	26	4/7
7212E	"	"	"	8-9	8	8	9-10	8	8	10/10	8/8	6/8	13	3/6
7212F	"	"	"	9	8	9	9-10	8-9	8-9	10/10	9/8	6/8	11	4/6
7213A	54	36	10	10	9-10	7	9	8-9	7	10/10	10/10	10/10	31	10/10
7213B	"	"	"	10	10	7	10	9-10	7	10/10	10/10	6/8	29	10/10
7213C	"	"	"	10	9	8-9	9-10	9-10	8-9	10/10	10/10	4/8	30	10/10
7213D	"	"	"	9	9	8	10	9	8	10/10	10/10	10/10	21	7/8
7213E	"	"	"	10	9-10	8-9	9-10	9	8-9	10/10	10/10	10/10	15	4/5
7213F	"	"	"	9	9	8	10	9	8	10/10	10/10	5/8	7	5/5
7214A	51	34	15	9-10	8	7	8	8	7	10/10	10/10	8/8	33	10/10
7214B	"	"	"	10	7-8	7	9	7-8	7	10/10	10/10	10/10	29	10/10
7214C	"	"	"	9-10	8-9	8	9-10	8-9	8	10/10	10/10	6/8	25	10/10
7214D	"	"	"	10	8-9	8-9	10	8-9	8-9	10/10	10/10	8/8	27	10/10
7214E	"	"	"	8-9	8-9	8	9	8-9	8	10/10	10/10	5/8	13	4/6
7214F	"	"	"	8-9	9	8	9-10	9	8	10/10	10/10	3/7	1	4/6

Salt Fog Duration: (a) 504 hrs; (b) 816 hrs; (c) 960 hrs. For other keys, see Table 2.

as mica levels increased because of the higher oil absorption of this extender.

Primers were applied, as before, to nonblasted Q-Panels at 4 wet mils (100 microns) for test in both 5% salt spray and 3% NaCl bullet hole immersion. Dry film thicknesses were measured after the films had been applied for three weeks, and found to range between 0.9 and 1.2 dry mils (23 and 30 microns.)

Salt fog and bullet hole data are shown in *Tables* 5A to 5D. Salt fog panels were evaluated at three points during the test: (a) 505 hours; (b) 816 hours; and (c) 960 hours. As before, corrosion was judged on a linear scale, a rating of 10 indicating no corrosion, 0 indicating total corrosion. Blistering was rated as described in Test Method #6461 of the U.S. Federal Test Method #141A, where the first number indicated the frequency of the blistering, and ranges from a rating of 10 (no blisters) to a rating of 0 (total delamination), while the second number indicates the size of the blisters, ranging from a rating of 10 (no blisters) to a rating of 1 (extremely large blisters). Very fine pinpoint blisters are rated 9.

It is seen that the early blistering tendency that was

Table 5b—Composition and Performance Profile Of the Tri-Pigment (Zinc Flake/Mica/Zinc Potassium Chromate) Systems

Notebook Reference	Percent Volume Composition			5% Salt Spray									3% NaCl Bullet Hole Immersion	
	Z.F./Mica/Z.P.C.			Scribe Corrosion			Corrosion of the General Panel			Blistering (Degree/Size)			Days to Bullet Corrosion	Blistering (Degree Size)
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)		
7215A	47.5	47.5	5	9-10	9	9	9	9	6	10/10	10/10	6/8	20	10/10
7215B	"	"	"	10	10	10	9-10	9	7	10/10	10/10	10/10	19	10/10
7215C	"	"	"	9	7-8	7-8	8-9	7-8	7	10/10	10/10	6/8	17	10/10
7215D	"	"	"	9	9	8	9	9	8	10/10	10/10	10/10	18	10/10
7215E	"	"	"	9	8	8	8-9	8	7-8	10/10	10/10	5/7	7	5/7
7215F	"	"	"	10	8	8	10-9	8	8	10/10	10/10	8/8	3	5/7
7216A	45	45	10	9-10	9	8-9	8	6-7	6-7	10/10	10/10	10/10	22	10/10
7216B	"	"	"	9-10	8-9	8-9	8-9	8	7-8	10/10	10/10	10/10	18	10/10
7216C	"	"	"	9	9-10	8-9	9	8-9	7	10/10	10/10	10/10	17	10/10
7216D	"	"	"	9	8-9	8-9	10	9-10	9-10	10/10	10/10	10/10	16	10/10
7216E	"	"	"	8-9	8-9	8	10	8	8	10/10	10/10	8/8	7	10/10
7216F	"	"	"	9-10	9-10	8-9	10	9-10	9	10/10	10/10	8/8	1	10/10
7217A	42.5	42.5	15	8	7-8	7-8	6-7	6-7	6	10/10	10/10	10/10	19	10/10
7217B	"	"	"	8	7-8	7-8	6	7	5	10/10	10/10	6/8	18	10/10
7217C	"	"	"	8	8	8	7-8	7	6	10/10	10/10	10/10	18	10/10
7217D	"	"	"	8	8	8	8-9	8	7	10/10	10/10	8/8	1	10/10
7217E	"	"	"	8	9	8	8	7-8	6-7	10/10	10/10	5/8	8	10/10
7217F	"	"	"	8-9	8-9	8	9-10	8-9	8	10/10	10/10	9/8	1	10/10

Salt Fog Duration: (a) 504 hrs; (b) 816 hrs; (c) 960 hrs. For other keys, see Table 2.

Table 5c—Composition and Performance Profile Of the Tri-Pigment (Zinc Flake/Mica/Zinc Potassium Chromate) System

Notebook Reference	Percent Volume Composition			5% Salt Spray									3% NaCl Bullet Hole Immersion	
	Z.F./Mica/Z.P.C.			Scribe Corrosion			Corrosion of the General Panel			Blistering (Degree/Size)			Days to Bullet Corrosion	Blistering (Degree Size)
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)		
7218A	38	57	5	9	9	8	7	5-6	5	10/10	6/9	6/9	1	10/10
7218B	"	"	"	8-9	8-9	8	7-8	6-7	5	10/10	7/9	7/9	1	10/10
7218C	"	"	"	8	8-9	8	9	7-8	6	10/10	9/9	9/9	1	10/10
7218D	"	"	"	8	8	8	9-10	8-9	8-9	10/10	10/10	10/10	1	10/10
7218E	"	"	"	9-10	9-10	9-10	9	6-7	6-7	10/10	8/7	5/7	1	10/10
7218F	"	"	"	10	9	9	10	8-9	9	10/10	6/8	6/8	1	5/5
7219A	36	54	10	8	8	8	6	6-7	6	10/10	10/10	10/10	1	10/10
7219B	"	"	"	8	8	8	6	6-7	6-7	10/10	10/10	10/10	1	10/10
7219C	"	"	"	8	8	8	7	7	6-7	10/10	10/10	10/10	1	10/10
7219D	"	"	"	7-8	7-8	7-8	8-9	7	6-7	10/10	10/10	10/10	1	10/10
7219E	"	"	"	8-9	8-9	8	9-10	8-9	9	10/10	10/10	10/10	1	10/10
7219F	"	"	"	10	10	10	10	9-10	10	10/10	10/10	10/10	1	10/10
7220A	34	51	15	8	8	5	7	7-8	7-8	10/10	9/9	10/10	1	10/10
7220B	"	"	"	7-8	7-8	6-7	7	7-8	7-8	10/10	8/9	10/10	1	10/10
7220C	"	"	"	8-9	7-8	5	7	7-8	7-8	10/10	7/8	7/8	1	10/10
7220D	"	"	"	8	7	5	6-7	7	7	10/10	6/8	6/8	1	10/10
7220E	"	"	"	8	6-7	6	7-8	7-8	7-8	10/10	8/8	6/7	1	10/10
7220F	"	"	"	8	7	7	10	9	8	10/10	10/10	8/8	1	10/10

Salt Fog Duration: (a) 504 hrs; (b) 816 hrs; (c) 960 hrs. For other keys, see Table 2.

inherent in unmodified zinc flake systems was here largely eliminated, and this would seem clear justification of the spacing hypothesis. The blistering resistance was, in fact, weakest where zinc flake contents were substantially greater than mica contents (series 7222, 7223, and 7224), and intensified as PVC decreased. This phenomena was seen to be accompanied in salt spray, at least, with a more rapidly deteriorating general panel corrosion resistance, although the bullet hole protection of such high zinc content formulations was generally better than the lower zinc systems as was scribe corrosion resistance in salt fog. Alternatively, too low a level of zinc flake (series 7218, 7219, and 7220) produced generally lower performance in corrosion of the scribe and of the general panel; although, the decline in performance with the duration of exposure was less marked in these very low zinc systems than in the high zinc content materials. Bullet hole protection of such low zinc content formu-

Table 5d—Composition and Performance Profile Of the Tri-Pigment (Zinc Flake/Mica/Zinc Potassium Chromate) System

Notebook Reference	Percent Volume Composition			5% Salt Spray									3% NaCl Bullet Hole Immersion	
	Z.F./Mica/Z.P.C.			Scribe Corrosion			Corrosion of the General Panel			Blistering (Degree/Size)			Days to Bullet Corrosion	Blistering (Degree Size)
				(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)		
7222A	66.5	28.5	5	10	9-10	8	8-9	8	3-4	10/10	7/8	3/8	20	10/10
7222B	"	"	"	9	9	7	9	7-8	3-4	10/10	6/8	4/8	20	10/10
7222C	"	"	"	10	9-10	8	8	7-8	4	10/10	7/8	4/8	34	6/6
7222D	"	"	"	9	9	8	8-9	7-8	6	10/10	8/8	6/8	27	2/7
7222E	"	"	"	10	8	7-8	9	7-8	5-6	10/10	8/9	5/9	15	4/4
7222F	"	"	"	8-9	6-7	3-4	7	4	1	10/10	2/9	2/8	15	4/8
7223A	63	27	10	10	10	8-9	8	8	2-3	10/10	8/9	7/9	27	10/10
7223B	"	"	"	9	9-8	8	7-8	7-8	3-4	10/10	9/9	9/9	27	10/10
7223C	"	"	"	10	10	9	10	7	3-4	10/10	7/8	2/9	27	10/10
7223D	"	"	"	10	9-10	8	9-10	6-7	3-4	10/10	4/8	3/8	27	10/10
7223E	"	"	"	10	8-9	6-7	9	7	4	10/10	6/8	4/8	19	4/8
7223F	"	"	"	9	8	5	10	5	2	10/10	3/8	2/8	20	4/7
7224A	59.5	25.5	15	9-10	9	8	8-9	7-8	4	10/10	8/9	6/8	46	10/10
7224B	"	"	"	9-10	8-9	8	7-8	7-8	6	10/10	9/9	9/9	27	10/10
7224C	"	"	"	10	8-9	7	9-10	7-8	3	10/10	8/9	4/8	28	10/10
7224D	"	"	"	10	8-9	8	10	7-8	4	10/10	7/9	5/9	27	10/10
7224E	"	"	"	9	8	6-7	9-10	7-8	4	10/10	6/9	4/8	19	4/8
7224F	"	"	"	10	9	*	9	8-7	*	10/10	8/9	*	19	4/7

Salt Fog Duration: (a) 504 hrs; (b) 816 hrs; (c) 960 hrs. For other keys, see Table 2.
* Panel lost

Table 6—Zinc Dust and Zinc Flake Phenoxies—An Approximate Comparison

	1077 hrs 5% Salt Fog Exposure				Bullet Hole Immersion Testing[a]		
Primer Composition	Film Thickness	Scribe Corrosion	General Panel Corrosion	Blistering Resistance	Film Thickness	Days to Bullet Corrosion	Blistering Resistance
Unmodified Zinc Dust Pigment	3.2	8	7	8/8	1.5	28	3/5
12% Chromate Modified Zinc Dust Pigment	3.2	10	10	4/4	1.0	76	3/6
12% Chromate Modified Zinc Flake Pigment	3.3	8	8	7/8	1.0	78	4/5

(a) Test Liquor was renewed every five days.
(b) Chromate Modified Form only. No comparative data available on a Tri-pigment System.

lations was, in effect, nonexistent. These comparisons again indicated that systems having high zinc content were too rapidly exhausted under aggressive test conditions such as salt fog. They provided excellent cathodic protection, but higher zinc availability resulted in relatively rapid consumption leading to zinc exhaustion, corrosion product conversion, and film break-up. On the other hand, high mica content tended to increase the electrical resistance of the film, and controlled zinc availability. In the case of 7218, 7219, and 7220 series this control was so severe that insufficient current was produced to maintain large areas of the steel cathodic. While scribe corrosion resistance was not as badly effected by such control, zinc reactivity was too low to give even a modicum of protection to the large area of uncoated steel in the bullet hole test. Where zinc reactivities were further reduced by the inhibitive effects of chromates, even scribe corrosion resistance in salt spray began to suffer (compare series 7220 with 7218).

Between these extremes were series 7212 to series 7217. These systems represent, in fact, a compromise having both better longevity than series 7222 to 7224 (because of lower conductivity and a more controlled rate of zinc dissolution), but allowing enough zinc reactivity to provide a good cathodic protection to bare steel. Thus, while the bullet hole data from the series was not, perhaps, as encouraging as that from the 7222–7224 series, cathodic protection was sufficient to give good resistance at a favorable PVC to bare steel in the bullet hole test and to scribes in the salt spray tests. Consequently, the longevity of protection was prolonged compared to the high zinc systems.

In these series (7212–7217) the effects of PVC and chromate control can also be noted. In the bullet hole data, for example, there is a general reduction in longevity as PVC is decreased. This, in the 7212–7214 series is not severe, although it becomes more marked as chromate concentration increases. In general, however, effects are not serious until PVC's decrease below 41%. In the 7215–7217 series, bullet hole performance is not as long lived; it falls off more sharply, and, in the case of the high chromated study 7217, it falls off at a higher PVC. At the other end of the scale, salt fog protection shows more rapid fall off at high PVC's in high zinc flake systems having lower chromate content (see series 7217).

Perhaps the best compromise in these studies, although not necessarily the optimum combination as far as the tri-pigments are concerned, is seen in the mid-range PVC's of the 10% and 15% chromated, 54% and 51% zinc flake systems (series 7213 and 7214).

Taken as a whole, the data is most interesting as it again shows the versatility of zinc flake. Using spacers like mica and inhibitors like zinc potassium chromate, systems may be tailored to suit a variety of environments, and zinc reactivity may be readily controlled to any extent required. Protection may range from that which is almost entirely barrier in nature, to that that is almost entirely sacrificial. Such systems lend themselves to maximum cost effectiveness in any given environment, and organic zinc rich systems are no longer absolutely tied to strictly defined high zinc loading.

Like the unmodified zinc flake systems, chromated systems, mica modified compositions, and the tri-pigment systems all display significantly reduced settling tendencies and require little agitation to ensure homogeneity. The Ecka-31129/G flake evaluated was found to give excellent long term stability and showed little gassing tendency in even acidic vehicles. In separate studies, chlorinated rubber, styrene butadiene, and epoxy polyamide systems have also been evaluated without problems, as have the alkyl silicates noted earlier. Some problems have been encountered in certain alkaline silicate systems, such as lithium silicate, probably due to the hydrophobicity of the long chain fatty acid surface modification which was originally considered responsible for the blistering of the unmodified flake film.

Limited exposure studies of the Phenoxy systems (two years in the Northeastern United States) show no untoward effect to date, and compare very favorably with both zinc dust systems and hot dip galvanized steel, although none of the tri-pigment systems have yet to be evaluated outside of the laboratory.

While no attempt has been made nor is intended in this work to directly compare zinc dust and zinc flake, the data in *Table* 6 is useful as a rough bench mark against which to view many of the results from the experiments described herein. For the formulations described in *Table* 6, Phenoxy systems were used and primers were formulated with similar raw materials (thixatropes, solvent systems, etc.) at equal volume solids and PVC:CPVC ratios (1.06:1.0) with CPVC's calculated from measured oil absorptions. The authors would caution, however, that despite these controls, the surface morphology and the presentation of one film to the test environment compared to the other is so different that such comparisons are relatively meaningless. It is stressed that in this work the formulation technology of zinc flake primers is considered alone with little or no relativity to the formulation technology of zinc dust primers.

Much work still needs to be done, and the work described herein can only be considered to point the way for others. Certainly, further investigation of inorganic systems should be highly rewarding.

Concern over the health hazards of hexavalent chromium should foster additional work with nontoxic inhibitors in tri-pigment systems. Although early results in this area show these materials were not as effective as the chromates, the borates (calcium boro silicate and barium metaborate) have shown some promise. Other possibilities might include the use of phosphosilicates, phosphites, or molybdates. While much has already been accomplished to improve the cost effectiveness of such systems, (high mica / low PVC systems are very low priced systems compared to normal zinc rich primers based on zinc dust, for example) further investigation may bring additional rewards in this direction.

CONCLUSION

The objective of the foregoing study has been to examine zinc flake as a potential raw material for use in anticorrosive metal primers, to determine if it could work (and if so how?), to lay down a technology for its utilization, and to provide a starting point for formulas to illustrate its use. Zinc flake does work, and lends itself easily to significantly greater formulating versatility than does zinc dust. While the full optimization of its performance potential may yet remain to be realized, the range and variation of sacrificial coatings made possible with zinc flake systems makes this a most interesting and valuable raw material for use by the coating industry.

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Trademark References

Ecka® 31129/G	Eckart Werke
Dacromet® and Zincromet®	Diamond Shamrock Corp.
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Testape	Clive H. Hare, Inc.

Modification of Acrylic Polymers For High Solids Coatings

A.N. Theodore and M.S. Chattha
Ford Motor Company*

A procedure has been developed for grafting ε-caprolactone onto a low molecular weight hydroxy acrylic polymer in the presence of dibutyltin oxide. High solids coatings formulations based on the graft polymer (cured with melamine resins) exhibit impact strength and flexibility superior to that obtained with either the starting acrylic polymer or a hydroxy acrylic polymer of equivalent glass transition temperature. At comparable solids levels, the viscosity of paints based on the graft copolymer is slightly higher than that of paints formulated from the parent acrylic polymer.

In accelerated weathering, the durability of coatings based on the graft polymer is intermediate to coatings obtained from the parent and low glass transition temperature acrylic polymers.

INTRODUCTION

Coatings with high solids are attractive for meeting emission regulations. Several new high solids coating systems have recently been reported.[1-4] These coatings have excellent physical properties, but better impact strength and stone-chip resistance are desired. Stone-chip resistance is desirable to reduce corrosion and maintain good appearance of autobody panels.

Two approaches are known for improving the flexibility and impact strength of acrylic films. The first involves incorporation of external plasticizers in the coating.[5] However, these materials adversely affect the long term durability of coatings. Alternatively, monomers with long side chains can be copolymerized with other acrylic monomers for preparing low glass transition temperature (Tg) acrylic polymers with improved impact strength.[6] However, coatings from such polymers display inadequate intercoat adhesion and do not have good long term weatherability.

In this paper, the preparation and characterization of ε-caprolactone grafted acrylic polymers are described. The properties and durability of pigmented films based on grafted polymers are compared to those of the starting acrylic polymer and a low Tg acrylic polymer.

EXPERIMENTAL

Materials

ε-Caprolactone[†] (purity $99^{+}\%$, boiling point 96°C/15 mm) was used without further purification. Solvents (reagent grade butyl acetate and methyl amyl ketone) were dried over molecular sieves Type 5A (Baker Analyzed Reagent) before use in solution polymerization and in adjusting the viscosity of coatings.

Coatings were formulated using a blocked type catalyst prepared from p-toluenesulfonic acid and 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate.[7] Hexamethoxymethyl melamine (Cymel 301, American Cyanamid) was used as a crosslinking agent.[8] A nonaqueous dispersion (NAD) flow control agent and a white mill base were obtained from Ford Paint Plant, Mt. Clemens and used in coating formulations. The mill base was composed of acrylic hydroxy polymer (10.20%), titanium dioxide (72.50%), and solvent blend (17.30%).

Polymer Synthesis

Hydroxy Acrylic Polymer A: Hydroxy acrylic polymer A was prepared by solution polymerization in methyl amyl ketone (145–150°C). The monomers (500.00 g styrene, 650.00 g hydroxyethyl acrylate, and 990.00 g isobutyl methacrylate) and 99.00 g tert-butyl peroxide were combined and added to the refluxing solvent (985.00 g) in six hours under nitrogen atmosphere. After completion of monomer addition, 5.00 g tert-butyl peroxide was added dropwise to the polymer solution

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*Polymer Science Dept., Engineering and Research Staff, 20000 Rotunda Dr., Dearborn, MI 48121.

[†] Obtained from Aldrich Chemical Co.

Table 1—Polymer Composition and Properties

Polymer Type	Monomer Composition[a] STY	HEA	IBMA	BMA	2-EHA	OH/ε-CL[b] Ratio	Tg, °C	M_w/M_n	Apparent Viscosity, cP (mPa · s)
Hydroxy acrylic A	25	30	45	—	—	1/0	43	8,150/3,930	2800 (2800)
Grafted acrylic B	25	30	45	—	—	1/1	0	23,350/5,160	3000 (3000)
Low Tg hydroxy acrylic C	—	30		66	4	1/0	0	6,300/3,040	—

(a) Sty = Styrene, HEA = hydroxyethyl acrylate, IBMA = isobutyl methacrylate, BMA = butyl methacrylate, 2-EHA = 2-ethylhexyl acrylate.
(b) OH/ε-CL Ratio = Equivalents of hydroxy acrylic polymer per equiv. of ε-caprolactone available for reaction.

for five minutes. Refluxing was continued for two additional hours. Molecular weight and viscosity are listed in *Table* 1.

GRAFTED ACRYLIC POLYMER B: Hydroxy acrylic polymer A (613.20 g), as prepared above by solution polymerization, was combined with ε-caprolactone (137.40 g), dibutyltin oxide (2.93 g), and methyl amyl ketone (43.40 g).[9] The mixture (76% solids) was poured in a three-liter flask equipped with a condenser, gas inlet tube, thermometer, and mechanical stirrer. After stirring the mixture for 15–20 minutes at ambient temperature, a 150 ml portion was withdrawn for determination of initial viscosity. This portion was returned to the reaction flask and the temperature of the mixture quickly raised to 160-167°C under a nitrogen atmosphere. The reaction was carried out for 17 hours at the reflux temperature (160–167°C) of solution. The properties of grafted acrylic polymer B are given in *Table* 1.

LOW TG HYDROXY ACRYLIC POLYMER C: The low Tg hydroxy acrylic polymer C was also prepared by solution polymerization in methyl amyl ketone (145–150°C). Butyl methacrylate (530.00 g), hydroxyethyl acrylate (241.00 g), 2-ethylhexyl acrylate (32.12 g), and tert-butyl peroxide (39.00 g) were combined and added to the refluxing methyl amyl ketone (359.00 g) in five hours under nitrogen atmosphere. An additional 2.00 g of tert-butyl peroxide were added dropwise to the polymer solution and refluxing was continued for three more hours. The resulting polymer solution (70% solids, M_w/M_n 6300/3040) was used in formulating high solids coatings (*Table* 1).

Measurement of Properties of Reaction Products

APPARENT VISCOSITY MEASUREMENTS: The apparent viscosity of hydroxy acrylic polymer/ε-caprolactone reaction mixture was measured at time intervals of at least every two hours with a Brookfield viscometer (Model LV). All measurements were made at ambient temperatures.

MOLECULAR WEIGHT DETERMINATIONS (GPC): Gel permeation chromatography measurements (M_w/M_n) were made at room temperature on a Waters Associates 150-C ALC/GPC instrument. The column set was calibrated with hydroxy acrylic polymer of known molecular weight. Polymer solutions in tetrahydrofuran were used for all measurements.

GLASS TRANSITION TEMPERATURES (TGS): The glass transition temperatures of the polymers were determined using a DuPont 942 thermomechanical analyzer. The temperature was increased at a programmed rate of 10°C per minute. All polymers were coagulated in hexane, decanted and heated in an air circulating oven at 140°C for 20 minutes before determining their glass transition temperatures.

Table 2—Acrylic and Acrylic/ε-Caprolactone Paint Formulations

	Formulation A	B	C
	Acrylic Hydroxy	Acrylic OH/ε-CL (1 OH/1ε-CL)	Acrylic Hydroxy (Low Tg)
Polymer solution, g (% solids)	70.00 (76.00)	77.70 (76.00)	77.00 (68.60)
Solvent (butyl acetate/methyl amyl ketone), g	23.5/30	23.3/30	25/20
Cymel 301, g	28.67	25.00	27.50
Blocked catalyst, g	1.60	1.70	1.60
NAD resin, g (50% solids)	21.00	21.00	21.00
White mill base, g	52.20	52.50	52.50
Flow control additive, g	1.54	1.54	1.54
Solids content, % by weight	60	60	60
Cure schedule	20 min at 140°C	20 min at 140°C	20 min at 140°C
Substrate	primed steel	primed steel	primed steel

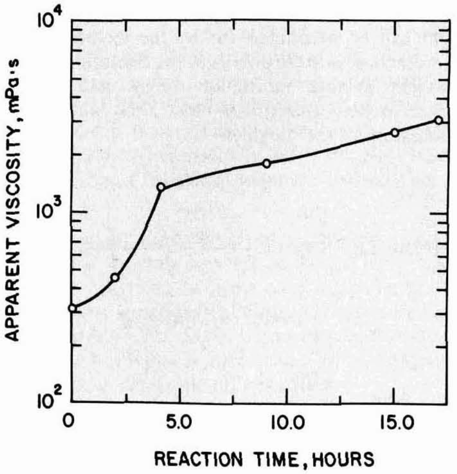


Figure 1—Variation of Apparent Viscosity with reaction time; Polymer B prepared from 1 OH/1ε-CL in presence of dibutyltin oxide catalyst

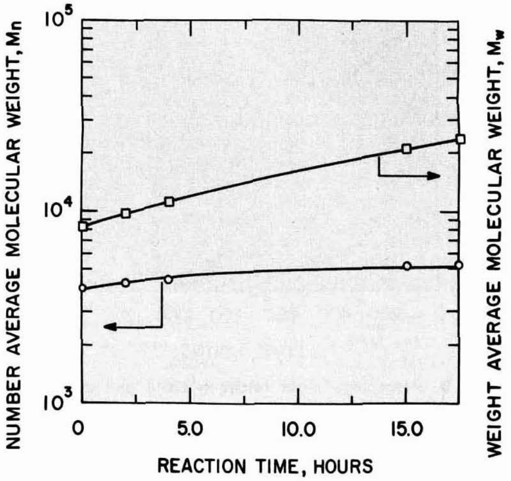


Figure 2—Number average (M_n) and weight average (M_w) molecular weight as a function of reaction time; Polymer B prepared from 1 OH/1ε-CL in presence of dibutyltin oxide catalyst

Paint Formulations and Film Evaluation

Pigmented coatings were prepared using the ingredients listed in *Table* 2 (Formulations A, B, & C). After dispersing the ingredients with a paint shaker for two-three hours, the formulations were applied by spraying with a suction-feed gun on primed steel panels in 3–4 coat applications depending on coating viscosity. The flash time between applications was one minute and the final flash time five minutes. Baking was carried out in an air circulating oven at 140°C for 20 minutes. Film properties were determined using ASTM or Ford Motor Company testing procedures. The weathering of coatings was examined in the Cleveland Humidity chamber and in Q-panel Company's QUV Cyclic Weathering Tester. QUV cycles consisted of eight hours light at 60°C followed by four hours darkness and 100% humidity at 50°C.

RESULTS AND DISCUSSION

The grafted acrylic polymer B is prepared by reacting equivalent amounts of hydroxy acrylic polymer A and ε-caprolactone in the presence of dibutyltin oxide catalyst (*Table* 1). The function of the pendant hydroxyl groups on hydroxy acrylic polymer A appears to be that of an active hydrogen initiator in this grafting reaction. This is the only source of active hydrogen for the ring opening of ε-caprolactone since the materials of the reaction mixture are dried over molecular sieves Type 5A and the reaction is run under inert conditions at relatively

Table 3—Paint Properties: Acrylic and Acrylic/ε-Caprolactone Paint Formulations

	Formulation		
	A	B	C
Solids content, % by weight	60	60	60
Viscosity, #4 Ford cup, sec.	17.0	22.0	18.0
Film thickness, μm	46	46	41
Gloss/20°	76	65	64
Xylene resistance, 1 min. spot	Excellent	Excellent	Excellent
Methyl ethyl ketone resistance (50–100 double rubs)	Excellent (50 double rubs)	Excellent (100^+ double rubs)	Excellent (50 double rubs)
Flexibility, mm crack (23°C) (mandrel bend)	102	3.2	6.4
% Elongation, (23°C)	4.2	25	19
Impact, in-lbs (M-Kg): direct	31 (0.35)	>160 (>1.85)	80 (0.92)
Impact, in-lbs (M-Kg): reverse	<2 (<0.02)	>160 (>1.85)	16 (0.19)
Hardness, pencil	HB	HB	HB
Adhesion, tape	pass	pass	pass
knife	pass	pass	pass
Cleveland Humidity Chamber (13 days)	No discoloration, No change	No discoloration, No change	No discoloration, No change

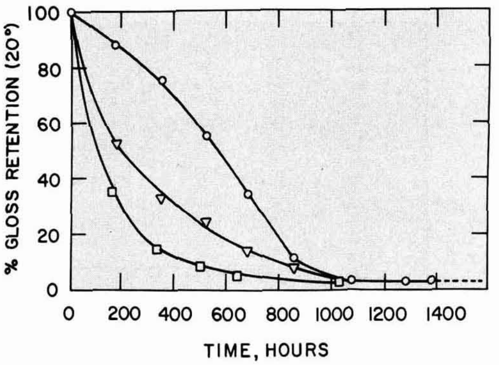
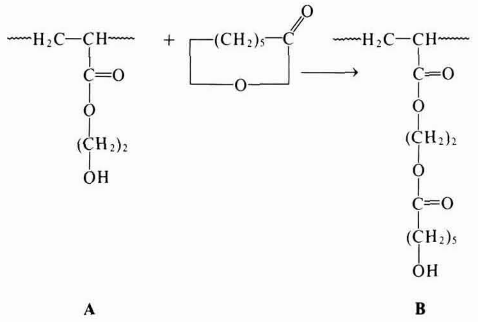


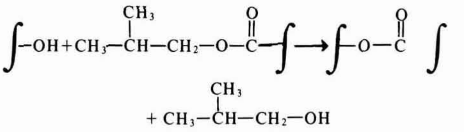
Figure 3—Percentage gloss retention (20°) plotted against exposure time in QUV: (○) Acrylic hydroxy polymer A paint; (▽) Grafted acrylic polymer B paint; (□) low Tg hydroxy acrylic polymer C paint

high temperatures. The anticipated average product of the reaction is the following:



The reaction was carried out in concentrated solution because the hydroxy acrylic polymer A could then be used as prepared by free radical solution polymerization and the resulting grafted polymer B could be used for high solids coatings without removal of solvents. As a result, the reaction temperature was limited to the reflux temperature of the reaction mixture (165°C). Dibutyltin oxide was used as catalyst (0.26% of ϵ-caprolactone by weight) because of its use as a catalyst for the bulk polymerization of ϵ-caprolactone.[9] The reaction product was colorless.

The course of hydroxy acrylic polymer/ϵ-caprolactone grafting reaction was followed by measuring the apparent viscosity of reaction mixture at 25°C with a Brookfield viscometer (model LV). In *Figure* 1, the apparent viscosity of the reaction mixture is plotted as a function of reaction time. Although the increase in the apparent viscosity with reaction time is initially quite rapid due to the consumption of ϵ-caprolactone, it slows down after five hours of reaction. It is also evident from *Figure* 1 that the viscosity does not level off with reaction time. This is due to the continuing increase in weight average and number average molecular weight as shown in *Figure* 2. The increase in number average molecular weight can be accounted for by the incorporation of ϵ-caprolactone into the polymer. The continuing increase in weight average molecular weight and attendant increase in polydispersity is most likely due to transesterification of the polymer.



$$\int\!-OH + CH_3-\overset{CH_3}{\overset{|}{C}H}-CH_2-O-\overset{O}{\overset{\|}{C}}-\!\int \longrightarrow \int\!-O-\overset{O}{\overset{\|}{C}}\ \int + CH_3-\overset{CH_3}{\overset{|}{C}H}-CH_2-OH$$

Crosslinking of hydroxy acrylic and grafted acrylic polymers was accomplished with Cymel 301 crosslinker in the presence of blocked catalyst.[7] The above reactants were employed at a hydroxy/methoxymethyl ratio ($OH/CH_2\text{-}OCH_3$) of 1/3 because this relative ratio resulted in films with good properties. Although use of the blocked catalyst at a level of 1% on total resin solids resulted in films with very good properties, no improvement in properties was observed at higher catalyst levels. At lower catalyst levels, the xylene and methyl ethyl ketone solvent resistance of films was not acceptable.

White paint formulations were prepared with the hydroxy acrylic polymer A, grafted acrylic polymer B, and low Tg acrylic polymer C (*Table* 1) to compare their properties. Details on paint formulations A, B, & C are found in *Table* 2. Upon spraying these formulations, it was established that formulation B does not wet primed (epoxy-ester) surfaces as well as the formulations containing polymer A and C. However, this deficiency could be corrected by coagulation of polymer B in hexane prior to use in formulating. This coagulation eliminates the low molecular weight components (≃ 5%) present in the grafted acrylic polymer. The low molecular weight components may include unreacted ϵ-caprolactone and its oligomers resulting from its reaction with traces of moisture.

Because of the difference in the glass transition temperature the impact resistance of Formulation B which contains the ϵ-caprolactone grafted polymer is expected to be improved over formulation A but to be similar to that of formulation C. The data of *Table* 3 clearly indicate that formulation B films containing the grafted acrylic polymer B have superior flexibility and impact strength when compared to formulation A as well as formulation C. The improved flexibility and impact resistance should result in improved chip resistance.

Accelerated weathering of pigmented films obtained from formulation A, B, and C is shown in *Figure* 3. The percentage gloss retention of films obtained from formulation A containing the parent hydroxy acrylic polymer A is higher up to 850 hours when compared to the percentage gloss retention of films from Formulation B and C containing the grafted and low Tg polymers, respectively.

SUMMARY

Reaction of equivalent amounts of low molecular weight hydroxy acrylic polymer and ϵ-caprolactone in the presence of dibutyltin oxide catalyst resulted in a grafted acrylic polymer. The modified acrylic polymer exhibits slightly higher viscosity but lower glass transition temperature (Tg) than the parent hydroxy acrylic polymer.

Although paint films based on the hydroxy acrylic, grafted acrylic, and low Tg acrylic polymers have in general good properties, the films containing the grafted polymer exhibit superior flexibility and impact strength. The accelerated weathering of the pigmented films based on the grafted polymer is intermediate to that of parent acrylic and low Tg acrylic polymer films.

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Routes to Low Pollution Glamour Metallic Automotive Finishes

Alan J. Backhouse
Imperial Chemical Industries Limited*

As the application solids of spray applied paints rises, the change in viscosity due to solvent evaporation falls. In order to maintain flow control, the viscosity change can be augmented by the use of a paint with pseudoplastic rheology.

The degree of pseudoplasticity of a basecoat in a basecoat/clear process is not constrained by considerations of gloss to the same extent as it is in a finish.

Basecoats can be formulated, using polymer microgels, which can be sprayed at high solids. Although such basecoats are even in appearance, the highest solids are only achieved at the expense of aluminum orientation and loss of 'flop'.

A water-borne basecoat of pseudoplastic rheology achieves a high degree of aluminum orientation and flop, together with a low level of atmospheric pollution.

INTRODUCTION

For a number of years, there has been an increasing demand to reduce the amount of atmospheric pollution caused by solvents emitted during industrial painting processes. In the case of the painting of automobiles, two technologies have emerged, high solids and waterborne. Since the main function of the large amount of organic solvents commonly used in automobile finishes is to effect and control a change in viscosity between the spray gun and the substrate, the practical consequence of both these technologies is to reduce the level of viscosity control provided by the paint formulation and hence, to make more difficult the application of metallic finishes with high stylistic effects. In the case of high solids paints, the reduced amount of solvent directly affects the magnitude of the viscosity change obtainable and constrains the fine control usually obtained by the careful blending of solvents of different evaporation rates and solubility parameters. In the case of waterborne paints, although a large viscosity change can be obtained under favorable conditions, it is extremely sensitive to changes in relative humidity.

Paint Rheology

In order to compensate for the loss of control of viscosity obtained by solvent evaporation, several authors have analyzed the ideal rheology for a high solids paint.[1,2,3]

They reach similar conclusions: a pseudoplastic rheology is desirable. Such a rheology is illustrated in *Figure* 1 which shows the relationship between shear rate $\dot{\gamma}$ and shear stress τ. Such a rheology may be treated by the Ostwald power law $\tau = \eta^1\dot{\gamma}^n$ in which case a plot of log τ against log $\dot{\gamma}$, as shown in *Figure* 2, is a straight line of slope in which may be extrapolated to a low shear rate, e.g., 1 $\sec^{-1}$ approximately equivalent to conditions during sagging, or to a high shear rate, e.g., greater than 10,000 $\sec^{-1}$ approximately equivalent to shear conditions in spray application.

Real paint systems may not provide a perfect fit to such a model but the model can provide a valuable tool in predicating spray behavior. Paint application processes subject the paint to fairly high, and in spray processes, to very high shear rates for a very short period. Once the paint is on the substrate, however, a very low shear stress or shear rate applies so that a paint which is pseudoplastic will show a rise in apparent viscosity which can compensate for the limited viscosity change available in high solids finishes caused by evaporation of the small amount of solvent. In the case of a finish coat, the apparent viscosity on the substrate must not be so high as to prevent adequate leveling of the paint film.[1,4]

METALLIC APPEARANCE

About 70% of the cars produced in the United States, and a smaller, but still high, percentage produced elsewhere, are coated with a metallic finish. The difference

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*Paints Div., Wexham Rd., Slough SL2 5DS England.

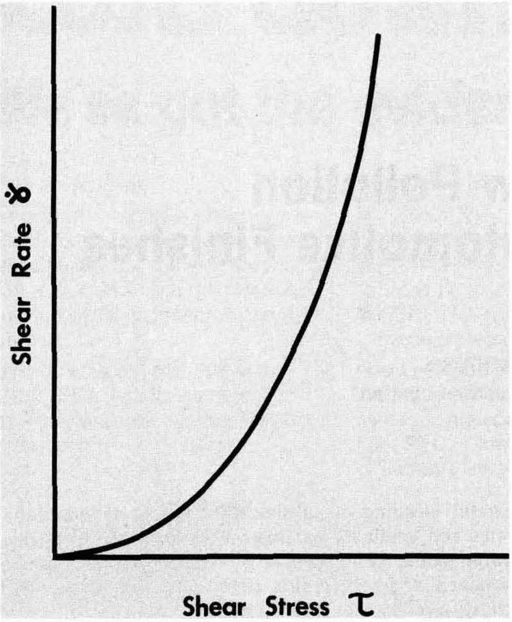


Figure 1—Typical shear rate–shear stress curve for a pseudoplastic liquid

in brightness and hue obtained when such a finish is observed from different angles, emphasizes the styling lines of the car, highlighting small curvatures, and is popular with customers and designers alike. It may even enable simpler pressings to be used without sacrifice of style. The effect is known as flop or geometric metamerism (*Figure* 3).

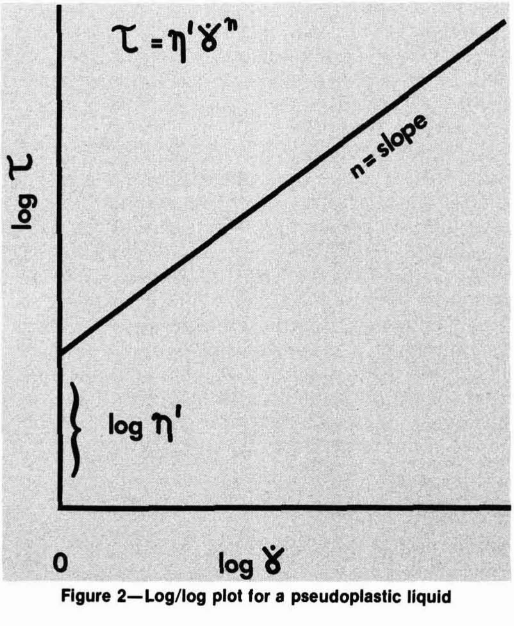


Figure 2—Log/log plot for a pseudoplastic liquid

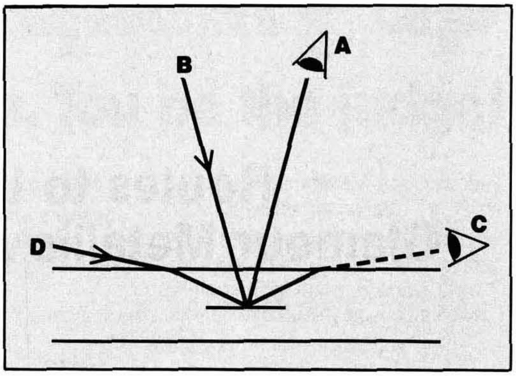


Figure 3—Reflection of light in a metallic flake pigmented film

For maximum effect, the metallic finish should appear much darker when observed at a low angle to the surface (C) than when viewed at an angle (A) near normal to the surface. The metallic finish is then said to have good flop.

The effect is due to the orientation of aluminum flakes parallel to the surface. The observer at A sees the incident light B reflected by the flake. A similar situation exists for the observer at C with light incident at D. Because of the longer path length within the film at D-C, light intensity is lower at C than A.

Measurement of Metallic Orientation

The effect can be measured by a goniophotometer (*Figure* 4). The paint film is covered by a glass hemisphere with an intermediate oil film to exclude air. In this way specular gloss is eliminated. A well collimated beam of light is incident at the panel at angle I. The intensity of the reflected light at angle V is measured by a photocell. The angle V is varied for a given incident angle I. The reflected light intensity is plotted against the viewing angle and gives a curve as shown in *Figure* 5 for a silver metallic finish with good flop (Paint A). At the chosen angle, I = 45°, the relative height of the peak at V = 45° correlates well with flop as judged visually.

Figure 5 also shows a curve for a silver metallic of poor flop (Paint B). At an angle V = 45°, the paint film A reflects light at an intensity some 2.5 times greater than the paint film B, and at V = 15° the curves cross showing the wider scatter of the incident light emitted by paint film B. Sections of the same two paint films are shown in *Figures* 6 and 7. The aluminum flakes of paint film A are orientated parallel to the substrate throughout the film, whereas, in the case of film B the flakes are more randomly orientated.

Factors Influencing Aluminum Orientation

Factors governing the orientation of flakes in the paint films have been examined by several authors[5-7] and various hypothesis were proposed. At present, good flop effects are invariably obtained by controlling the solids of application and the evaporation rate of thinning solvents, so that the paint may be applied to the auto-

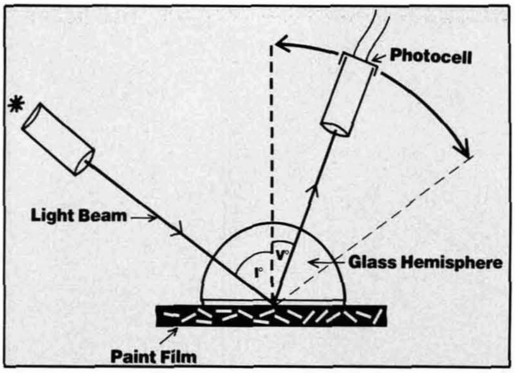


Figure 4—Measurement of metallic flake orientation by a goniophotometer

mobile at a viscosity high enough to limit the movement of the aluminum flake under the effect of gravity or convection due to the evaporative cooling after application. Yet the solids should be low enough that subsequent shrinkage of the film thickness causes parallel alignment of the flakes. *Figure* 8 illustrates how the shrinkage of a paint film on flash off can cause parallel flake alignment when flake size and film thickness are comparable. For this reason, high flop acrylic lacquers are currently applied in a number of coats each giving 10–15 microns dry film thickness; the solids at application are low so that during the flash off period between successive coats considerable shrinkage and aluminum alignment can occur.

The coating in *Figure* 6 and coating A in *Figure* 5 are typical thermoplastic lacquer silver finishes applied in four successive coats at an application solids of 15 wt %. The coating in *Figure* 7 and coating B in *Figure* 5 are high solids thermosetting acrylic silver finishes applied in two coats at an applications solids of 45 wt %. Similar results were reported by Van Oene and Labana.[7] All present evidence suggests that flop of metallic paints will deteriorate as solids at application are raised.

BASECOAT/CLEAR AS A LOW POLLUTION SYSTEM

A way around this problem is offered by the basecoat clear system, which has been pioneered in Europe for its good gloss and image clarity properties. The dry film thickness ratio of the two components clear/basecoat is commonly 3/1. The need for high shrinkage in order to achieve good flop applies only to the basecoat, which is the minor component on a volume basis, and not to the clearcoat which is the major component. The solids content of the clearcoat at application can then be raised without detracting from the metallic appearance. When this is done and the solids of the basecoat are kept at a level which achieves good flop, V.O.C. figures may be obtained for the overall system which would compete with high solids finishes but which would give a metallic appearance equal to the standards of a low solids lacquer.

Another consequence follows from the adoption of

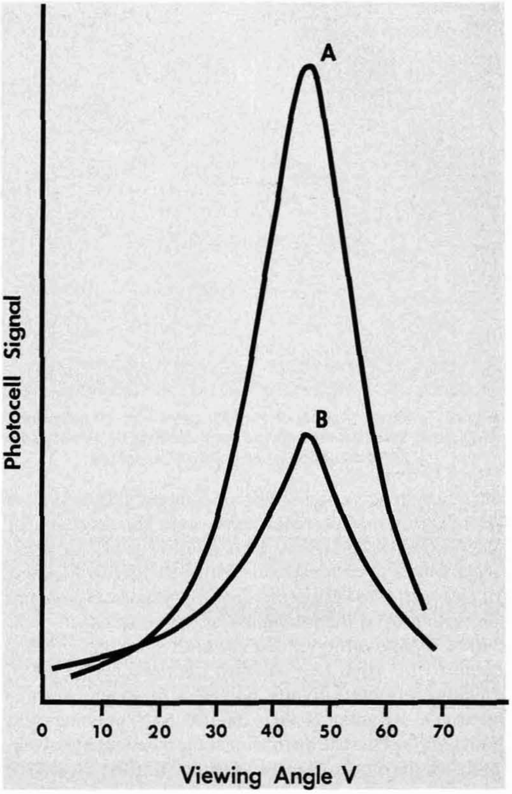


Figure 5—Goniophotometer curves for metallic panels of good and poor metal alignment. (A) Silver metallic acrylic lacquer applied in four coats with intermediate flash off. Application solids 15 weight %. (B) Silver metallic acrylic thermosetting finish applied in one coat. Application solids 15 weight %

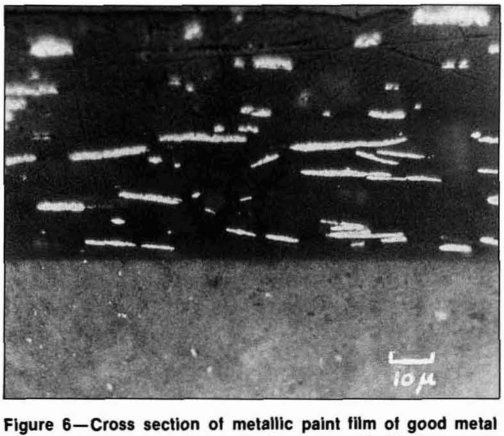


Figure 6—Cross section of metallic paint film of good metal alignment. Silver metallic acrylic lacquer applied in four coats with intermediate flash off. Application solids 15 wt. %. A small sample of the paint films including surfacer, groundcoat and metal substrate were set in epoxy resin. Sections were cut and the surfaces polished. The exposed cross section of the film was photographed using an optical microscope and vertical reflected illumination

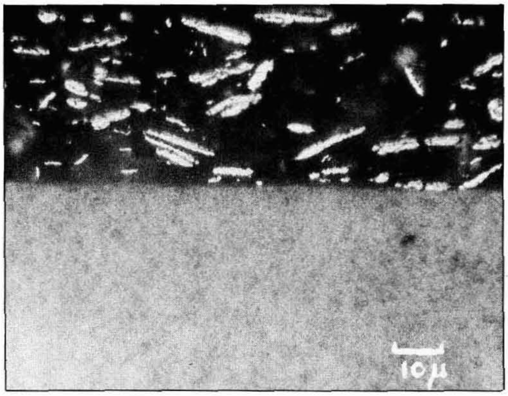


Figure 7—Cross section of metallic paint film of poor metal alignment. Silver metallic acrylic thermosetting finish applied in one coat. Application solids 45 weight %

such a system. A higher degree of pseudoplasticity can be tolerated in a basecoat paint, since the necessity for good flow out to achieve gloss and image clarity is less if the film is to be overcoated with a 50 micron thickness of clearcoat. A basecoat can have low gloss levels without detracting from the final gloss of the clearcoat.

The high viscosity on the car after spraying, which is required for good flop, is often obtained by the use of cellulose acetate butyrate polymers of weight average molecular weight of 80,000–200,000. Such polymers also function to resist the distortion of the basecoat by solvent and low molecular weight species from the clearcoat, which is usually applied without an intermediate bake in order to reduce application costs. Basecoats of this type are used with great success, but low solids viscosities are very high and typical application solids may be as low as 12% by weight.

Basecoats Formulated with Organic Microgels

Since 1977 ICI has been using specially prepared organic microgels to assist rheological control during the application of thermosetting acrylic metallic finishes.[8] The microgel particles are prepared by a nonaqueous dispersion polymerization method.[9] A typical example is as follows:

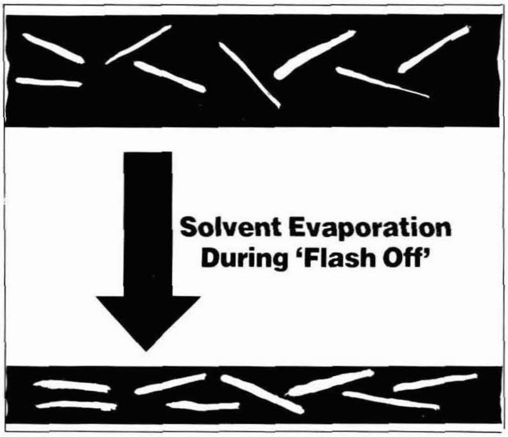


Figure 8—Alignment effect of restriction of metal flake movement during film shrinkage

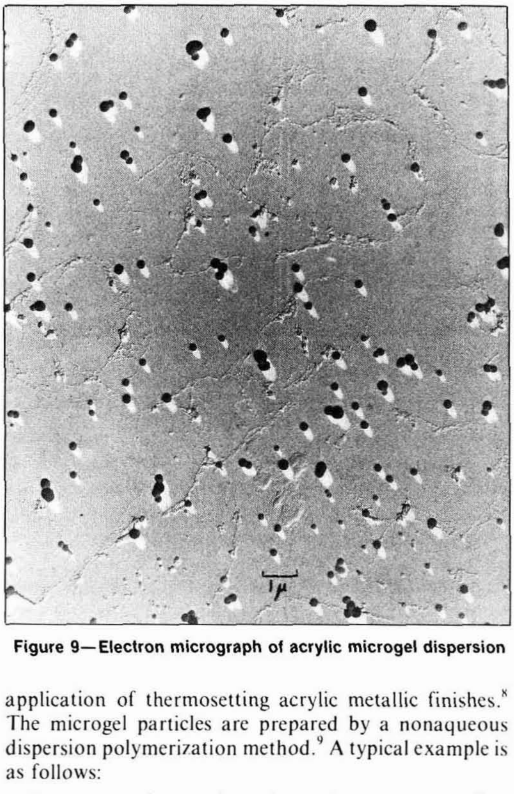


Figure 9—Electron micrograph of acrylic microgel dispersion

To a vessel fitted with stirrer, thermometer, reflux condenser, and provision for adding a liquid feed to the returning condensate, was charged:

Aliphatic hydrocarbon (boiling range 170°–210°C; aromatic content 5%)	15.880 parts
Hexane	3.890 parts
Heptane	20.802 parts
Methyl methacrylate	2.364 parts
Azodiisobutyronitrile	0.187 part
Graft copolymer stabilizer (33% solution; as described below)	0.881 part

The vessel and contents were purged with inert gas; the temperature of the reactants was raised to 100°C and held there under reflux for one hour. The following ingredients were premixed and fed into the hydrocarbon returning from the condenser at a uniform rate over a period of six hours:

Methyl methacrylate	44.918 parts
Methacrylic acid	0.458 part
Glycidyl methacrylate	0.458 part
Azodiisobutyronitrile	0.602 part
Graft copolymer stabilizer solution (as described below)	9.453 parts

There was additionally included, in the last hour of the feed procedure, 0.033 part of triethylene diamine. After completion of the feed, the reaction mixture was maintained under reflux for three hours, when a fine dispersion of insoluble gel microparticles was obtained.

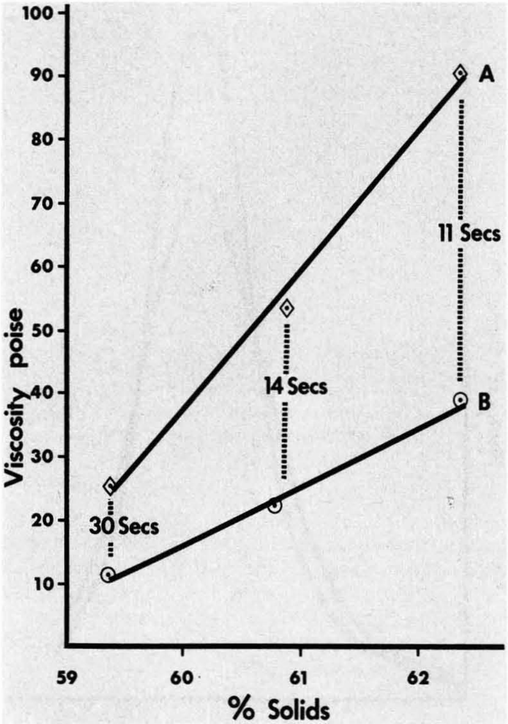


Figure 10—Variation of low shear viscosity of an acrylic thermosetting composition with total resin solids before and after conditioning at 2500 sec^{-1}. (A) No conditioning before determination; (B) 1 minute conditioning at 2500 sec^{-1} immediately before determination. The time taken to recover viscosity after conditioning is indicated for each determination

The total solids content of the dispersion was 52%; the content of insoluble microparticles was 31.2%.

The graft copolymer stabilizer used in the above procedure was obtained as follows. 12-Hydroxystearic acid was self-condensed to an acid value of about 31-34 mg KOH/g (corresponding to a molecular weight of 1650-1800) and then reacted with an equivalent amount of glycidyl methacrylate. The resulting unsaturated ester was copolymerized at a weight ratio of 2:1 with a mixture of methyl methacrylate and acrylic acid in the proportions of 95:5.

MODIFICATION OF MICROPARTICLES WITH AUXILIARY POLYMER: To a vessel fitted as described above, there was charged:

Microparticle dispersion obtained	47.471 parts
Aliphatic hydrocarbon (boiling range 115°-145°C)	16.382 parts

This charge was heated to recycling temperature (115°C) in an inert gas atmosphere. The following ingredients were premixed and fed at a constant rate over a period of three hours to the hydrocarbon returning from the condenser:

Methyl methacrylate	3.342 parts
Hydroxyethyl acrylate	1.906 parts

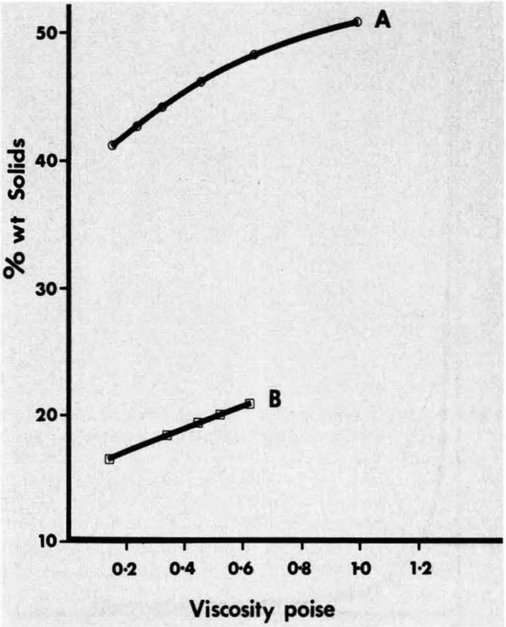


Figure 11—Viscosity and weight solids of silver basecoat formulated with (A) Acrylic microgel and (B) Cellulose acetate butyrate. The viscosity was determined by means of a cone and plate viscometer at a calculated shear rate of 10,000 secs.$^{-1}$

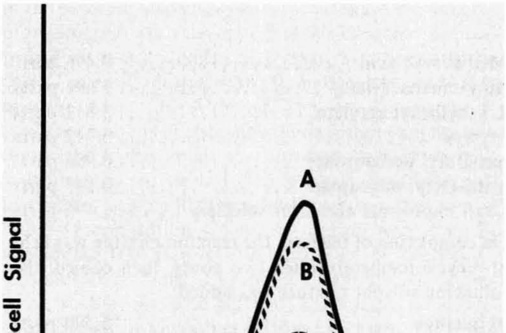


Figure 12—Goniophotometer results for a microgel basecoat applied at different application solids. (A) 5 weight % solids; (B) 20 wt. % solids; (C) 25 weight % solids; (D) 30 weight % solids

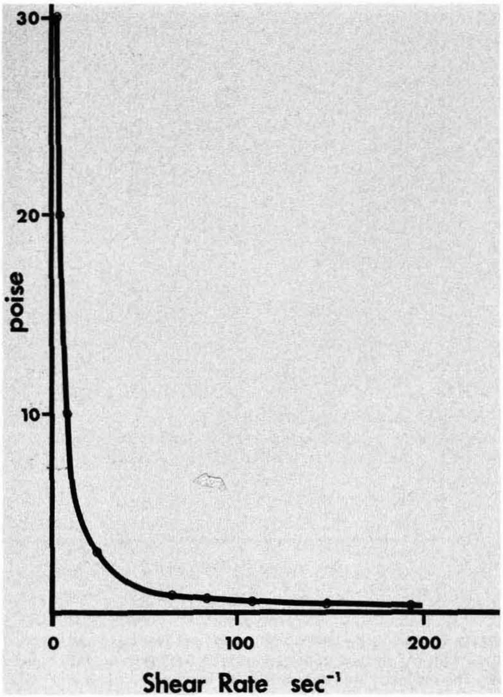


Figure 13—Viscosity and shear rate for water-borne microgel basecoat

Methacrylic acid	0.496 part
Butyl methacrylate	3.691 parts
2-Ethylhexyl acrylate	3.812 parts
Styrene	5.712 parts
tert-Butyl perbenzoate	0.906 part
prim-Octyl mercaptan	0.847 part
Graft copolymer stabilizer solution	1.495 parts

On completion of the feed, the reaction mixture was held at recycle temperature for two hours, then cooled; the following solvent mixture was added:

n-Butanol	5.590 parts
Aromatic hydrocarbon (boiling range 160°-175°C)	3.723 parts
Butyl acetate	4.627 parts

The composition thus obtained had a total solids content of 45%; the content of insoluble gel microparticles was 25%. An electron micrograph of such a dispersion dried and shadowed is shown in *Figure* 9.

During the polymerization of the microgel the carboxyl and epoxide groups react so that the particles become insoluble in organic solvents. When the dispersions are blended into paint compositions, the microparticles remain undissolved when paint thinners are added.

Such microgels have an effect on the apparent viscosity of the paint as solids increase, not only by virtue of the phase volume occupied by the microgel, as described by the Einstein equation or its modifications, but also because increased thixotropic viscosity is observed with an increase in the concentration of the polymer solution in the continuous phase of the dispersion.[11,12]

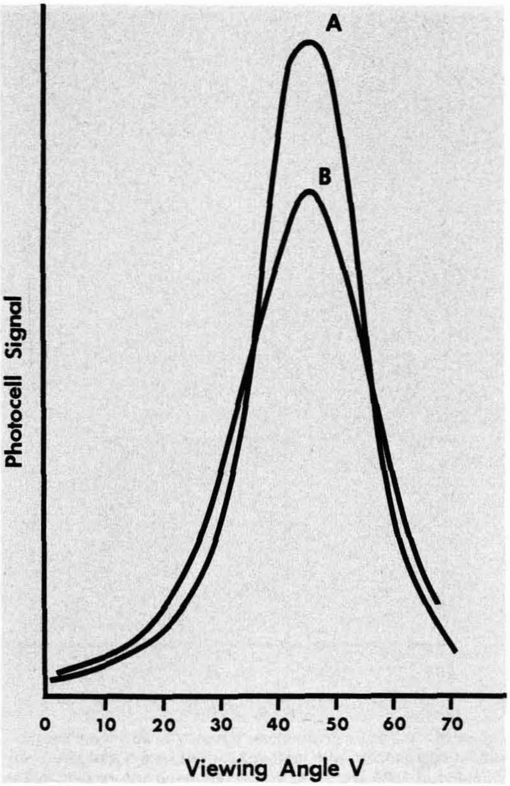


Figure 14—Goniophotometer curves for (A) Water-borne microgel basecoat and (B) Low application solids polyester basecoat

The following results were obtained using the ICI Low Shear Viscometer.[10]

A small sample of the material to be examined was placed between parallel plates at a controlled temperature of 25° C. A small angular displacement was made to the top parallel plate against the restoring force of a spring. The spring modulus was chosen to simulate the shear stress of a vertical paint film of 50 microns under gravity. The decay of shear stress with time was measured and from the slope of this curve, values for apparent viscosity at a preset point during the decay were calculated. The instrument also had the capability to condition the sample by rotating the top plate at a constant speed for a set time immediately before the stress relaxation measurement is made. Further stress relaxation measurements were made at time intervals after the conditioning. The speed of rotation was such that it subjected the sample to a volume average shear rate of 2500 sec^{-1}.

An acrylic copolymer containing pendant hydroxyl and carboxyl groups of 20,000–30,000 molecular weight and typical of the type used in thermosetting acrylic finishes was blended with a melamine formaldehyde resin at a nonvolatile weight ratio of 70:30.

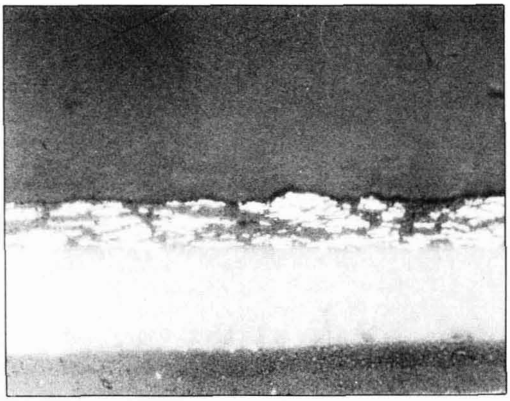


Figure 15—Cross section of water-borne microgel basecoat clear film. Cross section prepared as for *Figure* 6

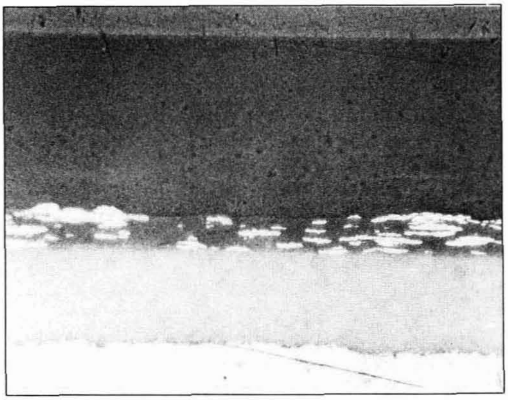


Figure 16—Cross section of low application solids polyester basecoat. Cross section prepared as for *Figure* 6

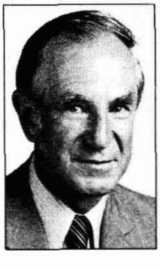
In a second sample, a portion of the acrylic polymer was replaced with the microgel composition such that the weight proportion of the insoluble acrylic microgel was 10% of the nonvolatile components.

The two compositions were concentrated by evaporation. Samples were taken at different nonvolatile concentrations and measured by the method described above.

The results for the sample containing microgel are illustrated in *Figure* 10. The upper line shows the increased apparent viscosity with increasing concentration of the total nonvolatiles, measured without conditioning.

If, however, the paint film is conditioned at a shear rate of 2500 sec^{-1} for one minute before each measurement is made, the lower line is obtained. The time taken to recover from the lower conditioned viscosity to the higher unconditioned viscosity is shown. The recovery time becomes shorter as the nonvolatile concentration rises, showing that as the paint film concentrates with loss of solvent by evaporation, an increasing component of the rise in viscosity is due to structure within the paint film. Similar measurements on the identical acrylic finish without microgel particles gave viscosities which were unaffected by conditioning up to 65% nonvolatile concentrations. The effect of the viscosity recovery after the spray application of a metallic paint is to improve sag and mottle control of the paint during application. The likely cause of this behavior is a reversible flocculation of such insoluble particles caused by the increasing concentration of continuous phase polymer, discussed by Sieglaff, Luckham, Vincent and Waite.[11,12] In the case of basecoats there is no need to preserve the gloss level, and high levels of microgel can be used of the order of 20-30% of the nonvolatile film volume.[13] High molecular weight polymers such as C.A.B. can be omitted from the basecoat formula and replaced by thermosetting acrylic polymers of 10,000-20,000 weight average molecular weight. As a result, basecoats can be formulated which have a much higher solids content at application viscosity.

Figure 11 compares the viscosity in poise against percent weight of solids in a silver basecoat formulated using cellulose acetate butyrate (lower plot) with that of a composition formulated with a high level of microgel (upper plot). As the shear rate during the application process is high, the viscosities have been measured using a cone and plate viscometer at a calculated shear rate of 10,000 sec^{-1}. If we assume a practical apparent viscosity for satisfactory spray application of 0.2 poise, formulation with microgel enables an increase in application solids of from 13% to 43%. The increase in application solids can be obtained without uneven application faults such as mottle or fish eyes. A high microgel concentration in the basecoat also gives the basecoat film a high degree of resistance to the solvency effect of a clearcoat, applied over it without an intermediate bake, as is normally the case. *Figure* 12 illustrates the flop effect obtained from microgel basecoats. Although they can be sprayed at application solids of up to 40% solids without application faults, the higher solids levels cannot be used without some loss in the overall flop level. A blue basecoat, formulated using a high microgel level, was applied at a range of application solids. All panels were even in appearance; the flop level is illustrated by the goniophotometer readings. The use of a light absorbing pigment, such as the blue pigment, accentuates the differences caused by aluminum orientation. Light which has



DR. ALAN J. BACKHOUSE, a native of Gloucestershire, England, received his B.Sc. degree in 1951 and Ph.D in 1954 from Leeds University, England. After a brief period in the Royal Air Force, where he taught the chemistry of propellants and explosives, he joined the Paints Division of ICI Ltd, Slough, England in 1956. He has worked on the chemistry of autoxidation, research and development of resins for electrodeposition. Dr. Backhouse presently is Senior Research Scientist with responsibility for research and development of topcoats for the motors industry, an area in which he holds a number of patents.

a longer path length in the film is affected more by the light absorbing pigment. As the solids at application is raised, the level of flop falls for reasons discussed earlier. An increase in application solids of from 12% to about 20% represents a considerable reduction in pollution, but even with high solids clearcoat, it will fall short of the pollution levels which are now required.

WATER-BORNE BASECOATS

A rough calculation shows that if we assume equal transfer efficiencies, 50% volume solids as an achievable application solids for solvent-borne clearcoat, and a 3/1 volume solids ratio for clearcoat/basecoat, an application solids of about 70% is needed for a basecoat system to achieve a V.O.C. of 3.8 lbs/U.S. gallon. As discussed, low solids are needed for the best aluminium appearance. The only way then of achieving such low solids at application with a low V.O.C. is to use a water-borne system.

We have found that the same arguments can be applied to a water-borne basecoat as are applied above to the solvent borne case. In many ways they are even more appropriate. Water-borne microgel basecoat systems were designed which are extremely pseudoplastic, as is illustrated in *Figure* 13.[14] The ready for use paint has an apparent viscosity of 0.28 poise at a shear rate of 10,000 sec^{-1} and 30.0 poise at 1 sec^{-1}. A rheology of this type results in a change in apparent viscosity between spray gun and car body, large enough to enable good atomization on the one hand and to prevent sagging or aluminum mottle on the other. This change is largely independent of the loss of water by evaporation. In this way, one of the main disadvantages of a water-borne finish, namely the high sensitivity to ambient humidity, is greatly diminished. Such a rheology can be achieved at application solids of 20–25% allowing enough shrinkage to give an equivalent flop effect to the best low solids solvent borne basecoats. *Figure* 14 compares the goniophotometer curves of our water-borne and of a typical low solids solvent borne silver basecoat based on the same grade of aluminum flake. In this case, the peak reflectance of $V = 45°$ is higher than in the case of the low solids solvent borne silver basecoat giving it a flop effect which is very pronounced and equivalent to the best conventional basecoat/clear systems. The comparison is further illustrated by *Figure* 15 and 16 which show photomicrographs of sections of these films. The similarity of the parallel orientation of the aluminum flake is easily seen as is the relative film thickness of basecoat and clearcoat.

Another persistant problem of water-borne finish systems is also eliminated: popping of entrapped air due to the low solubility of air in water compared to organic solvents does not occur due to the low film thickness used. After the usual flash off period, the basecoat is close to its final dry film thickness of 10–15 microns and entrapped air escapes before the clearcoat is applied. The low film thickness of a basecoat compared to a single-coat finish enables residual water in the film to be removed more readily in a short flash off period. When humidities are high during application, the removal of water may need the aid of an air blow, which is already common in many plants using conventional basecoats. These basecoats can then be overcoated, without an intermediate bake by solvent borne clearcoats of either conventional solids or high solids. The microgel content of the water-borne basecoats resists distortion caused by the solvency of the clearcoat, even when the clearcoat contains a high level of low molecular weight species as in high solids formulations, some of which cause great problems over conventional basecoats. Thus, most of the problems which have been associated with water-borne finishes up to now do not occur.

ACKNOWLEDGMENTS

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A Model for the Uptake Of Linseed Oil by Wood

M.H. Schneider and A.R. Sharp
University of New Brunswick*

Direct gravimetric measurements of the along-the-grain uptake of linseed oil by white spruce sapwood are reported. The uptake vs time curve is characterized by three different time constants, (tens of days, days, hours) each with an associated equilibrium uptake. The interpretation is that the observed time constant of one to two days is associated with lumen capillarity in cells which are damaged by drying stresses or have partially open pits, and an uptake time constant an order of magnitude longer than this with lumen capillarity in less permeable cells. These time constants account for 60% and 30% to 40% of the observed uptake, respectively. About 5% to 10% of the total uptake proceeds with a time constant of a few hours. The mechanism for this is thought to be uptake along subvisible cracks in the wood.

INTRODUCTION

In many processes involving impregnation or coating of wood, a liquid is applied to the surface of the wood under atmospheric pressure, and subsequently penetrates the wood. It is important to understand the role of each of the possible uptake mechanisms, and, in particular, the rate of uptake for each mechanism, in order to design coating or impregnation processes. In this paper, a study is reported of the uptake of linseed oil by sapwood of white spruce, *Picea glauca* Moench. (Voss). Several possible uptake mechanisms have been considered, including hydrostatic effects, capillarity of cell lumens, capillarity of cell walls, and film spreading on cell surfaces. The relative importance of each mechanism is examined and uptake rates are estimated.

Linseed oil was chosen for the study because it is a component of many wood coatings and is a good sealer in its own right. White spruce was chosen as the wood because it is well characterized and because cell lumens are of nearly uniform size and are interconnected in a similar manner throughout.[1]

Wood prepared in a cutting process, such as sawing, seldom has the wood cell axes lined up exactly parallel to the surface, and, therefore, penetration occurs along the grain. The longitudinal movement of fluid is much faster than radial or tangential movement across the cells,[2] and thus, the longitudinal uptake dominates. This is the reason for studying the along-the-grain direction in this experiment.

EXPERIMENTAL PROCEDURE

Wood Samples

The wood used for this work was the sapwood of white spruce, *Picea glauca* Moench. (Voss). Three samples, contiguous in a 70 year-old bole, were made. The dimensions of each were 14.3 cm along the grain and 15 cm^2 in cross section. All samples were slowly air dried in the laboratory and their moisture content measured. They were free of gross splitting and checking.

Linseed Oil

Raw linseed oil from a single batch was used throughout this work. This oil had a free fatty acid content of 0.64%, a viscosity of 33.1 centistokes at 30°C, and a density of 0.927 g cc^{-1} at 22°C. The oil's IR and NMR spectra were comparable to published spectra.[3]

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*Fredericton, N.B. Canada E3B 5A3. Dr. Schneider is associated with the Department of Forest Resources and Dr. Sharp is with the Department of Physics.

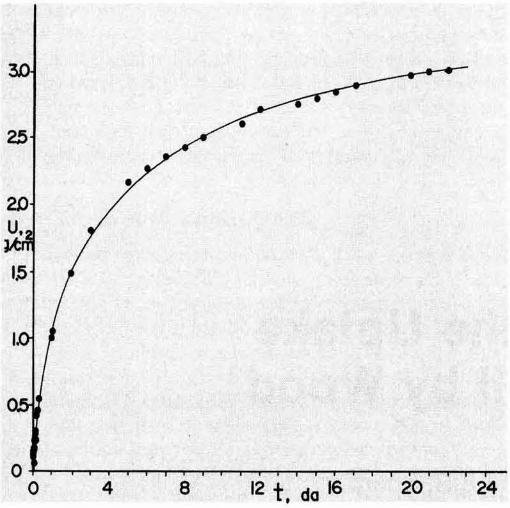

Figure 1—Linseed oil uptake along the grain of spruce over several days

Oil Uptake Measurements

In order for oil uptake to proceed along a well-defined grain direction, the following procedure was used. Each sample was sealed with silicone rubber around the periphery of the area which was to be exposed to oil. After the rubber had cured, the sample was placed in a flat pan, exposure surface down, on wire 1 mm in diameter. Oil was poured into the dish to a head of 5 mm above the sample exposure surface and the head was maintained throughout the experiment. At intervals, the samples were removed from the oil, excess oil was wiped from the surface, and the samples were weighed to an accuracy of 0.01 g before being replaced in the oil.

RESULTS AND DISCUSSION

The average total uptake along the grain for the three samples is shown in *Figure* 1, on a time scale of several days. The general characteristic is a rapid uptake on a short time scale, shown separately in *Figure* 2, followed by much slower uptake which takes many days to come to equilibrium. For reasons given below, the experiment was not continued to equilibrium.

The behavior, shown in *Figure* 1, is characteristic of an exponential increase toward a maximum value. If the increase takes place through a single process, the equation for the uptake at time t is

$$U(t) = U_o[1 - e^{-t/T}] \qquad (1)$$

where t is the time since penetration began, U_o is the equilibrium uptake toward which the increase proceeds (U_o is reached at $t = \infty$), and T is a time constant.

Where the total uptake is the result of more than one mechanism, each proceeding independently of the others with its own characteristic time constant, the total uptake at time t is

$$U(t) = U_{o1}[1 - e^{-t/T_1}] + U_{o2}[1 - e^{-t/T_2}] + \cdots + U_{on}[1 - e^{-t/T_n}] \qquad (2)$$

In this case

$$U_o = \sum_{i=1}^{n} U_{oi} \qquad (3)$$

so that

$$U(t) = U_o[a_1(1 - e^{-t/T_1}) + a_2(1 - e^{-t/T_2}) + \cdots + a_n(1 - e^{-t/T_n})] \qquad (4)$$

where $a_1 + a_2 + \ldots a_n = 1$, and each of $a_1, a_2, \ldots a_n$ gives the fraction of the total uptake which occurs with time constants $T_1, T_2, \ldots T_n$ respectively.

Therefore, if more than one independent process is responsible for the uptake, and each process has a characteristic time constant, both the time constant and the fraction of the total uptake for each process may be determined. This is shown in *Figure* 3 where $\ell n \frac{U_o - U}{U_o}$ vs t is plotted for the data shown in *Figure* 1. As can be seen from equation (1), this plot will result in a straight line of slope $-\frac{1}{T}$ and intercept 1 if a single process is involved. From equation (4), such a plot will be a sum of straight lines, with slopes $-\frac{1}{T_1}, -\frac{1}{T_2} \ldots -\frac{1}{T_n}$ and intercepts $a_1, a_2, \ldots a_n$, if several independent processes are involved.

The data of *Figure* 3 requires at least two straight lines for a good fit. When the data at shorter times are taken into account (from *Figure* 2), a third term is also required. The results have therefore been fit with a sum of three exponential terms. The results of the fit are given in *Table* 1 for two different assumed values of U_o.

Before the data can be interpreted, the maximum equilibrium uptake for each possible mechanism must be known. Estimates of these values have been made (see Appendix) and are summarized in *Table* 2. The two values assumed for U_o in *Table* 1 are the apparent assymptotic value of uptake from *Figure* 1 (3.25 gm/cm^2), and the maximum equilibrium uptake estimated for all mechanisms combined in *Table* 2 (5.6 gm/cm^2). These represent the lower and upper limits on U_o respectively. The ambiguity about what to use for the total equilibrium uptake was caused by the experiment being terminated before a true equilibrium value had been reached. Waiting a longer time may have resulted in erroneous results if significant amounts of curing of linseed oil had occurred. However, only the parameters for the longest time constant fraction depend strongly on the value of U_o used for the analysis and this does not influence the interpretation, as will be shown below.

It is important to understand that the actual uptake observed will be less than the maximum estimated in *Table* 2. The estimates assume that there are no blockages in any of the capillaries and that air is excluded. In reality, both effects occur and reduce the volume accessible to the linseed oil, thereby reducing the actual uptake.

A second point of importance is that the uptake estimates consider the amount of oil which penetrates the wood at equilibrium and, by themselves, give no information on the rate at which the penetration occurs. The

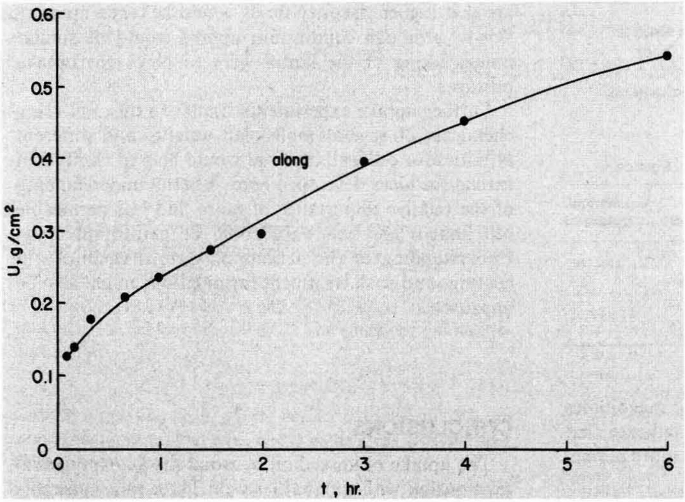

Figure 2—Linseed oil uptake along the grain of spruce over several hours

rate of penetration is dependent upon a set of parameters including viscosity and diffusion coefficients of the linseed oil.

The penetration experiment performed is a rate experiment which was not allowed to proceed to equilibrium for reasons discussed above. However, the individual mechanisms of penetration each proceed toward an equilibrium value, even though that equilibrium value was not attained. In order to associate the measured rates of uptake with particular mechanisms, the equilibrium values toward which those mechanisms proceed is useful, as discussed below.

The two long time constant fractions must be related to lumen capillarity, since no other mechanism can account for such large uptake (*Table* 2). One possible explanation of the results is the following.

It is possible that wall capillarity may only proceed once the oil has entered a cell lumen and subsequently penetrates into the walls. Therefore, the rate of movement of oil into cell walls may depend chiefly upon lumen capillarity and may be coupled therefore with the lumen capillarity and not separately detectable in an experiment such as this (recall that the analysis used in equation (4) is strictly valid only when the processes are *independent*). The sum of the magnitudes of the uptake mechanisms with the longer time constants (*Table* 1) suggests this possibility when compared with the sum of the magnitudes for estimated equilibrium uptakes (*Table* 2) for lumen and cell wall capillarity.

Since both longer time constant components of the uptake are associated with capillarity in the cell lumens, why are there two different time constants? The probable answer lies in the detailed nature of the wood anatomy. White spruce is an impermeable wood, that is, mass movement of fluids within the wood is difficult. Typically, however, there are some cell interconnections which are better than others because of damage resulting from drying stresses or intercellular pits that have not closed as tightly as others. The rate of movement of fluid into such cells should therefore be much faster than into the other cells where air blockages and relatively impermeable walls lead to a higher resistance to liquid entry. Capillarity in the former cells would thus be assigned to the time constant of a few days, whereas, capillarity in the latter cells would take place with the

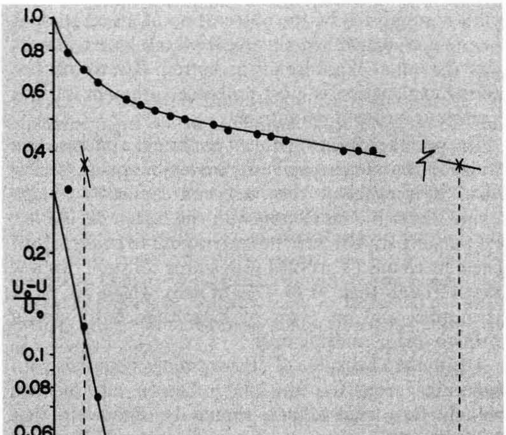

Figure 3—Graphical analysis of the data shown in *Figure* 1

Table 1—Time Constants and Equilibrium Uptake For Three Independent Mechanisms (a, b, c) Assuming Two Different Values For the Total Equilibrium Uptake of All Mechanisms

Assumed Total Equilibrium Uptake U_o	5.6 gm/cm^2		3.25 gm/cm^2	
Mechanism	Time Constant	Equilibrium Uptake	Time Constant	Equilibrium Uptake
	T_i	U_o, gm/cm^2	T_i	U_o, gm/cm^2
a	52 days	3.6	11 days	1.7
b	2 days	1.7	1.5 days	1.2
c	4 hours	0.3	4 hours	0.35

time constant tens of days long. The relative magnitudes of the uptakes in these cases (*Table* 1) indicate that between 30 and 40% of the cells are of the more permeable variety.

The time constant of four hours may have at least two different explanations. The first of these is that this uptake arises from hydrostatic effects, since the equilibrium uptake has nearly the correct magnitude (compare *Tables* 1 and 2). However, the very rapid uptake must be accomplished in this case by oil passing through the end walls of several cells, a process which seems to take a much longer time when dealing with a lumen capillarity mechanism. These facts seem inconsistent. A second alternative is that the rapid uptake occurs along cracks and other imperfections and, quite by accident, results in the observed equilibrium uptake. This possibility is supported by the observation of an oil stain at the top of a sample, visually free from cracks, only hours after the initial exposure of the bottom face to oil. The second explanation is most probable, although it is not possible to prove it definitively.

The results of this experiment confirm the microscopic evidence[4] that lumen capillarity is a major uptake mechanism. It is probable that cell wall capillarity is also taking place in conjunction with the lumen capillarity, but swelling studies were not carried out to confirm this. These mechanisms proceed with a time constant of a few days through that 30 to 40% of cells which are more permeable, and an order of magnitude more slowly through less permeable cells.

The uptake behavior of other coatings materials with molecular properties similar to linseed oil, such as phthalic-fatty acid alkyds, should be similar to that demonstrated in this experiment. The major differences are that higher viscosity fluids would be taken up more slowly, although equilibrium uptake would be similar unless curing of the liquid were to block the uptake passages.

Further uptake experiments similar to this, but using chemicals of several molecular weights and different affinities for cell wall material would help to clarify and extend the ideas developed here. A better understanding of the relative importance of more and less permeable cell lumens and cell walls could be gained this way. Understanding of the actions of various chemicals in coatings and soak treatment formulations might also be improved.

Table 2—Estimated Maximum Equilibrium Uptake For Several Mechanisms (see Appendix)

Mechanism	Maximum Equilibrium Uptake (gm/cm^2 of exposed surface)
Lumen capillarity	$U_\ell = 4.8$
Wall capillarity	$U_w = 0.50$
Hydrostatic effects	$U_h = 0.34$
Film spreading on lumens	$U_f < 2.6 \times 10^{-3} = 0.0026$

CONCLUSIONS

The uptake of linseed oil by wood fits an exponential relationship with time rather well. Three time constants result from such a fit. They have magnitudes of tens of days, days, and a few hours. Approximately 60% of the total uptake is accounted for by the long time constant; 30% to 40% by the intermediate one; and 5% to 10% by the short one. The interpretation is that the longest time constant results from oil moving into cell lumens through inter-connections having low permeability, the medium time constant from oil movement into lumens through higher permeability cell walls, and the short time constant from imperfections in the wood.

ACKNOWLEDGMENTS

The authors wish to thank Dr. M. MacBeath for measurements of the dipole moment of linseed oil and Dr. T.B. McMahon for discussions. Research was supported in part by the Natural Sciences and Engineering Research Council of Canada, and by the University of New Brunswick Research Fund.

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(8) Dr. M. MacBeath, personal communication. Using the heterodyne beat method with cyclohexane solvent, the dipole moment was 2.46 debye. Using the Guggenheim method, the dipole moment was 2.58 debye. The best experimental value was 2.5 ± 0.1 debye.

APPENDIX

UPTAKE MECHANISMS

Several possible penetration mechanisms are examined here and the maximum equilibrium oil uptake, U, arising from each mechanism is estimated.

HYDROSTATIC EFFECTS: Voids in the wood will be filled with oil to the height of the oil head. The uptake by this mechanism is thus

$$U_h = A\ h\ V\ \rho \qquad (A1)$$

where h is the fluid head, ρ is the density of linseed oil, V is the wood fractional void volume, and A is the cross sectional area of the exposed surface.

LUMEN CAPILLARITY: In an infinitely long capillary of uniform radius, the equilibrium rise is given by[5]

$$R = \frac{2\gamma \cos \theta}{r \rho g} \qquad (A2)$$

where R is the height of rise of the liquid in the capillary above the head level, ρ is the liquid density, γ is the liquid surface tension, r is the capillary radius, g is the acceleration due to gravity, and θ is the contact angle between the liquid and the substrate. Note that the largest diameter capillaries have the lowest rise. For wood samples, the cell lumens are the largest capillaries, reaching as much as 15 μm in diameter. Using the constants given in *Table* A1, it is possible to estimate from equation (A2) that maximum capillary rise (i.e. for $\theta = 0$) for linseed oil in wood with large lumens would be about 45 cm for the largest lumens and more for the smaller capillaries. Therefore, when each capillary mechanism has reached equilibrium, the volume uptake will be simply the product of the end surface area of the capillaries and the sample length since the sample length is always less than the estimated capillary rise of 45 cos θ cm for contact angles less than about 71.5°. For the following reasons, it is expected that linseed oil will always meet this contact angle criterion.

Linseed oil consists of a small amount of C_{18} free fatty acids in a preponderance of triglycerides of these same fatty acids (see *Table* A1). It is clear from previous work that the fatty acid portion can adsorb on cellulose surfaces. When converted to triglycerides, the proton-accepting potential of the molecule is lessened; whether there is sufficient polarity for adsorption on cellulose is unknown. However, measurements of the dipole moment of linseed oil using two different methods[8] give a dipole moment of 2.5 debye indicating that the linseed oil molecules should certainly be capable of sufficient interaction with cellulose hydroxyl groups to keep the contact angle in the required range. Furthermore, linseed oil does spread on wood surfaces, even with the roughness of the surface which should increase the contact angle. This indicates a wetting interaction; whether facilitated by interaction of the triglyceride portion of the molecule with the cellulose or by the hydrocarbon chain with other wood constituents is unknown. From either point of view, it seems likely that the contact angle will be less than about 71.5° as required.

The oil uptake by lumen capillarity at equilibrium is therefore approximately

$$U_\ell = LAF_\ell\ f_\ell \qquad (A3)$$

where L is the sample length, A is the sample cross sectional area, F_ℓ is the fraction of the cross section consisting of lumens, and f_ℓ is the fraction of the lumens occupied by oil. This latter was estimated, using microscopy, to be 0.5.[4]

F_ℓ may be readily estimated from the specific gravity of the wood if the cell wall density is known. For wood of specific gravity 0.4 on an oven dry weight and volume basis, typical of white spruce, the lumen area is about 75% of the cross sectional surface.[5]

Table A1—Some Properties of the Materials Used in This Study

Linseed Oil:	
Free fatty acid content	0.64%
Viscosity (η)	33.1 centistokes at 30°C
Density (ρ)	0.927 g cm^{-3} at 22°C
Surface tension (γ)[6]	30 dynes cm^{-2} at 22°C
Fatty acid molecular weight (M)	280
Fatty acid occupancy (A_m)[7]	2.05 × 10^{-15} cm^2
Spruce	
Specific gravity	0.4
Fractional void volume (V)	0.75
Average fibre diameter (d)[5]	33.3 μm
Fibres per unit area (n)[5]	90,000
Fraction of blocked lumens (f)[4]	0.5
Sample length (L)	14.3 cm

WALL CAPILLARITY: Estimation of the number and size of capillaries in the cell wall is difficult, there being various estimates based on various techniques. The best estimates available indicate that at maximum swelling, these capillaries are all interconnecting and have diameters on the order of 1000 Å. The number and diameter of these capillaries is strongly dependent on the degree of swelling, so that such direct evidence is of little value when considering the situation which prevails when much less swelling has occurred, as in this experiment. One must therefore make estimates based on the actual degree of swelling present in the samples used. One such estimate may be made as follows.

Water causes about a 10% volume increase in wood as a result of penetrating and swelling the cell walls.[1] The C_{18} free fatty acids are known to swell wood about 40% of the water swelling.[5] Therefore, linseed oil containing free fatty acids should swell wood by less than 4% volumetrically. Because virtually all swelling is across the grain,[5] less than 4% of the surface cross section will be made up of cell wall capillaries. By analogy with equation (A3), the oil uptake by cell wall capillarity at equilibrium is

$$U_w = L\ A\ F_w f_w \qquad (A4)$$

where the subscript w refers to walls and the symbols have analagous meanings to those of equation (A3). This is the maximum uptake possible for cell wall capillaries. In all likelihood, the small amount of free fatty acids contained in the linseed oil used (~ 0.64%) will not be sufficient to cause complete swelling, with a subsequent decrease in the uptake possible by this mechanism.

FILM SPREADING ON LUMEN SURFACES: Molecular forces may result in a film of oil spreading on lumen surfaces even when no bulk fluid is in the lumen. The maximum uptake for the lumen surfaces is

$$U_f = \frac{S\,N_o}{A_m\,M} \tag{A5}$$

where S is the lumen surface area, A_m is the area occupied on the surface by a single molecule of molecular weight M, and N_o is Avogardro's number. The available lumen surface area is given by[5]

$$S = A\,d\,V^{1/2}\,n\,L \tag{A6}$$

where n is the number of fibres of average diameter d in a unit cross sectional area. Values of all parameters for free fatty acids are given in *Table* A1. Note that because of three factors the influence of film spreading on the uptake of linseed oil will be reduced from that of the free fatty acids. First, the linseed oil has a larger molecular weight, M; second, the linseed oil is a larger molecule and would occupy a larger surface area (A_m is larger); and third, the linseed oil is not as strongly interacting with the surface as are the free fatty acids.

OTHER MECHANISMS: One other mechanism that may contribute to uptake is adsorption on excised cell walls on the exposure surface. This follows an analagous expression to equation (A5) except that the available surface area is that of the excised cells. This area is negligible compared to the lumen areas so that the uptake from such a process is much less than U_f and has been ignored.

UPTAKE ESTIMATES: Making use of equations (A1)–(A6) and the data in *Table* A1, the maximum equilibrium uptake possible for each of the mechanisms can be estimated. The resulting estimates are given in *Table* 2, listed according to magnitude of the uptake.

These estimates should be used with caution. In particular, they ignore any effects from air inclusions or blockages and the numerical result for film spreading on lumens is based on the data for free fatty acids where the effect is larger than for linseed oil. The effect of film spreading for linseed oil will likely be negligible.

These subcommittee reports are for the use of the membership of ASTM Committee D-1 in continuing its work and for the interest of readers in the activities of ASTM Committee D-1. The reports are not official actions of ASTM and may not be quoted as representing any action or policy of the American Society for Testing and Materials.

June 1982 Subcommittee Reports Of ASTM Committee D-1

The June 1982 meeting of ASTM Committee D-1 on Paint and Related Coatings and Materials was held on June 20-23 at the Harbour Castle Hilton Hotel, Toronto, Ontario. In the three and one-half days preceding the final report session and general meeting of Committee D-1, approximately 163 members and guests met in 148 scheduled meetings of D-1 subcommittees and working groups. The present membership of Committee D-1 is 512.

One of the highlights of the meeting was a presentation of the Society Award of Merit, as well as the title of Fellow of the Society, to Harold M. Werner.

The D01.90 Executive Subcommittee approved the recommendation of Sub. D01.94 on Awards and Memorials for the presentation of Certificates of Appreciation to 24 D-1 members.

Memorial Resolutions were approved for Arthur B. Holton, William Cady, and Thomas R. Hewitt.

Subcommittee Officer appointments included Sub. D01.07 on Government Contacts—A.A. Chasan to replace R.F. Brady as Chairman, and Sub. D01.48 on Zinc-Rich Coatings—D.C. Kinder to replace M.D. Tellor as Chairman.

Highlights

The following projects of major interest to the coatings industry represent areas for special emphasis:

VOC Determinations—CARB arbitrarily placing precision, or variance, at 10%. An STP on Sub. D01.21's work on VOC will be published to aid in unifying EPA and State implementation of enforcement.

Metals in Air Particulate—Sub. D01.21.72's proposed standard on test for lead and chromium in air particulate to be balloted by D-1. The group is also seeking persons interested in determination of basic lead silico chromate in pigments. (See also Committee E-34's new E848-82 "Standard Practice for Safety and Health Requirements Relating to Occupational Exposure to Water-Soluble Chromates.")

Sustained Burning Tests—Sub. D01.22 methods passed D-1 ballot with no negatives. Can eventually affect transportation regulations.

Electrical Properties of Liquid Coatings—New group, Sub. D01.24.26, formed. First priority will be volume resistivity. Interested group members sought.

"Scab" Corrosion—Sub. D01.27.09 planning speakers on subject for next meeting in effort to develop accelerated method.

Latex Paint Purchasing Guide—"Standard Guide For Purchasing Interior Flat Latex Paint" rejected overwhelmingly by Sub. D01.41 members on letter ballot vote. New approaches to be explored at January 1983 meeting. Ideas solicited.

Cure of Zinc-Rich Coatings—Sub. D01.48.02 seeking ideas and aid in developing method that can be used "on-site."

Prediction of Field-Applied Paint Performance on Hardboard Siding—Sub. D01.52, Group B, reviewing possible test methods. Test fence exposures to be summarized and reviewed at January 1983 meeting.

"Coil Coated Metal"—Sub. D01.53 adopted this new name, replacing "Factory Coated Strip Metal." Sub. D01.53.02 still seeking a good method for cure determination. Precision of solvent-rub method still being questioned.

Artists' Paints Labeling Specifications for Chronic Toxicity—Passed Sub. D01.57 letter ballot, will be submitted to D-1 ballot.

Future Meetings

January 23-27, 1983—Lake Buena Vista, Florida (Dutch Inn)
June 23-26, 1983—Nashville, Tennessee (Hyatt Regency)

New standards which will appear in February and March, 1983 Volumes 06.01, 06.02 or 06.03, succeeding 1982 Parts 27, 28 and 29:

D 3934-82, Test for Closed-Cup Flash Point of Liquids by the Flash, No-Flash Equilibrium Method (Sub .22) B/S Vol 06.03, 1983.

D 4139-82, Practice for Determining Volatile and Nonvolatile Content of Pigments (Sub .21) B/S Vol 06.02, 1983.

D 4140-82, Practice for Determining Volatile and Nonvolatile Content of Driers, Drying Oils, Naval Stores, and Solvents (Sub .21) B/S Vol 06.03, 1983.

D 4141-82, Practice for Conducting Accelerated Outdoor Exposure Tests of Coatings (Sub .27) B/S Vol 06.01, 1983.

D 4142-82, Practice for Testing Epoxy Resins (Sub .33) B/S Vol 06.02, 1983.

D 4143-82, Practice for Testing Latex Vehicles (Sub .33) B/S Vol 06.02, 1983.

D 4144-82, Estimating Package Stability of Coatings for Ultraviolet Curing (Sub .52) B/S Vol 06.01, 1983.

D 4145-82, Test for Coating Flexibility of Prepainted Sheet (Sub .53) B/S Vol 06.01, 1983.

D 4146-82, Test for Formability of Zinc-Rich Primer/Chromate Complex Coatings on Steel (Sub .53) B/S Vol 06.01, 1983.

D 4147-82, Practice for Applying Coatings Using the Wire Wound Drawdown Bar (Sub .53) B/S Vol 06.01, 1983.

DIVISION 1
ADMINISTRATIVE

SUBCOMMITTEE D01.15
LECTURES AND SYMPOSIA

H. A. Wray, Chairman

The January 26, 1983 Joint ASTM/SSPC Symposium on "New Concepts for Coating Protection" will be held in the Dutch Inn, the host hotel for ASTM Committee D-1, in Buena Vista, Florida. The SSPC group will stay at the Howard Johnson in the same city.

The symposium will necessitate an additional day's session. The meeting will be from January 23 to 27, 1983, with Sunday for executive and other administrative subcommittees, Monday for task group and subcommittee meetings, Wednesday for the symposium, and Thursday for the final subcommittee meetings and D-1 Report Session. SSPC will have their specific sessions on Thursday and Friday following the symposium.

Concerning the seminar for the June 1983 meeting in Nashville, the Vice-President of the Dupont Company's F & F Department, has consented to speak or to provide a speaker from top management of that department. The general topic will be "How do paint companies' top management view ASTM's worth to the paint industry?." Suggestions for specific topics will be welcomed. Efforts should be made to invite other management personnel to attend this seminar.

A discussion concerning a program on formaldehyde emissions resulted in the suggestion that it would be best for this to be handled by an Ad Hoc group from Subcommittees 52 and 55 meeting with the Government personnel to see what should be done to provide methods for measuring these emissions.

SUBCOMMITTEE D01.16
DEFINITIONS

S. LeSota, Chairman

Definitions for cathodic protection, hydroxyl number, metal marking resistance, nonvolatile content, temporary coating, zinc dust, zinc powder, and zinc-rich primer will be sent to subcommittee members for balloting. This work is being done effectively by mail.

DIVISION 20
RESEARCH AND GENERAL METHODS

SUBCOMMITTEE D01.20
SAMPLING, STATISTICS, ETC.

H. E. Ashton, Chairman

A review of D3980, "Interlaboratory Testing of Paint and Related Materials," section on number of materials, laboratories, and replications, and revisions prepared as the result of the withdrawal of a negative on the D-1 ballot 81-4, was made. Minor changes were made to make it more acceptable, but it was also agreed to change the definition of replicates to include separate measurements at short time intervals on two specimens of liquid samples. Other changes as the result of balloting, or the chairman's review, were also discussed. It was agreed that they could be added and that the item be submitted for simultaneous subcommittee and committee ballot.

SUBCOMMITTEE D01.21
CHEMICAL ANALYSIS OF PAINTS AND PAINT MATERIALS

R. W. Scott, Chairman

Group 13, Coordination of VOC Standards, J. C. Weaver, Chairman, discussed three areas: (1) Transfer Efficiency Perspectives—Centec has a contract from U.S. EPA to complete a transfer efficiency practice with supporting test methods for compliance. On May 17, a meeting was held with concerned representatives from industry and EPA to address the problems and to discuss progress to date. There is some question as to when, and if, ASTM will become involved; (2) California Air Resources Board deviation from ASTM usage—CARB is citing ASTM methods, but arbitrarily placing precision, or variance, on VOC determinations of ± 10%. From Sub. D01.21's work on water-reductible coatings this variance might be larger. The next round-robin on VOC calculations should clarify this gray area of precision; (3) EPA and State Implementation Enforcement Problems—To unify EPA and State implementation enforcement of determining VOC levels in coatings, it is the plan of the chairman to publish an STP, with a discussion on Sub. D01.21's work on VOC, a listing of available ASTM methods applicable to the subject and a guideline.

Group 22, Analysis of Electrocoat Bath Samples, A. G. Yeramyan, Chairman, reported that results of the last round-robin indicate the methods used for determining pH and conductivity are acceptable and are ready for Sub. D01.21 letter ballot. However, more work is required on the G.C. method to determine the solvent composition and concentration in electrocoat bath samples.

Group 27, Low Temperature Furnace Ash Content, W. V. Moseley, Jr., Chairman, reported that seven collaborators will participate in a round-robin to determine the pigment content of seven different types of materials.

Group 42, AAS Analysis of Pigment, W. V. Moseley, Jr., Chairman, reported the method is ready for Society ballot. The next round-robin will analyze the lead, chromium, and iron in basic lead silico chromate primers.

Group 46, X-Ray Analysis of Pigments, H. Neubold, Chairman, will conduct a new round-robin for determination of titanium using oil-based and water-based coatings. An x-ray diffraction method for determining crystalline pigments will be evaluated since initial results indicate the method is good.

Group 53, Trace Levels of Monomers in Paints, G. Cunningham, Chairman, found that initial evaluation of results of the first round-robin for determination of five acrylate monomers and styrene monomer in butyl acrylate/vinyl acetate latex indicates interlaboratory agreement was poor. A new round-robin will be initiated using a modification of the method and a new set of samples.

Group 55, Halohydrocarbons in Paints, C. Niemi, Chairman, will evaluate a procedure for the determination of 1,1,1 trichloroethane, methylene chloride, and Freon 113 using gas chromatography. Four different coatings have been found for testing the levels of the first two solvents. Freon 113 will not be tested in this round-robin.

Group 56, Review of D3960, Calculation of VOC, M. Sites, Chairman, met for the first time. This group was formed to validate VOC test methods and calculations as presented in D3960, primarily the determination of water content. A round-robin will be initiated on four coatings by nine collaborators. Methods used will be D3792 (G.C.) and D4017 (Karl Fisher).

Group 71, Metals in Low Concentration, H. D. Swafford, Chairman, found evaluation of statistical data from the round-robin to evaluate a proposed digestion procedure alternate to that in D3335 showed much poorer precision than that obtained from the original procedure. A new round-robin will be initiated using more collaborators and fewer paints.

Group 72, Metals in Air Particulate, L. DiCarlo, Chairman, reported the proposed "Test for Lead and Chromium in Air Particulates . . ." will be changed to reflect the negative resolutions and comments from the Sub. D01.21 ballot and will be submitted to D-1 ballot. He requests all persons with an interest in determination of basic lead silico chromate in pigments by use of x-ray diffraction and confirmation by x-ray spectrometry contact him for further information. A round-robin will be initiated if there is sufficient interest. (See also Committee E-34's new E848-82 "Standard Practice for Safety and Health Requirements Relating to Occupational Exposure to Water-Soluble Chromates."

Group 80, Exploratory Analytical Research, D. P. Emerick, Chairman, will survey Sub. D01.21 members and other interested parties for input on available instrumentation and techniques relating to (1) Improvement of the G. C. method for water determination (D3792); (2) methodology for size exclusion chromatography for determination of trace monomers; and (3) general instrumental methods for use in specification of specific polymers and resins.

SUBCOMMITTEE D01.22 HEALTH AND SAFETY

H. A. Wray, Chairman

In light of new evidence that the Los Angeles area is interested in tests to determine fire retardancy of building materials, the plan to withdraw the tunnel and cabinet tests will be abandoned.

In an effort to reduce the number of flash point tests on the books the subcommittee recommended that D3143 be withdrawn since it references an existing method, D1310, and is not necessary.

The "sustained burning tests" (the Wick Test and the Combustibility Test) have passed main committee ballot with no negatives and will be submitted to Society ballot.

Volunteers are being sought by the chairman for round-robin testing for the determination of flash point of viscous liquids.

The chairman reported on the activities of the Coordinating Committee For Flash Points . . . (CCFP) as follows: (1) D1310-80 has been adopted by the Department of Defense and the Consumer Product Safety Commission has gone from open to closed cup flash point testing; (2) OSHA may permit adoption by industry of the labeling practices now in existence, such as, NPCA's Hazardous Material Identification System (HMIS) or Dupont's "S" type system; (3) The DOT has proposed a "solids" determination test involving heating a quart can of material to 100° F for 24 hours, inverting the can, and timing when a certain amount flows, or does not flow, from the can. The CCFP task group on flammable solids has suggested a test involving the determination of the amount of material which will flow through a paint strainer. A third method makes use of the Brookfield Viscometer. These suggested methods will be circulated to Sub. D01.22 members for comment; and (4) The DOT has proposed definitions and tests for flammable solids and oxidizers.

SUBCOMMITTEE D01.23 PHYSICAL PROPERTIES OF APPLIED PAINT FILMS

M. P. Morse, Chairman

Group 10, Adhesion, H. E. Ashton, Chairman, has revised D3359, "Adhesion by Tape Test," to inform the user as to the sources of tapes that meet the specifications of the method. Other suggestions for further revision include accommodation of thick films by using a tool that produces wide-spaced cuts, and the use of reverse impact in conjunction with the cross-cut procedure.

Test data obtained with the tensile tester pull-off method were submitted which showed that the geometry of the studs of the pull-off mechanism has a significant effect on the adhesion values obtained. Difficulty has been encountered in obtaining coated panels exhibiting differences in the medium range of adhesion. The next attempt will be to use an alkyd system on steel panels, half of which will be sandblasted.

Group 11, Wet Film Thickness, H. A. Ball, Chairman, after considerable discussion, agreed there is need for a practice for the use of notch-type thickness gauges. A standard practice is being drafted which will describe the characteristics of suitable gauges and the precautions that must be taken with their use.

Group 12, Dry Film Thickness, K. A. Trimber, Chairman, reported the accuracy of the measurements obtained with the instruments in the round-robin test of methods D1186 and D1400 is being determined. The coatings have been cross-sectioned and measured with a microscope. The two sets of values will be compared. It is proposed to publish the results in an ASTM data series publication. A draft of D1005, "Measurements of Dry Film Thickness of Organic Coatings," is being further revised to include the use of hand-held micrometers and to specify techniques for removing the film from the substrate. A round-robin is being planned to evaluate the precision of the revised method.

Group 14, Hardness, Mar and Abrasion Resistance, M. P. Morse, Chairman, has proposed to publish the results of the round-robin tests conducted with the three recently developed abrasion resistance methods in an ASTM data series publication. Data were presented showing a comparison of hardness values of automotive coatings as determined with the Tukon Tester (equipped with a Knoop Indentor) and with the Persoz Pendulum Tester. Analysis of the data shows the Persoz to have a substantially greater sensitivity than the Tukon Tester in detecting hardness differences produced by the number of coats applied, baking temperature, and type of additives and their concentrations in coatings. It was agreed that the Pendulum Hardness Tester can provide useful results. It is planned to draft a method for its use.

Group 15, Slip Resistance, G. D. Ernst, Chairman, initiated a round-robin to evaluate coefficients of friction measurements performed with the Instron Tensile Tester using a leather-faced sled to compare the results obtained from three other testing devices used to measure the friction characteristics of flooring, shoe sole materials, and floor polishes. Difficulties were encountered in obtaining reproducible results, due presumably to difficulty in maintaining a uniform leather surface. A more suitable material is sought.

SUBCOMMITTEE D01.24 PHYSICAL PROPERTIES OF LIQUID PAINTS & PAINT MATERIALS

C. K. Schoff, Chairman

Group 18, Dispersion Phenomena, V. B. Waltz, Chairman, discussed the revision of D1483, "Oil Absorption of Pigments by Gardner-Coleman Method." D. C. Kinder agreed to organize interlaboratory testing to generate data for a precision statement. The group also discussed D1210, "Fineness of Dispersion." This method will be submitted for reapproval with an editorial addition of the comparable ISO method.

Group 19, Viscosity by Efflux Cups, C. K. Schoff, Chairman, discussed the revision of D1200, "Viscosity by Ford Cup." The method, with some editorial revisions as a result of the D-1 ballot, will be submitted to Society ballot. The latest draft of the proposed test method for Viscosity by Dip Type Viscosity Cups was also discussed. It was decided that the fact that dip type cups should be used only for control purposes should be given more emphasis. In addition it was decided that the variability of Zahn cup volume and orifice size from manufacturer to manufacturer must also be emphasized.

With these changes and additions of figures it will be submitted to Society ballot.

Group 20, Rotational Viscometers, D. Howard, Chairman, discussed D2196, "Viscosity by Brookfield Viscometer," and the need for a precision statement. Interlaboratory testing is being organized to generate data for the precision statement. Four Trade Sales paints will be run on RVT and RVF viscometers. More cooperators are needed. Members of D-1 and other interested people will be surveyed to establish the level of interest in writing methods for other types of rotational viscometers, especially concentric cylinder types.

Group 23, High Shear Viscometers, C. K. Schoff, Chairman, reported the proposed method for high shear viscosity is being held up by the lack of a precision statement. Interlaboratory testing was carried out, but the data were incomplete.

Group 26, Electrical Properties of Liquid Coatings, R. J. Huddleston, Chairman, met for the first time to establish objectives. Three areas suggested were (1) volume resistivity by direct current bridge (Ransburg Meter); (2) volume resistivity by alternating current bridge; and (3) dielectric constant. It was agreed that volume resistivity will be the first priority since this property is very important to electrostatic spraying. This working group is seeking more members. Those interested should contact Chairman Huddleston or ASTM headquarters.

SUBCOMMITTEE D01.26 OPTICAL PROPERTIES

C. J. Sherman, Chairman

Group 2, Color Measurement, C. S. McCamy, Chairman, reported that D3134, "Selecting and Defining Color and Gloss Tolerances of Opaque Materials and Evaluating Conformance," was revised and will be submitted to subcommittee ballot. D2244, "Instrumental Evaluation of Color Differences of Opaque Materials," will be revised extensively and simplified to make it more applicable to paint technology prior to being submitted to subcommittee ballot. It will be recommended to Committee E-12 on Appearance that it prepare an appropriate standard for measuring color difference in general. Since D2616, "Evaluating Change in Color with a Gray Scale," is very general and not specific to paint, it was voted to recommend to D-1 that the responsibility for it be transferred to Committee E-12.

Group 6, Hiding Power, L. Schaeffer, Chairman, reported that D344, "Test for Relative Dry Hiding Power of Paints," will be revised with changes in the precision statement as a result of negatives on the last ballot. It will be reballoted by the subcommittee.

Group 11, Gloss and Goniophotometry, B. T. Merriman, Chairman, found a negative persuasive on the simultaneous balloting of the proposed standard, "Method for Visual Evaluation of Gloss Differences between Surfaces of Similar Appearance," will revise it accordingly and reballot. D523, "Test for Specular Gloss," will be revised to include a statement warning that the black glass gloss standards require recalibration every two years.

Group 23, Retroreflectance of Horizontal Coatings, N. Johnson, Chairman, will revise D4061, "Specific Luminance of Horizontal Coatings," to update the precision statement and submit it to Sub. D01.26 ballot.

SUBCOMMITTEE D01.27 ACCELERATED TESTS FOR PROTECTIVE COATINGS

E. A. Praschan, Chairman

After resolution of a negative by an editorial change deleting a footnote, the proposed new chalking method will be submitted to Society ballot. Revisions as a result of a negative by H. E. Ashton will be substantial, requiring reballoting by Sub. D01.27 and D-1. The subcommittee approved unanimously a proposal by Group 10 to request publishing the data generated in the preparation of the new practice for conducting accelerated outdoor weathering tests in an ASTM data series publication. Also approved was the inactivation of Group 6 on Detergent Testing since no work is currently underway.

The chairman noted that efforts are being made to get one or more speakers for the next meeting of Sub. D01.27.09 on Corrosion Tests. The group plans to develop an accelerated method or practice for determining the resistance of a coating system to "scab" corrosion. This form of corrosion is of particular concern to the automobile industry and cannot be predicted based on existing accelerated tests. Since a great deal of information has already been developed on testing for this failure, it is felt that a direct discussion with those most familiar with current testing procedures will be very beneficial.

Group 2, Water Tests, G. Grossman, Chairman, has completed screening tests on methods of artificially promoting blistering and a round-robin will be conducted to compare the four current methods used for determining blister resistance of coating systems.

Group 4, Light and Water Exposure Apparatus, S. M. Totty, Chairman, will circulate a questionnaire to D-1 members requesting information on the type of cycles being used with fluorescent-UV/ condensation equipment, end-use of coatings being tested by this method, and any correlation with in-use properties. This information will be used in establishing a practice in D-1 which will be an extension of Practice G-3, but for the specific purpose of testing coatings.

Group 11, Revision of D2485, "Coatings Designed to be Resistant to Elevated Temperatures During Their Service Life," J. Robbins, Chairman, decided to editorially revise the method and keep it on the books. As a result of a negative on a recent D-1 ballot it will be revised and reballoted.

Group 14, Filiform Corrosion, R. DeGraaff, Chairman, anticipates that the revised version of D2803, "Filiform Corrosion Resistance of Organic Coatings on Metal," will be approved by Society ballot and will appear in the next Book of Standards. The group will remain active to determine if a higher temperature will accelerate the development of filiform corrosion to a greater degree.

Group 17, Evaluating Weathering Effects, D. Gleason, Chairman, will direct the next actions toward the revision of D660, "Evaluating Checking," and D661, "Evaluating Cracking," to bring them more in line with the type of failures found with current coating systems.

SUBCOMMITTEE D01.28 BIODETERIORATION

D. L. Campbell, Chairman

Group 1, Package Stability, W. B. Woods, Chairman, discussed a tentative procedure for determining the resistance of latex paint to bacterial attack, using a presumptive challenge test. This method is now used in the cosmetics industry. Four laboratories agreed to participate in a round-robin to evaluate the procedure.

Group 2, Rapid Determination of Enzyme Presence, A. J. Desmarias, Chairman, will distribute to Sub. D01.28 members and other interested persons a revised procedure for detecting both enzymatic redox contaminants in latex paints. The current method requires the use of hydroxyethylcellulose having an M.S. of 2.5. The new procedure will use HEC with an M.S. of 1.5. This lower M.S. material will have less substitution on the polymer backbone, resulting in more rapid degradation of the HEC by cellulytic enzymes. A round-robin will be run prior to the January 1983 meeting. Lumac Systems has a method of determining bacterial presence through the use of ATP analysis. Unpreserved vinyl acrylic paints inoculated with *B. subtilis*, *E. coli*, and *P. aeruginosa* were plated by Hercules and the ATP levels determined by Lumac. Determinations of organisms down to 10^3 were obtained by the ATP method, but results were variable because the microbial growth had not stabilized. Samples of spoiled paint from Tenneco showed no growth when plated out or through ATP analysis. Investigation of Lumac's procedure will continue and, if promising, a round-robin will be suggested.

Group 3, Accelerated Tests, K. A. Haagenson, Chairman, reported that three of the five collaborators have supplied mold ratings for five paints whose mold resistance had previously been studied through the use of the tropical chamber. The paints are exposed vertical north in Florida, Tennessee, and Puerto Rico, and under eave in Tennessee. The purpose of the round-robin is to evaluate correlation between the tropical chamber and environmental exposures. Results of the Tennessee (16 months), Puerto Rico (6 months), and Florida (12 months) exterior exposure studies show some inconsistency with the results of exposures in the tropical chamber. It is anticipated that additional data from the exterior studies will resolve this inconsistency. It is expected that all the data will be collected, analyzed, and presented at the January meeting.

Group 4, Resistance of Paint Films to Attack by Algae, W. B. Woods, Chairman, reported that algae media, test cultures of oscillatoria and coated tongue depressors have been shipped to three collaborating laboratories in preparation for evaluation of a tentative procedure. Several modifications were suggested. Two alternative methods for sanitizing the tongue depressors were proposed: ultraviolet irradiation (15 min at 5 cm from an ultraviolet source) and heat treatment (30 min at 160°F). The light source for promoting the growth will be two 40 watt fluorescent lights. Specimen preparation will be standardized to two dip coatings on the tongue depressors. Four methods of specimen disinfection will be tested as part of the study to determine whether algae can be consistently cultivated on the surface of an unpreserved paint film in the laboratory.

Group 5, Recoating Mildewed Surfaces, D. L. Campbell, Chairman, discussed results of the D0101 letter ballot on the new Standard Guide for Determining the Presence of, and Removing, Microbial (Fungal or Algal) Growth on Paint and Related Coatings. A negative ballot concerning the possible mixture of sodium hypochlorite with a detergent containing ammonia, resulting in the release of toxic gases was found persuasive. All references to use of detergents will be deleted and only trisodium phosphate recommended as a wash. H. E. Ashton recommended the surface be washed first with the 5% TSP solution and then with the 5% aqueous sodium hypochlorite solution, rather than as stated in the third draft of the guide. It was agreed that the order of surface treatment should be reversed. A reference will be added further describing the raised nutrient agar culture medium and a source for it. The revised guide will be submitted for simultaneous Sub. D01.28 and D-1 letter ballot.

SUBCOMMITTEE D01.29 SUBSTRATE PREPARATION FOR COATING TESTING

S. D. Ozenich, Chairman

The subcommittee discussed the need for interlaboratory testing as a first step in developing a method for preparation of sandblasted steel panels for testing. It was determined that in order to assess the uniformity of the preparation method three variables should be looked at first: (1) differences between cleaned and uncleaned substrates prior to blasting; (2) differences between immediate use

and longer term storage of (1) and; (3) use of cold-rolled versus hot-rolled steel as the primary substrate.

To minimize the variables, it was agreed that one laboratory should provide all unblasted test panels to the collaborators along with the instructions for blasting and coating the panels. The coated panels will then be returned to one laboratory for all testing. Testing shall consist of: (1) Elcometer pull-off adhesion, both initially and after exposure testing; (2) Salt Fog test (B117) and; (3) outdoor exposure. Each of the participants (four should be optimum) could provide a coating or system of his choice, of the same batch, to all other participants. Details will be sent to all members of Sub. D01.29 and other subcommittees thought to be interested.

DIVISION 30 PAINT MATERIALS

SUBCOMMITTEE D01.31 PIGMENT SPECIFICATIONS

C. W. Fuller, Chairman

The retirement of K. R. Hancock, Secretary of D01.31, was announced. Task Group chairmen were elected for 13 groups. Specifications and ballot results were reviewed and action taken as follows: D964, "Copper Powder for use in Antifouling Paints," is past due for balloting—an extension will be requested and it will be reviewed for balloting. D480, "Sampling and Testing Aluminum Powder and Paste," is being reviewed for simultaneous ballot later this year, D561, "Standard Specification for Carbon Black Pigment for Paint," will be changed editorially as recommended by H. E. Ashton and be submitted to simultaneous ballot. D1649, "Standard Specification for Strontium Chromate," will be submitted to simultaneous ballot. The question about ISO 2040 differences will be reviewed for possible future changes. D3619, "Standard Specification for Aluminum Silicate Pigments (Anhydrous)," will be submitted to simultaneous ballot. D3721, "Standard Specification for Synthetic Red Iron Oxide Pigment," will be revised to accommodate R. Odenthal's negative vote and to lower the Fe_2O_3 content to 93% from 95%. Editorial additions suggested by H. E. Ashton were also accepted. It will be submitted to simultaneous ballot. D3722, "Standard Specification for Natural Red and Brown Iron Oxides," will be submitted to Society ballot with recommended editorial changes. A composition change will be circulated for Sub. D01.31 consideration as follows: Change matter soluble in water in primer pigments only from 1% to 0.5%—based on response, place on December ballot, D3724, "Standard Specification for Synthetic Brown Iron Oxide Pigment," will be submitted to simultaneous ballot with editorial changes, including deletion of "pure" from the scope.

Eight specifications were assigned for review in 1983. A proposed specification for calcium borosilicate, submitted by W. C. Spangenberg, was approved, after several corrections, for subcommittee ballot.

SUBCOMMITTEE D01.33 VARNISH & RESINS, INCLUDING SHELLAC

A. C. Abbott, Chairman

The chairman reviewed the list of methods under the jurisdiction of Sub. D01.33. Ten methods require subcommittee action this year. One of these methods, D1395, "Abrasion Resistance of Clear Floor Coatings," should be transferred to Sub. D01.42. Extensions will be requested for overdue methods D154, D1395, and D3132.

Group 1, Varnishes, H. A. Ball, Chairman, reviewed the status of D1643, "Gas Checking and Draft Test of Varnish Films," and agreed to recommend that it be submitted to letter ballot for deletion, the same as was recommended in 1979. A review of the status of D1639, "Acid Value of Organic Coating Materials," resulted in the decision to rewrite the method to include most of the suggestions and comments received on the last letter ballot negatives. After submitting for review to those making the suggested changes, it will be submitted to letter ballot. The same procedure will be followed for the revised D1647.

Group 12, Urethanes, R. A. Foss, Chairman, was told that the chairman is no longer able to participate in the subcommittee activities. Current round-robin results on determination of free isocyanate will be compiled and circulated to Sub. D01.33 members and other interested parties. Future round-robins should include standard mono-isocyanates as a part of the submission.

Group 23, Epoxy & Phenolic Resins, P. Kamarchik, Chairman, reviewed results of subcommittee balloting on the new Test for Total Chlorine. Those comments found persuasive will be incorporated in the method. However, three points of a negative from H. Hoehn were found not persuasive. No further work will be conducted on a new method for acid value of phenolics, since D1639 and D3643 are sufficient.

Group 24, Nitrogen Resins, J. H. Smith, Chairman, reviewed the results of the Society ballot on D1597, "Melamine Content of Nitrogen Resins," and D1727, "Urea Content of Nitrogen Resins." A single user has been identified for D1597, with no other interest noted. As a result, J. Smith withdrew her negative , allowing this method to be withdrawn. Editorial comments received from H. E. Ashton on the practice for Testing Amine Resins will be included and the method will be submitted to D-1 letter ballot. The possible need for a test for free formaldehyde was discussed. The chairman will consult the ASTM literature for an available method and solicit methods from suppliers and Sub. D01.33 members.

Group 26, Polymer Emulsions, O. E. Brown, Chairman, presented results of a recent subcommittee survey for a new standard for the determination of nonfilterable solids content (grit) of latex vehicles. Fifteen forms were returned from about 60 sent out. As a result of the comments received it was decided to combine certain elements of the two test methods distributed with the survey forms. The following experimental variables were agreed upon: (1) employ only one mesh size (250 mesh); (2) use disposable screens; (3) use a 1/5 latex/water dilution ratio; (4) reduce the latex specimen quantity to accommodate the 1/5 dilution ratio; (5) base nonfilterable solids content on latex weight rather than on latex solids content; and (6) specify dilution of latex with water rather than addition of latex to water. A revised test will be written and a round-robin will be initiated so that results can be presented at the January meeting.

SUBCOMMITTEE D01.35 SOLVENTS, PLASTICIZERS AND CHEMICAL INTERMEDIATES

L. R. Thurman, Chairman

J. A. Sickmann resigned as secretary of Sub. D01.35, effective the January meeting, due to company realignment. W. J. Frost will replace him.

Group 1, Hydrocarbon Solvents, W. J. Frost, Acting Chairman, was preceded by a meeting of Task Group D01.35.01C on Benzene in Hydrocarbon Solvents which discussed the results of the subcommittee letter ballot on the new "Standard Test for Benzene in Hydrocarbon Solvents by Gas Chromatography." The comments were editorial in nature. The standard will be amended and the task group dissolved. On the ballot on D235, "Specification for Mineral Spirits," E. Morgan's negative asked that Type IV be returned to "exempt" status. A note will be added such as, "Aromatics and olefins may be determined for conformance to regulations and end use." W. Engle's negative against the residual odor specification was voted not persuasive because (1) dry cleaners really need a residual odor specification, and (2) Sect. 4.1 of D1296 for odor allows "suitable intervals" and does not impose a time limit on the test. D3734 received a negative from J. LeBeau because a change in gravity specification from D2935 to D891 resulted in inconsistent language. D891 will be reinstated, so LeBeau's negative was withdrawn. D3735, "Specification for VM&P Naphtha," received a negative from J. Nielson who wanted a Type IV for "exempt" VM&P. This was voted not persuasive because there is a note which addresses the "exempt" status adequately. An improved GC method for aromatics in hydrocarbon solvents using OV-275 columns was discussed. Previous work by D-2 showed poor precision with this method. These columns are excellent for many purposes, but not for a referee method. No further work is planned.

Group 2, Oxygenated Solvents, T. H. Golson, Chairman, reviewed results of subcommittee letter ballots on seven standards. All negatives were resolved and all were recommended for D-1 ballot, except D1296, "Odor of Volatile Solvents and Diluents," which will be submitted to subcommittee ballot after revision for better definition for the use of characteristic odor testing and further clarification of hazards associated with the method.

Results of simultaneous Sub. D01.35/D-1 letter ballots on 12 standards were also reviewed. Of these, the following will be revised and resubmitted to subcommittee letter ballot: D330, "Spec. for 2-Butoxyethanol," D343, "Spec. for 2-Ethoxyethylacetate (95% Grade)," D2916, "Standard Spec. for Isophorone," and D3128, "Standard Spec. for 2-Methoxyethanol." Seven will be sent on to D-1 ballot and one to Society ballot.

Group 3, Chemical Intermediates, L. R. Thurman, Chairman, voted as not persuasive negatives on D1152, D2693, D2694, D2695, and D2696 by R. G. Davis, concerning the use of the term "apparent specific gravity," based on established precedent and the valid definition referenced in D268. Negatives on D2693 and D2695 concerning the lack of a chloride specification (10 ppm maximum), were voted not persuasive because this specification would exclude non-polyester grade ethylene glycol producers and a supporting method for chlorides does not exist. A negative by W. S. Engle on D1152 indicated that the specification for methanol purity at a 99.85% purity minimum did not have sufficient precision to support the standard. This was voted persuasive and W. Johnson and T. Golson were assigned to review the standard.

DIVISION 40 PAINT PRODUCTS APPLIED ON SITE

SUBCOMMITTEE D01.41 CRITERIA FOR THE PURCHASE OF COMMERCIAL PAINTS AND COATINGS

R. A. Brown, Chairman

At the January meeting a motion was made to submit the latest draft of the document, "Standard Guide for Purchasing Interior Flat Latex Paint," or a modified version of it, to Sub. D01.41 ballot. The motion was defeated by a narrow margin with only committee members voting. At a subsequent meeting of the D01.90 Executive Subcommittee in January, it was voted to submit the draft to all persons on the Sub. D01.41 roster, along with the minutes of the January meeting, all round-robin test results, and the letters from R. F. Brady, Jr. and R. A. Brown, which described the GSA and the Paint Industry positions, respectively.

The ballot and information package was mailed on January 28, 1982 with an April 9 deadline for receipt of the ballots. Seventeen negative ballots were received. The chairman suggested to the D01.90 Executive Subcommittee at its meeting on June 20 that the June 21 meeting of Sub. D01.41 be spent in exploring new approaches to the problem of purchasing commercial paints rather than taking the time to resolve all these negatives. Sub. D01.90 concurred.

At its meeting Sub. D01.41 passed a motion to postpone any action on the negative ballots and to mail copies of the negative comments to each member of Sub. D01.41. Action on the negatives is at the option of the chairman, but must take place no later than January 1983. This action was taken because of the impracticality of resolving 17 negatives which the subcommittee members had not read.

W. V. Moseley, Jr., Vice-Chairman of Sub. D01.41, discussed a meeting with GSA officials which he and R. A. Brown attended on May 18, 1982. Moseley was assigned the task of contacting both the Technical and Procurement divisions of the Federal Supply Service of GSA in an attempt to arrange a trial procurement in one of the FSS regions for latex flat wall paint. The trial procedure would involve the use of ASTM D3927, "State and Institutional Purchasing of Paint," or a modification of it.

R. A. Brown will contact the offices of the Housing and Urban Development Agency (HUD) in Washington to learn more about the method used by it to buy commercial paint products and the results obtained.

SUBCOMMITTEE D01.42 ARCHITECTURAL PAINTS

R. H. Rowland, Chairman

Group 1, Wet Abrasion Resistance, M. S. Abriss, Chairman, met to resolve the negatives on the simultaneous ballot on new standard "Test for Wet Abrasion Resistance of Interior Paints by Weight Loss." H. E. Ashton's negative was withdrawn upon agreement to make his editorial change recommendations. Paul Gardner's negative was voted not persuasive on the basis that no data had been submitted to confirm that his scrub tester would give equivalent results to the present scrub tester, either at the specified 37 cycles per minute or the 100 cycles per minute he recommended. It was agreed by the task group that at least two of Mr. Gardner's new scrub testers would be needed for evaluation purposes, in two or more laboratories to obtain reproducibility data, and if the data are warranted, this unit could then be listed in the footnotes to the method as an alternate tester. The method will be submitted to Society ballot.

Group 4, Wet Adhesion, F. Winkelman, Chairman, discussed methods of conducting wet adhesion tests. A number of variables such as substrate type, dry film thickness, age of the coatings prior to testing, recovery time prior to testing, and method of application will need to be addressed, in addition to selecting the method by which the wet adhesion evaluation will be performed. Several cooperators agreed to draft a round-robin procedure. The methods which have been proposed included: (1) Knife Peel Test; (2) a pull-off adhesion test utilizing cheesecloth imbedded in the coating film; (3) a tape adhesion test; and (4) a Balance Beam Scrape Adhesion test.

Group 13, Brushability, J. Desmarias, Chairman, reviewed data presented by four cooperators on a round-robin. The cooperators had difficulty obtaining steady ICI viscosities on the five samples of paint used. There were also insufficient differences between the manual brushability of the samples. Brush and substrate quality were discussed and it was decided to run another round-robin before the January meeting. Two types of brushes will be used, one being the standard polyester brush used previously and another a brush of the cooperators choice conforming to the 2½ inch × 2 inch × 9/16 inch dimensions previously set up. Prior to their shipment to the cooperators, a wall sealer will be evaluated as a primer over the paper substrate in addition to new charts having non-slip surfaces. The better surface will be selected for the round-robin tests. A number of commercial latex paints will be evaluated to obtain a wide range in brushability.

Group 16, Opacity (Practical Method), R Armstrong, Chairman, discussed the results of a round-robin which consisted of roller applying three different paints to paper panels printed with three different gray colored stripes. Repeatability within each laboratory was found to be good while reproducibility by cooperators in different labs was not very good. Different techniques were discussed which could improve the precision of the method. Another round-robin will be conducted using a procedure to distribute the test paints more evenly over the surface of the panels. Those panels evaluated in the previous round-robin were all similar in hiding. This next time paints with differing hiding will be evaluated and ranked.

Group 17, Roller Spatter, J. Price, Chairman, was told that the present method discriminates between paints of varying degrees of spatter in that cooperators obtained results yielding similar rank order. Lab to lab reproducibility in a more absolute sense was lacking. Mechanization of the roller would be necessary to eliminate the differences due to the cooperators motor skills. The group agreed that the test should be kept simple, relatively inexpensive, and left in its present form for comparison purposes. It was decided to restrict the test to latex paints and not include solvent-thinned paints. It was agreed to initiate another round-robin to compare the previously tested notched spool approach and an actual roller cover in order to verify the validity of the notched spool method.

SUBCOMMITTEE D01.44 TRAFFIC COATINGS

R. L. Davidson, Chairman

Group 1, Thermoplastics, D. Miller, Chairman, R. L. Davidson chaired the meeting. A new round-robin will be organized to evaluate various methods of test to include the following: Bond Strength, Directional Reflectance, Softening Point, and Abrasion Resistance. R. Ryan agreed to circulate Cataphote's pressurized abrasive units for the Abrasion test. Hydrocarbon and epoxy thermoplastics will be tested.

Group 2, Traffic Paints, E. B. Countryman, Chairman, agreed to add a statement regarding the cleaning of the rubber O-rings to D711, "Dry to No-Pick-up Time." Three different types of traffic paints with differing drying times have been prepared for distribution to six collaborators to determine the precision of this method. The results of the last round-robin on D1309, "Accelerated Settling," and D869, "Degree of Settling," will be submitted for statistical analysis. It was decided to submit D1309 to D-1 ballot with several changes. D869 will be submitted without any changes. An in-depth discussion of D2205, "Recommended Practices for Testing Traffic Paints," including extensive recommendations by H. Ashton, resulting in a decision to submit a revised version to subcommittee ballot. It was agreed to submit D821, "Degree of Abrasion and Erosion in Road Tests," to ballot for withdrawal since it is not valid when compared to actual road tests. In D913, "Degree of Chipping in Road Tests," it was agreed to eliminate the numbers under the photographs while listing percentages, since the numbers were not consistent with the reference statement in D713.

Group 3, Night Visibility, J. Ritter, Chairman, R. L. Davidson chaired the meeting. Samples will be distributed by J. Ritter to establish precision statements for D1155, "Roundness of Glass Spheres," and D1214, "Sieve Analysis of Glass Spheres." It was voted unanimously that D1213, "Crushing Resistance of Glass Spheres," be submitted to ballot for withdrawal because it is no longer valid. R. L. Davidson distributed a five-page report with sixteen attachments observing the study done in Pennsylvania on various retro-reflectometers versus visual ratings of traffic paints, thermoplastics, catalyzed coatings, and tapes. This study will continue and he will keep the group informed.

Group 6, Glass Bead Retention, E. Kelch, Chairman, will conduct a round-robin on a proposed method for measurement of Glass Bead Adhesion of Traffic Marking Films submitted by W. V. Moseley, Jr., of Virginia DOT.

SUBCOMMITTEE D01.45 MARINE COATINGS

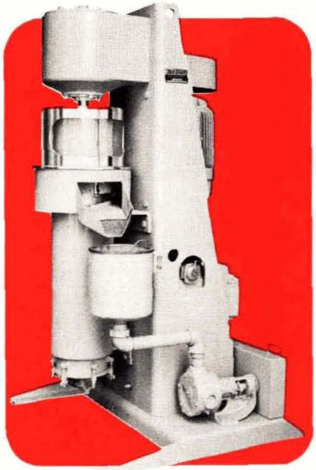
L. S. Birnbaum, Chairman

Group 5, Algae Control, C. D. Stevens, Chairman, studied a report sent by the chairman on setting up two algae test tables. A method for rating antifouling coating algal efficacy was also discussed. One characteristic should be percent of surface area "covered," or more precisely, "attached," and the other should be "intensity," "density," or "thickness" of the growth. Sub. D01.45 members are requested to submit definitions of these terms. D. Stevens will be asked to bring photographs showing algal growth with time on test panels exposed in the new equipment to the next meeting. Anyone else having photos of various degrees of algal fouling should bring them also to consider establishing pictorial standards.

Group 6, Dynamic Testing, D. Laster, Chairman, heard that the goal of dynamic testing is to predict with a small scale the ranking efficacy of different antifouling paints, and, hopefully, the service life of each paint on a ship. Rotating drum tests are underway and C. Perez showed pictures of the first few months' exposure on the unit at Miami Marine Research. D. Laster will write a draft of a rotating drum test method for discussion at the next meeting.

Group 7, Antifouling Rating, C. Perez, Chairman, heard a description of test results to date with pictures of the panels exposed at Miami Marine Research for the round-robin to evaluate the improved rating system for shallow submergence over that given in D3623. To date, only slime and algal spores have been found on the panels. H. Ashton's affirmative comments on the D-1 ballot on reapproval of D3623, "Testing Antifouling Panels in Shallow Submergence," were accepted. Regarding the reference to MIL-P-15328, paragraph 6.2.1 should be changed to "issue D" to be consistent with the 2.2, 8.2 and Table A1.1.

Sub. D01.45 chairman, L. S. Birnbaum, requested comments from subcommittee members on proposed new tasks to develop methods for the following: (1) Surface profile measurement; (2) Evaluating underwater brush cleaning; (3) Measuring release rates of bioactive materials from antifouling coatings; (4) Evaluating ablation rates of ablation coatings; and (5) Inspecting ships for performance of antifouling coatings.



A Fall meeting of Sub. D01.45 is planned, possibly at DTNSROC in Annapolis. A visit to Miami Marine Research is planned in conjunction with the January meeting in Buena Vista, Florida.

SUBCOMMITTEE D01.46 INDUSTRIAL PROTECTIVE PAINTING

D. M. Berger, Chairman

Group 2, Surface Preparation, K. Trimber, Chairman, received a request recently from Navy CEL, Port Hueneme, CA to develop an ASTM counterpart to TT-C-490B, "Cleaning Methods and Pre-treatment of Ferrous Surfaces for Organic Coatings." CEL was advised that there was no one on the subcommittee with the background needed to undertake the project. There was also a question of whether such a method properly belonged in Sub. D01.46.

Group 3, Repainting, D. M. Berger, Chairman, as the first step in writing a standard practice for repainting will obtain a description of a paint identification kit originally developed by Navy CEL and now available commercially from Tinker-Rasor.

Group 4, Pull-off Adhesion Test, A. Cunningham, Chairman, is preparing a fourth draft of a proposed test procedure so that round-robin testing can get underway. Coating systems under consideration for panel testing include MIL-P-2441, a coal tar coating SSPC-Paint/6, a zinc-rich primer with vinyl topcoat, a thin film vinyl of the VR-3 type, and an alkyd selected from a Federal specification.

Group 10, Topcoating Galvanized Steel, No chairman designated. Consensus was reached that the group will use the guide soon to be published in the new edition of Steel Structure Painting Council, Volume I, as a starting point for a standard practice in ASTM format.

SUBCOMMITTEE D01.48 ZINC RICH COATINGS

D. C. Kinder, Chairman

This new subcommittee met with no chairman as yet agreed upon. Subsequent to this meeting D. C. Kinder accepted the appointment. A statement of scope was discussed, with the following being approved by those present: "To develop standards for zinc-rich coatings."

Group 2, Determination of Cure, A. Cunningham, Chairman. In the absence of the chairman, the following was agreed upon: (1) Work being done by ASTM Committee D-33 on developing a standard to determine cure of zinc-rich coatings will be investigated; (2) J. Lanning, of Porter Paint Co., volunteered to evaluate Pencil Hardness and the "Coin" test for determination of cure. An inorganic zinc, spray-applied, and air dried, will be used as a test specimen; and (3) J. Stout, of Hanna Paint, will investigate the Pencil Hardness test and the MEK Solvent Rub test on a baked inorganic zinc-rich primer.

Group 3, Laboratory Evaluation of Zinc-Rich Films, R. H. Wakefield, Chairman, will be presented with a tentative laboratory procedure at the January meeting of the "Circle Test," or "Bullet-Hole Test," by the chairman. J. Everts will report at that same meeting on the SSPC test work involving zinc-rich primer evaluation by the "Bullet-Hole Test" and the V-Notch test.

Group 4, Determination of Volume Solids, met without a permanent chairman. There is need to determine rate of coverage. NACE report T-6A-36 will be obtained and made available for the next meeting. It was proposed that this be written up as an ASTM standard. This should be done by Sub. D01.21.

Group 5, Topcoating, No permanent chairman designated as yet. D. C. Kinder will review the SSPC files on work done to date.

DIVISION 50 PAINTS FOR FACTORY APPLICATION

SUBCOMMITTEE D01.52 FACTORY-COATED WOOD PRODUCTS

R. C. Marck, Chairman

Group B, Hardboard, S. B. Schroeder, Chairman, discussed the need for a test method to predict the performance of field-applied paint on hardboard siding. The chairman presented evidence, which was supported by several committee members, which showed that many of today's housepaints contain surfactants which can attack hardboard, causing swelling and water pick-up. Parallel efforts by the American Hardboard Association were also discussed. Test fence exposures are in progress and will be summarized at the January meeting.

Group 12, Textured Paneling, R. A. Marck, Chairman, has expanded its scope to include textured siding as well as paneling. It was agreed that once the finish has been removed from the substrate, failure of the product is more likely to occur. Preliminary tests removing the coating from the high areas of the textured surface with a Gardner Abrasion Tester and then testing for water pick-up with the Cobb test and Weather-O-Meter® exposure will be undertaken and discussed at the next meeting, along with Oregon State University Tests.

SUBCOMMITTEE D01.53 FACTORY-COATED STRIP METAL (COIL-COATED METAL)

E. E. Haney, Chairman

Group 1, Formability, W. H. Gunn, Chairman. In the absence of the chairman, the meeting was conducted by E. Haney who reported that the method on Formability on Cold Rolled Steel has been issued. An evaluation was to be made for the need of a method for biaxial draw on galvanized steel. It was decided that there is no need, at the present time, for a method to be used with precoated galvanized steel.

Group 2, Cure, K. Luyk, Chairman. E. Haney conducted this meeting also in the absence of the chairman. The need still exists for a good method for cure determination. It was felt the solvent rub method needs to be finished to determine the precision of the method. An effort will be made to complete the present round-robin. Other methods, including the update on the Meseran and IR will be reported at the next meeting.

Group 3, Pretreatments, R. L. Williamson, Chairman, discussed the status of proposed methods of determining phosphate coating weights on cold-rolled steel and zinc substrates. The panels for a round-robin on steel will be in the cooperators hands in the near future. A copy of the method and special instructions will accompany the panels. Work will be started on preparing a method for aluminum to be used with the Portaspec.

At the main subcommittee meeting the title of the subcommittee was discussed. At one time the present title was probably a good one. However, this subcommittee serves the coil coating industry where "factory" and "strip" are not presently common reference terms. It was felt the title should be upgraded the same as the methods are kept up-to-date. It was voted unanimously to change the title to "Coil-Coated Metal." A letter was submitted to the D01.90 Executive Subcommittee for consideration. (Approval for this title change was given by Sub. D01.90 at a subsequent meeting.)

E. E. Haney announced that this would be his last meeting due to his retirement. R. A. Cassel will be the new chairman.

SUBCOMMITTEE D01.55 FACTORY-APPLIED COATINGS ON PREFORMED PRODUCTS

F. Zurlo, Chairman

Group I, Coatings for Wood Products, M. E. Mull, Chairman, discussed D1211, "Cold Check Resistance of Wood Lacquers." A source of test panels has been established (Georgia-Pacific Corp.). Participants for a round-robin are being sought. Test lacquers will be supplied by J. Behrle, of Lilly. The group proposes a thorough study of specifications for test equipment, as well as the test cycle, comprising one cold check cycle, to be made in conjunction with the first round-robin test series. The equipment specifications as to size, number of panels under test in a given piece of equipment, may need to be stated more specifically.

Group 7, Water Reducible Industrial Coatings, F. Zurlo, Chairman, reviewed the third draft of a recommended practice for testing water reducible industrial coatings. Page by page corrections were made. The revised draft will be submitted to subcommittee ballot. There was also a discussion on acid rain resistance of coatings. A test method will be prepared.

SUBCOMMITTEE D01.56 PRINTING INK

J. M. Fetsko, Chairman

Group 6, Ink Tack, C. Shepard, Chairman, that the subcommittee ballot on the new method, "Apparent Tack of Printing Inks by the Inkometer," drew two negatives, both directed at the restrictive nature of the test data used for the precision statement. A round-robin to check this will be run with 10 to 15 cooperators in accordance with ASTM guidelines.

Group 2, Lightfastness of Printed Matter, R. Kinmouth, Chairman, suggested revisions for updating D3424, "Evaluating the Lightfastness of Printed Matter," reapproval of which is overdue. After extensive discussion about the lack of experimental details, it was voted for withdrawal of the method. J. Benson was appointed group co-chairman to examine prevailing practice and to organize a round-robin for development of a new method.

Group 8, Smoke Testing. The chairman having resigned, J. Benson was appointed "guardian" chairman to keep track of pertinent developments since interest in smoke of printing inks has diminished.

Group 9, Tinting Strength, A. Scarlatti, Chairman. In the absence of the chairman, J. Fetsko reported that a survey of the printing ink and pigment industries indicates wide variations in test protocol despite the existence of ASTM and NPIRI standard test methods. R. Johnston-Feller presented a new approach for an instrumental method. The task group will study various approaches for a round-robin to be conducted this Fall.

Group 11, Nonvolatile Matter (of Heat Set Inks), B. Blom, Chairman, reported that, of the several existing ASTM test methods, D1259, "Nonvolatile Content of Resin Solutions," is the only one that operates at the requisite low film thickness. However, the method specifies an oven time of either one-half or two hours, instead of the one hour found optimum for printing inks. Other ASTM methods and modifications thereof were also discussed. H. Robbins will supply samples of conventional and high solids printing inks for a round-robin designed to compare the several existing and modified test procedures.

Group 13, Ink Mileage, B. Blom, Chairman, reported that 10 laboratories participated in an exploratory round-robin on ink mileage of a sheet-fed and heat-set printing ink. Although no test details were prescribed, results were remarkably uniform. H. Robbins and J. Benson will search for inks that give different mileages on a production press. Meanwhile, present participants whose results were out of line were requested to examine possible sources of error.

Group 10, Ink Emulsification, G. Bien, Chairman, reported that additional work was conducted by the three companies who had provided the case history info for the previous round-robin. Excellent results were obtained using a three-point volumetric approach with an in-house fountain solution instead of the previous 10-point gravimetric technique with distilled water. The same companies, plus other volunteers, will now study their own inks with deionized water and a prescribed etching solution containing no additives, isopropanol and a prescribed alcohol substitute.

Group 12, Fineness of Grind, J. Cichon, Chairman, reported that 14 laboratories participated in a round-robin designed to prepare, at the request of ASTM, a precision statement for D1316, "Fineness of Grind of Printing Inks by the Production Grindometer." Preliminary analysis of the results indicates that the four-scratch readings were far more consistent than 10-scratch readings and, in turn, speckle readings. Best differentiation between the four inks was obtained with a new parameter suggested by NPIRI—60° gloss readings with the beam centered on calibration mark No. 2. V. Waltz also reported that a grindometer with deeper and/or wider paths was being utilized for measurements on premixes and liquid ink systems. NPIRI will be requested to investigate the matter further.

SUBCOMMITTEE D01.57 ARTISTS' PAINTS AND RELATED MATERIALS

J. T. Luke, Chairman

Group 1, Preparation of Samples for Colorimetric Determination, H. W. Levison, Chairman, reported that the final draft of the method has been sent for review before being submitted to subcommittee ballot. The accuracy of the "Hand" draw-down method is being reviewed.

Group 2, Lightfastness of Pigments, H. W. Levison, Chairman, reported that "Test Methods for the Lightfastness of Pigments Used in Artists' Paints" will be submitted to subcommittee ballot. There was discussion on an instrument built by Hewlett-Packard that could possibly be redesigned for use in testing artists' colors.

Group 4, Investigation of Test Methods Applicable to the Subcommittee, A. L. Spizzo, Chairman, discussed the fourth draft of the text of the specification and made several changes in it. Several new definitions will be included. The "Pigments Approved for Use in Artists' Fine Oil and Acrylic Paints" was amended to add Category III. Pigments in this category (fading between 8 and 12 ΔE's) would not qualify for the Approved List, but would have relative lightfastness indicated and could have mandatory common names. Pigments such as Alizarine Crimson, Rose Madder, Hooker's Green, etc., would be included. The Ad Hoc Committee on Common Names prepared individual reports for consideration and review. After all had an opportunity for review, agreement was reached on common names to be added to the list. The revision of the Approved List will be sent to all Sub. D01.57 members.

Group 8, Toxicity Determination, W. Stopford, M.D., Chairman. Draft #12 of the "Labeling Specifications for Chronic Toxicity" received one negative vote by Lloyd Flanner of Aerosol System, Inc. After discussion it was voted not persuasive. After adjournment, Roy Conner phoned Mr. Flanner, who withdrew his negative unconditionally after explanation of the group's position.

Elections

BALTIMORE

Active

Becker, Michael J.—Sampson Coatings Inc., Richmond, VA.
Bills, Douglas J.—North American Paint, Baltimore, MD.
Chasan, Alexander A.—US Navy-DTNSRDC, Annapolis, MD.
Grumbine, C. Theodore—Lemar, Inc., Baltimore, MD.
Grumbine, Theodore J.—Contact Paint & Chem. Corp., Baltimore, MD.
Morgereth, Gary A.—Jotu Balto Copper Pain, Baltimore, MD.
Raszewski, Lewis R.—Sherwin-Williams Co., Baltimore, MD.
Sheikh, Muhammad Saied—Rust-Oleum Corp., Hagerstown, MD.
Van Horn, Robert A.—Contact Paint & Chem Corp., Baltimore.

Associate

Dantzer, Robert E.—Rohm & Haas Co., St. Davids, PA.
Grossman, Judith E.—NL Chemicals, Hightstown, NJ.
Kuhl, Joanne L.—W.R. Grace & Co., Baltimore, MD.
Lipskin, Stuart J.—Byk-Mallinckrodt Inc., Chalfont, PA.
Love, Everette H., Jr.—Diamond Shamrock Co., Matthews, NC.
Reitano, Philip A.—Kay-Fries Inc., Montvale, NJ.
Scott, James P., Jr.—Mineral Pigments Corp., Beltsville, MD.
Sears, Henrietta L.—Sherwin-Williams Co., Baltimore.

BIRMINGHAM

Active

Blunston, David W.—Holden Surface Coatings, Birmingham, England.
Boulton, Ian—Shell Chemicals UK, London, England.
Evans, Frederick A.—Blundell-Permoglaze, Birmingham, England.
Morris, John—Lawrence Industries, Surrey, England.
Webb, John P.—Cornelius Chemical Co., London, England.

CHICAGO

Active

Chiang, C. Peter—Sherwin-Williams Co., Chicago, IL.
Hinrichs, Robert L.—Union Chemical Div., Schaumburg, IL.
Karickhoff, Mike—Sherwin-Williams Co., Chicago.
Kost, Eugene R.—Desoto, Inc., Chicago Heights, IL.
Patel, Parmanand—S.C. Johnson & Sons, Inc., Racine, WI.
Rehfeldt, Thomas K.—Sherwin Williams Co., Chicago.
Reimer, Reinhold L.—ECP Corp., Chicago, IL.

Associate

Merrall, Diane M.—BASF Wyandotte Corp., Palatine, IL.
Oberzal, Robert A.—GLS Chemicals, Chicago, IL.
Soni, Bharat—Bunker Ramo Corp., Cicero, IL.

HOUSTON

Active

Bevitz, Laird S.—Gulf Metals Industries, Houston, TX.
Eng, John—Hempel Technology, Houston, TX.
Fields, Mike—Reichhold Chemicals Inc., Houston, TX.
Hendry, C. Malcolm—Hempel Technology, Houston.
Lundquist, Charles M.—Cron Chemical Corp., Houston, TX.
Turpin, Beth—Hempel Technology, Houston.

NEW ENGLAND

Associate

Fahey, Mike T.—General Electric Co., Waterford, NY.
Saad, William T.—General Electric Co., Waterford.

TORONTO

Active

Crosby, Doug—Shell Canada Ltd., Oakville, Ont., Canada.
Lo, Tinbo—PPG Industries Canada, Ltd., Mississauga, Ont., Canada.

Associate

Roycroft, John—Mackenzie and Feimann Ltd., Oakville, Ont., Canada.
Senier, James P.—Nuodex Canada Ltd., Toronto, Ont., Canada.

Meetings/Education

Detroit Society Jointly Sponsors Fall Coating Courses

The Polymer Institute of the University of Detroit, the Detroit Society for Coatings Technology, and the Detroit Paint & Coatings Association are jointly sponsoring coating courses currently being held at the university. Beginning in September, the courses offered include:

"Chemistry of Protective Coatings"—This two-semester course is being offered as a six-credit course which may be used toward a Bachelor's degree or a Graduate degree at the university. Course instructor Dr. T. J. Anagnostou, of Wyandotte Paint Products, Inc., will cover the following subjects: basic polymer concepts, chemistry of fats and oils; drier technology; solvents, pigments; alkyd resins; paint formulation; epoxy resins; elastomers; color in coatings; and powder coating theory.

"Coatings Laboratory"—The seven-week course emphasizes "hands-on" experience as it covers the use and operation of equipment used in quality control and R&D laboratories. Course instructor is Dr. Daniel Klempner, of the Polymer Institute of the University of Detroit.

"Fundamentals of Automotive Paint Systems"—This 12-week session is a comprehensive survey of basic automotive paint raw materials and process systems. *Understanding Paint & Painting Processes,* by Gerald L. Schneberger, will be used. Donald Mordis, of Ford Motor Co., is class instructor.

"Polymer Technology for Coatings"—This 12-week course will include lectures on basic polymer concepts, polymers commonly used in coatings, and the relationship between the structure of the polymers and the properties of the coatings. Pertinent Federation *Series Books* will be used. Class instructor is Dr. David Nordstrom, of Ford Motor Co.

"Principles of Color Technology"—Designed as an introduction for those with no previous education in the field, this seven-week, "hands-on" course will deal with color matching and color control. Robert Perchard, of Inmont Corp., is course instructor.

James J. Kilpatrick To Present Opening Address At NPCA Annual Meeting

One of the nation's foremost journalists and its most widely syndicated columnist, James J. Kilpatrick, will be opening speaker at the National Paint & Coatings Association's (NPCA) annual meeting scheduled for November 1–3 at the Washington Hilton Hotel, Washington, D.C. Mr. Kilpatrick will provide observations on the national and international political scene, drawing from years of experience as a newspaper reporter and editor, a nationally syndicated columnist, an author of books, and a television commentator and panelist.

Mr. Kilpatrick's journalistic career includes 17 years as editor of Richmond, Virginia's prominent daily newspaper, the *Richmond News Leader,* 18 years as author of the syndicated column "A Conservative View," which currently appears in 425 U.S. newspapers, authorship of half a dozen books and regular contribution of articles to both *National Review* and *Nation's Business.*

His television credits include a nine year stint as the conservative spokesperson for the "Point-Counterpoint" segment of *60 Minutes,* acting as critic and commentator for the CBS coverage of the 1980 presidential election and serving as a panelist on the widely syndicated political analysis program *Agronsky & Co.*

Baltimore, New York Societies Hold Coatings Courses

Co-sponsored coatings courses are being conducted this fall by both the Baltimore Society, at Essex Community College, and the New York Society, at a variety of raw material and coating manufacturers' laboratories.

Baltimore

The Baltimore Society offers a non-credit continuing education course in "Basic Coatings Technology" designed to meet the needs of technicians and chemists just entering the coatings industry, as well as marketing, production, and administrative personnel who wish to broaden their background in coatings fundamentals.

Topics being covered include: paint films; resins; solvents and plasticizers; pigments; formulation principles; paint calculations; emerging technologies; and state of current coatings technology.

The course is currently being held at Essex Community College, Baltimore, MD 21237.

New York

The New York Society along with the New York Paint and Coatings Association is currently holding a "Laboratory Course for Paint Technicians." The curriculum covers basic theory, demonstrations, and laboratory exercises for technicians with limited experience who are working in the coatings industry.

A series of lectures presented by experts in the industry are being held at the laboratories of each lecturer's employer. Topics include: film formation and testing of film properties; hiding and extender pigments; dispersion and color pigments; color measurement and theory; rheology and viscosity measurement; emulsion and latex technology; and solvents.

Administrator of the course is Jeffrey Kaye, of Maas & Waldstein Co., 2121 McCarter Hwy., Newark, NJ 07104.

20th CIE Congress Relocated to Amsterdam

The Central Bureau of the International Commission on Illumination (Commission Internationale de l'Éclairage, CIE) has announced with regret the postponement of the Warsaw Quadrennial Congress of the CIE until 1987. Instead, the 20th CIE Congress will be held in the RAI Congress Center, Amsterdam, The Netherlands, from August 31 to September 8, 1983.

The Congress will be held in two parts, each of four days: (1) a Conference including the opening session, invited and contributed papers, and poster presentations, from August 31 to September 3, and (2) Technical Meetings, including the CIE Technical Committee quadrennial meetings, joint and special meetings, and the closing session, from September 5 to 8.

Further information can be obtained from the U.S. National Committee, CIE, c/o National Bureau of Standards, Washington, D.C. 20034.

July Athens Conference Hosts Coatings Scientists from 14 Countries

The Eighth International Conference in Organic Coatings Science and Technology was held in July in Athens, Greece. The conference, sponsored by the State University of New York and the Greek Professional Society and endorsed by the Organic Coatings Division of the American Chemical Society, brought together leading scientists, engineers, industrialists, and educators to discuss all aspects of organic coatings science and technology. Participants from 14 countries of Europe, Asia, and the United States sought to establish more productive programs of research, development and production, and to increase the rate of useful technological innovation through the exchange of ideas and information.

The session's scientific program consisted of 24 invited papers, four contributed presentations, and two seminars on corrosion and critical pigment volume concentration. Papers presented featured topics such as the chemistry of high solids, new UV absorbers, and stabilizers for high solids coatings; corrosion mechanism and new techniques for studying corrosion; metal treatment and surface cleanliness; and thermal analysis of polymers. A session was devoted to the role of critical pigment volume concentration, the stability and energetics of pigment dispersion, and the structure of absorbed polymer layers on pigments. The importance of surface analytical instrumentation was addressed stressing the use of ESCA, Auger Spectroscopy, and related tools to better characterize the properties of the substrate. Other topics covered were radiation curing, clear finishes for wood, liquid and size exclusion chromatography, solvents in coatings, and recent advances in coatings for household appliances.

The conference, founded by Dr. Angelos Patsis, Head of the School of Chemistry and Director of the Materials Research Laboratory at the State University of New York, is already in the planning stages for the next session. Those interested in the advancement of coatings science should explore the possibility of attending or participating by presenting a paper. Information can be obtained by contacting Dr. Angelos Patsis, Head, School of Chemistry, Director, Materials Research Lab., State University of New York, New Paltz, NY 12562, 914-257-2175.

New York Society Cosponsors Basics Coatings Course

A two-semester course on "Understanding the Basics of Coatings, I and II" is being offered by the New York Society for Coatings Technology and the New York Paint & Coatings Association.

The fall semester, which began September 8, covered topics in basic raw materials, such as pigments, oils, solvents, and resins. The spring semester, to be offered in February 1983, will place emphasis on paint formulation and calculations, dispersion techniques, application equipment, and test methods.

The instructor, Don Brody, of Skeist Laboratories, Inc., will conduct the course at the Voorhees Building, New York City Technical College. Cost of the course is $130 per semester.

To obtain further information, or to register, contact Jeffrey Kaye, Maas & Waldstein Co., 2121 McCarter Hwy., Newark, NJ 07104.

IAT to Sponsor Coatings Course, Oct. 17–21

The Institute of Applied Technology (IAT) is offering an intensive course for professionals in the coating work industry October 17–21 in Pittsburgh, PA.

"Nuclear Quality-Assured Coating Work" will combine the latest in theory with the practical knowledge obtained from site inspectors, hands-on practice, and experienced course instructors. The course is designed for the specialist responsible for guaranteeing quality coating work and overseeing costs.

Topics to be included are: coating system design, supervision, and inspection for nuclear power plants, emphasizing NCR, ASTM, NASI, SSPC, NACE, and federal regulations; coating selection for corrosion resistance; and prevention of paint film defects. The course will also highlight QA programming, including: specification compliance, quality assurance documentation, painter and inspection qualification, safety related nuclear coatings, materials inspection and handling, and inspection criteria.

This four-day session is limited to 25 participants to maximize participation. Fee for the course is $675.

For additional information, contact Carmen A. Rivera, IAT, P.O. Box 32331, Washington, DC 20007.

Chromatographic Course To Be Held at KSU

"Fundamentals of Chromatographic Analysis" will be held at Kent State University, Kent, OH, October 18–21. The course is cosponsored by the university's chemistry department and conference bureau, and IBM Instruments.

Designed to provide a coherent overview of chemical separations via chromatographic methods, the session will be directed towards the beginning to intermediate chromatographer. Material will focus on gas, liquid, and thin-layer methods, stressing these three techniques as complementary rather than competing processes. Fundamental information on theory and instrumentation with applications will also be provided.

Course lecturers will include: Dr. Roger K.Gilpin, of IBM Instruments and Adjunct Associate Professor at KSU; Dr. Theodore Provder, Senior Scientist at Glidden Coatings & Resins Div., SCM Corp.; Dr. Fred E. Regnier, Professor at Purdue University; and Dr. Neil D. Danielson, Assistant Professor at Miami University. Instruments will be shown by Ronald L. Lewis, of IBM Instruments.

Additional information can be obtained from Carl J. Knauss, Course Coordinator, Chemistry Dept., KSU, Kent, OH 44242.

'Colloids and Surface Science' Sponsored by University of Minn.

A short course entitled, "Colloids and Surface Science," will be held October 18–22 at the University of Minnesota, Minneapolis, MN.

Designed for persons working with grinding, adhesives, sealants, wetting agents and other lubricants, emulsions and films, pigments, powders, printing inks, and soils and clays, the session will feature lectures, laboratory demonstrations, and problem solving groups. The following topics will be covered: methods of measuring surface tension; contact angles in wettability; characterization of materials by modern surface techniques; flocculation of colloids; electrophoresis; mono dispersed colloids; optical properties of colloids; colloid size, number and charge measurements; and rheology of colloids.

Instructors for the course are D. Fennel Evans, University Professor, and H.T. Davis, Professor and Head of the Department of Chemical Engineering and Materials Science, Institute of Technology at the university.

Fee for the course is $625 which includes test, course notes, laboratory fees.

For further information, contact Mary Walde, Program Associate, Dept. of Conferences, 222 Nolte Center, 315 Pillsbury Dr., S.E., University of Minnesota, Minneapolis, MN 55455, (612) 373-3173.

AFP/SME Announces 'Finishing '83' To Be Held October 11–13, 1983

The Association for Finishing Processes of the Society of Manufacturing Engineers (AFP/SME) will sponsor 'Finishing '83,' October 11–13, 1983, at the Convention-Exposition Center, Cincinnati, OH.

The theme for the fourth conference and exposition for coating and finishing technologies is "Know Your Coating Options for Quality Finishes." Designed to highlight the latest advances in coating methods with emphasis on higher, more consistent quality, the conference will explore electrocoating, wood finishing, paint manufacture, powder coating, radiation curing, water-borne coatings, surface preparation, and environmental/waste disposal. Six, one-day workshops, offered Monday, October 10, will discuss the basics of radiation curing, powder coating, liquid coating, surface preparation, wood finishing, and plastic coating.

Running concurrently with the conference will be the Finishing '83 exposition, focusing on demonstrations of new finishing/coating equipment, materials, and services. Equipment and system categories in the exposition will include surface preparation and cleaning, coating application, quality control and testing, curing, coating materials, material handling, safety, precoated materials and coatings, and engineering services.

Chairperson for the conference is John Ostrowski, Research Director for Valspar Corp., Minneapolis, MN. Dale Williams, of GAF Corp., Hubbard, OH, is serving as Co-Chairperson.

Additional information can be obtained from Susan Buhr, Administrator, SME, One SME Dr., P.O. Box 930, Dearborn, MI. For exhibiting details, contact Daniel Dembicki, Exhibits Development Manager, SME.

DuPont Announces Schedule For Statistical Seminars

The DuPont Co. has announced the schedules for three statistical seminars designed for research scientists, engineers, and others engaged in industrial or academic technical work.

The three courses, "Strategy of Experimentation," "Strategy of Formulations Development," and "Focus on Data," are presented in two-and-a-half day sessions in a variety of locations.

"Strategy of Experimentation"—This course concentrates on the use of statistical tools for effective designed experiments. It emphasizes proven, immediately applicable methods and their use. Students will collect data in workshop sessions using electronic simulators, and will learn to analyze the data and to draw valid conclusions. Dates and locations for the session are: Oct. 19–21—Toronto, Ontario; Nov. 16–18—Boston, MA; and Dec. 7–9—San Francisco, CA.

"Strategy of Formulations Development"—This course offers a practical introduction to the most efficient methods for the design and analysis of mixture experiments. Statistical models will be used to determine the optimum composition of mixtures under study. This session will be held November 9–11 in Houston, TX.

"Focus on Data"—Designed to teach students the three main phases of the data analysis process: exploration, analysis, and communication, the course will present graphical and statistical tools for effective problem solving. The session will include a series of lectures, workshops, and class exercises. Dates and locations for the course are: Oct. 26–28—Boston, MA and Nov. 30–Dec. 2—Cincinnati, OH.

For more information and registration materials, write to DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898.

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Eudowood Gardens, Towson, MD). Ed Countryman, Sherwin-Williams Co., 2325 Hollins Ferry Rd., Baltimore, MD 21230.

BIRMINGHAM (First Thursday—Calthorpe Suite, Edgbaston). D. H. Clement, Holden Surface Ctgs. Ltd., Bordesley Green Rd., Birmingham B9 4TQ, England.

CHICAGO (First Monday—meeting sites in various suburban locations). Fred Foote, U.S. Gypsum Co., 700 N. Rte. 45, Libertyville, IL 60048.

C-D-I-C (Second Monday—Sept., Jan., Apr., June in Columbus; Oct., Dec., Mar., May in Cincinnati; Nov., Feb., in Dayton). Robert A. Burtzlaff, Potter Paint Co. of Ind., P.O. Box 265, Cambridge City, IN 47327.

CLEVELAND (Third Tuesday—meeting sites vary). Ray Podlewski, Mansfield Paint Co., P.O. Box 998, Mansfield, OH 44901.

DALLAS (Thursday following second Wednesday—Steak & Ale Restaurant). T. Leon Everett, Dan-Tex Paint & Ctg. Mfg., Inc., P.O. Box 18045, Dallas, TX 75218.

DETROIT (Fourth Tuesday—meeting sites vary). Peter Burnett, Wyandotte Paint Products, Inc., 650 Stephenson Hwy., Troy, MI 48084.

GOLDEN GATE (Monday before third Wednesday—Alternate between Sabella's Restaurant on Fisherman's Wharf and the Sea Wolf at Jack London Square, San Francisco). Robert Miller, Frank W. Dunne Co., 1007 41st St., Oakland, CA 94608.

HOUSTON (Second Wednesday—Sonny Look's, Houston, TX) Richard D. Batchelor, Valspar Corp., 2503 W. 11th St., Houston, TX 77008.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). Gene Wayenberg, Tnemec Co., Inc., P.O. Box 1749, Kansas City, MO 64141.

LOS ANGELES (Second Wednesday—Steven's Steak House, Commerce, CA). Michael Gildon, Guardsman Chemicals, 9845 Miller Way, Southgate, CA 90280.

LOUISVILLE (Third Wednesday—Howard Johnson's, Louisville, KY). W. Jerry Morris, Celanese Plastics & Specialties Co., P.O. Box 99038, Jeffersontown, KY 40299.

MEXICO (Fourth Thursday—meeting sites vary). Teresa Suarez, Sherwin-Williams Co., Mexico, D.F., Mexico.

MONTREAL (First Wednesday—Bill Wong's Restaurant). M. Megelas, International Paints Ltd., P.O. Box 190, Outremont, Que., Can., H2V 4M9.

NEW ENGLAND (Third Thursday—Fantasia Restaurant, Cambridge). Charles J. Hoar, Union Chemicals Div., 67 Walnut Ave., Clark, NJ 07066.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). Michael Iskowitz, Koppers Co., Inc., 480 Frelinghuysen Ave., Newark, NJ 07114.

NORTHWESTERN (Tuesday after first Monday—Boulevard Cafe, Golden Valley, MN). Robert Mady, George C. Brandt, Inc., 2975 Long Lake Rd., St. Paul, MN 55113.

PACIFIC NORTHWEST (Portland Section—Tuesday following second Wednesday; Seattle Section—the day after Portland; British Columbia Section—the day after Seattle). William Shackelford, Gaco-Western, Inc., P.O. Box 88698, Seattle, WA 98188.

PHILADELPHIA (Second Thursday—Riverside East, Philadelphia, PA). William Georgov, J.M. Huber Corp., P.O. Box 310, Havre de Grace, MD 21078.

PIEDMONT (Third Wednesday—Howard Johnson's Coliseum, Greensboro, NC). James E. Husted, Mobil Chemical Co., P.O. Box 2438, High Point, NC 27261.

PITTSBURGH (First Monday—Skibo Hall, Carnegie Mellon Univ.). Clifford Schoff, PPG Industries, Inc., R&D Center, P.O. Box 9, Allison Park, PA 15101.

ROCKY MOUNTAIN (Monday following first Wednesday—Gusthaus Ridgeview, Lakewood, CO). Luis O. Garcia, Kelly-Moore Paint Co., 3600 E. 45th Ave., Denver, CO 80216.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant). William Truszkowski, Mozel Chemical Products Co., 4003 Park Ave., St. Louis, MO 63110.

SOUTHERN (Gulf Coast Section—Various Dates; Central Florida Section—Third Thursday after first Monday; Atlanta Section—Third Thursday; Memphis Section—Second Tuesday; Miami Section—Tuesday prior to Central Florida Section). S.G. Sanfilippo, Reichhold Chemicals, Inc., Technical Services Lab., P.O. Box 1610, Tuscaloosa, LA 35401.

TORONTO (Second Monday—Cambridge Motor Hotel). R.H. Stevenson, Tenneco Chems., Canada Ltd., 235 Orenda Rd., Bramalea, Ont., Can., L6T 1E6.

WESTERN NEW YORK (Third Tuesday—The Red Mill, Clarence, NY). Donald M. Kressin, Spencer Kellogg Div., Textron, Inc., P.O. Box 210, Buffalo, NY 14225.

Macbeth Color Seminars Are Scheduled for 1982–83

Macbeth, a Div. of Kollmorgen Corp., Newburgh, NY, will sponsor its seminar, "The Fundamentals of Color," at locations throughout the United States and Canada.

Held for the fifth straight year, the seminar will be divided into two one-day sessions which present a solid foundation in basic color science, providing a clear understanding of the problems and solutions associated with the measurement, specification, and control of color.

The first day of the seminar is devoted to lectures and practical demonstrations in the use of visual standards, controlled lighting and viewing conditions, and color measurement instrumentation. The fee for the first day is $125 which includes reference materials, workbooks, and lunch. The second day, for which there is no fee, provides the opportunity to apply color science theory in a "real world" hands-on session using lighting control and instrumentation.

The locations and dates are as follows:

Oct. 21–22	Denver, CO
Nov. 18–19	Cincinnati, OH
Jan. 13–14	Los Angeles, CA
Feb. 3–4	Miami, FL
Feb. 24–25	Houston, TX
Mar. 10–11	Birmingham, AL
Mar. 24–25	Charlotte, NC
Apr. 14–15	Seattle, WA
Apr. 28–29	Don Mills, Ont., Can.
May 12–13	Newton Lower Falls, MA
May 19–20	Cherry Hill, NJ
June 2–3	Rosemont, IL

In addition to the above schedule, arrangements can be made for an in-house presentation of the seminar.

Additional information and application forms can be obtained from Jeanne M. Dolan, Macbeth, Little Britain Rd., P.O. Box 950, Newburgh, NY 12550.

FUTURE SOCIETY MEETINGS

Note to all Society Program Chairmen:

All Program Chairmen are urged to forward their Society's meeting agenda for the 1982–83 meeting season to Federation headquarters as soon as possible.—Ed.

People

Elder C. Larson, Senior Research Chemist at Shell Development Co., Houston, TX, retired July 31 after 48 years with the firm. Mr. Larson, a Past-President of the Federation (1980-81), serves on the Federation's Board of Directors, and was a member of the Finance Committee, and the Editorial Review Board. He is a Past-President of both the Golden Gate and Houston Societies and was Program Committee Chairman of the Federation's 1977 Annual Meeting. He is an Honorary Member of the Houston Society.

Mr. Larson and his wife, Margaret, will remain in the Houston area.

Dr. William H. Brendley, Jr., Industrial Coatings Department Manager at the Rohm and Haas Company's research staff, Spring House, PA, has been cited by the firm for his development of improved powder coatings. His research has resulted in a patent issuance to the company. Dr. Brendley, a graduate of St. Joseph's University, received his Ph.D. from the University of Pennsylvania in 1965. He is a member of the Philadelphia Society and has served on the Federation's Editorial Review Board for the *Journal of Coatings Technology*. Dr. Brendley is also associated with the American Chemical Society and the Polymer Organic Coatings Division.

William E. Mahoney was named Vice-President of Sales and Marketing for the Humko Chemical Division of Witco Chemical Corp. Mr. Mahoney assumes responsibilities for the newly combined sales and marketing departments of Humko Chemical, Memphis, TN.

Nalco Chemical Co., Oak Brook, IL, has announced the re-assignment of **Richard E. Myers** to Division Vice-President, Corporate Sales. Mr. Myers began his career with Nalco in 1964 as a Sales Representative in the Water Treatment Chemicals Group. In 1966, he was appointed Area Manager and two years later became District Manager. He advanced to Sales Manager and was named General Manager of the WATERGY Group in 1977.

Also announced by the firm were the promotions of **Richard A. Storrs** and **Louis A. Goretta** to Technical Directors, Customer Analytical Services and Divisional Analytical Department, respectively.


E.C. Larson


W.H. Brendley


S. Augoustatos


C.M. Hendry

Steve Augoustatos, formerly of Sherwin-Williams Co., has been appointed Executive Vice-President and Chief Operating Officer for Illinois Bronze Paint Co., Lake Zurich, IL.

Roger H. Doering has been named Manager—Technical Information for SCM—Glidden International Co. He will be responsible for coordinating the release and exchange of technical data of the firm's coatings technologies to the company's licensees and export customers. Prior to his appointment, Mr. Doering served as Technical Manager—Electrocoat Research and Development. He is a member of the Cleveland Society.

Air Products and Chemicals, Inc., Allentown, PA, has named **Richard L. Westbrook** Midwest Regional Sales Manager for the Polymer Chemicals Division.

Ronald G. Falk has been appointed National Sales Manager of the Solvents & Intermediates Division of Union Carbide Corp., Danbury, CT.

Whaite M. Clark has been named Vice-President—Research and Development for Whittaker Corporation's Chemicals Group. Mr. Clark will assume responsibility for supervision of all product development programs, and coordination of technology transfer between the group's Research Center in Colton, CA and division technical laboratories in the U.S.

Also announced by the firm was the promotion of **Omar K. Skiver** to the position of Vice-President—Marketing, Coil and Extrusion Coatings. Mr. Skiver is a Past President of the National Coil Coaters Association and currently serves as a member on its board of directors.

Hempel Technology, Inc., a corporate research and development laboratory for Hempel's Marine Paints, has been opened in Houston, TX. Named General Manager of the laboratory was **Dr. C. Malcolm Hendry,** former Vice-President and Technical Director of Napko Paint. Dr. Hendry brings to Hempel Technology 35 years of R&D experience. He is a member of the Houston Society, serves as Vice-President of the Paint Research Institute, and is associated with NACE and SSPC.

The Chemical Products Division of Cargill, Inc. has announced the appointment of **Donald I. Jordan** to Western Region Sales Manager of the resins group. In this new position, Mr. Jordan will assume responsibility for sales of coating resins and unsaturated polyester resins in 11 western states, working out of the firm's Lynwood, CA office. Mr. Jordan is a Past-President and current member of the board of directors of the Los Angeles Society for Coatings Technology. He is also a member of the Golden Gate Society, the SCPCA and the GGPCA.

King Industries, Inc., Norwalk, CT, has appointed **Robert F. Baker** to the position of Marketing Manager, responsible for coordinating the firm's sales and marketing activities in the lubricant additive and chemical coatings industries.

David Einstein has joined The Mearl Corp., New York, NY, in its International Sales Department. He will assist in the administration of all export sales involving pearlescent pigments and related products.

James W. White has been appointed Sales Representative in the Chicago area for Myers Engineering.

Federation Past-President Neil S. Estrada, of Reichhold Chemicals, extended the respects of the Federation to the membership of the Australian OCCA recently at their annual meeting.

The Organics Division of Witco Chemical Corp., Houston, TX, announced the appointment of **Dr. William R. Proops** as Vice-President and Technical Director of the Division. Dr. Proops, formerly head of research and development for Witco's Isocyanate Products Div., is a member of the American Chemical Society.

Joseph Mazia has retired as Editor of *Metal Finishing* to re-enter the engineering services/communications and consulting business. His new firm, Mazia TechCom Services, is headquartered at 8401 Freyman Dr., Chevy Chase, MD. As time permits, Mr. Mazia will write for the coating industry media and continue to lecture on subjects pertinent to the organic finishes field.

Jeffrey R. Hamilton has been appointed Technical Sales Representative for the Pigments Division of Sun Chemical Corp.

William J. Freund was named Director, Global Specialty Chemicals for Johnston Wax, Racine, WI. He replaces **S.W. Cairns** who assumed a new position with the firm. Mr. Freund is a member of the Chicago Society.

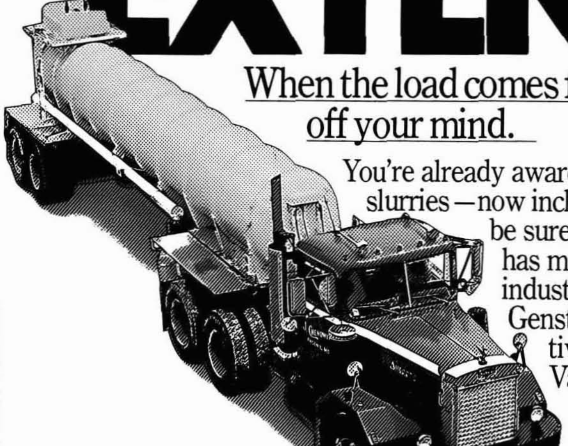
Paul F. Buchik has been appointed Market Manager for the Union Chemical Div., Union Oil of California, Schaumburg, IL.

Frank A.J. Creyaufmiller has been named to the position of Technical Sales Representative for the Industrial Coatings Division of H.B. Fuller Co., St. Paul, MN.

Obituary

Harold A. Wakefield, Sr., 85, who was associated with Imperial Color & Chemical Corp. for 35 years, died on May 8, at his home in Glens Falls, NY. He joined Imperial (which later became a department of Hercules Incorporated) in 1930 and was promoted to New York Sales Manager in 1933. He moved to Glens Falls in 1947 and retired in 1965.

George C. Robbins, 81, former President of Robbins Varnish Co., St. Louis, died on July 23. The company was founded in 1949 and closed upon Mr. Robbins' retirement in 1965. He was President of both the St. Louis Society and PCA.



Literature

Gauges

Information is available which features a pocket-sized portable electronic thickness gauge for measuring any dry nonconductive coating and a low cost magnetic coating thickness gauge that measures dry film thickness of any nonmagnetic material applied to a ferrous base. Contact Frank Rueter, Vice-President Marketing, Zorelco Ltd., P.O. Box 25468, Dept. M-29, Cleveland, OH 44125 for additional information.

Strainers

A new 12-page, four-color bulletin describing a line of self-cleaning V-Auto™ strainers is now available. Design, features, and typical applications of the strainers are highlighted. For copies of the bulletin, contact C-E Bauer, Combustion Engineering, Inc., P.O. Box 968, Springfield, OH 45501.

Esterdiol Specialty Intermediate

A six-page technical booklet on Esterdiol-204, a specialty product for the production of resins and intermediates, has been issued. Recommended uses, physical properties, specifications, and shipping data are listed. Storage and handling, safety and health considerations are also discussed. Copies of "Esterdiol-204," designated F-42126B, can be obtained from Union Carbide Corp., Specialty Chemicals and Plastics Div., Dept. M1552, Danbury, CT 06817.

Supplied-Air System Components

Literature describing a line of supplied-air system components has been published. The two-page, two-color sheet provides photos and descriptive text on the six components, designed for continuous service with minimum maintenance. Component specifications are also detailed. For copies of the data sheet, contact Racal Airstream, Inc., 7309A Grove Rd., Frederick, MD 21701.

Paint Spraying System

A new paint spraying system for the professional and industrial markets that can cut material costs as much as 70% has been announced in recent literature. Operational techniques and design of the CAP Spray are highlighted. For information, contact Control Air Products, 2665 152nd St. E., Rosemount, MN 55068.

Calculation Techniques

The Paint Research Association is offering "Calculation Techniques in the Formulation of Alkyd and Related Resins." This Special Publication demonstrates various calculation techniques by specific examples, comments on related general principles, and offers practice examples for handling calculations. Contents include: useful equations and definitions; essential theory dealing with basic concepts, functionality and average functionality, molecular weight and gelation, and the Flory approach; basic chemical arithmetic; theory and practice of gelation; formulating to chosen parameters; formulating a series of resins; and some special cases. Also featured is an appendix discussing the use of programmable calculators and minicomputers. For information, contact Mrs. Caroline Veitch, Publications Coordinator, Information Dept., PRA, Waldegrave Rd., Teddington, Middlesex TW11 81 D.

Clays

Literature is available which features two new densified rubber grade kaolin clays in low density polyethylene bags and in bulk form. Described are the organofunctional NUCAP® 100-W, which is recommended as a partial replacement for carbon black, and POLYFIL® OM, a high surface area hard clay, which is recommended where low die build-up is critical. For additional information, contact J.M. Huber Corp., Clay Div., Marketing Services, Rt. 4 Huber, Macon, GA 31201.

Microcomputer

Model 711 Microcomputer, based on the Zenith/Heath Z-89 and which controls up to three pumps and produces virtually any type of gradient or flow profile, is the subject of recently published literature. For information, contact The Anspec Co., Inc., P.O. Box 7730, Ann Arbor, MI 48107.

Temperature Indicator

A precision digital temperature indicator, TherMonitor Model TI-100, designed for use with all models and ranges from 0 to 4000°F, is featured in new literature. Application uses and special features of the Model TI-100 are highlighted. For information, contact Linear Laboratories, 445 S. San Antonio Rd., Los Altos, CA 94022.

Oxygen Analyzer

A compact flush panel mounted digital oxygen analyzer designed to monitor, analyze, and provide alarm contacts and a controlling output signal for a wide variety of process analysis and safety applications is the subject of recent literature. Contact Neutronics, Inc., 450 Drew Court, King of Prussia, PA 19406 for more information.

Hot Plate/Stirrer

Information is available which features a new laboratory hot plate/stirrer which gives the user control of temperature, stir speed, and time. Detailed descriptions, operations, and programs of the Dataplate Hot Plate/Stirrer are highlighted. For information, contact Paul N. Gardner Co., Inc., 218 Commercial Blvd., Suite 205, Lauderdale By-The-Sea, FL 33308.

Color Measurement

Measurement techniques for a fluorescent specimen which measures in a normal fashion and a fluorescent specimen whose peak is above 120% reflectance have been described in HunterLab's *Applications Notes.* For a copy, contact HunterLab, Hunter Associates Laboratory, Inc., 11495 Sunset Hills Rd., Reston, VA 22090.

Dimer Amines

Two dimer amines suggested as chemical intermediates, extenders, and crosslinking agents in polymeric and epoxy resin systems and as corrosion inhibitors are discussed in recently published bulletins. Kemamine® DP-3680 dimer diprimary amine and Kememine DD-3680 dimer diamine are featured as are their abilities to enhance flexibility in finished resins and their corrosion resistance and adhesion properties. Highlighted are the dimer amines suggested uses, specifications, and safety and handling data. Bulletins AMN:531 and AMN:533 are available from Humko Chemical Div., Witco Chemical Corp., P.O. Box 125, Memphis, TN 38101.

Exterior Vehicle

A new water-reducible exterior vehicle for air-dry waterborne wood coatings and stains, clear coatings for light-duty concrete compounds and light-duty maintenance coatings is the subject of recent literature. Suggested uses, applications, specifications, and formulations of the type 7350 water-reducible exterior vehicle are noted. For further information, write to Research Dept., Cargill, Inc., P.O. Box 9300, Minneapolis, MN 55440.

Products Directory

The revised and improved second edition of the Paint Research Association's "Paint and Pretreatment Products Directory" has been published to bring readers up to date with new products and profits from the experience of users of the first edition. Listed are the products of UK paint companies and over 3000 trade names which are grouped alphabetically in 12 main sections. Names, addresses, and telephone numbers of the manufacturers are given. For information, contact Mrs. Caroline Veitch, Publications Coordinator, Information Dept., PRA, Waldegrave Rd., Teddington, Middlesex TW11 8LD.

Aerosol Testing

Information is available on an aerosol testing customer service which helps manufacturers test aerosol products and produce improved formulations for existing and potential products. Any users of Aerothene™ MM and Aerothene™ TT solvents in the paint and coatings industries may use the service as often as desired. The accuracy of the testing, coupled with diversified technical service, can help manufacturers upgrade production and lower costs. For information about the free aerosol analysis service, write Dow Chemical Co., Aerosol Analysis, Inorganic Chemicals Dept., 2020 Dow Center, Midland, MI 48640.

Filling Machine

A brochure describing Spectrum I, a new automatic filling machine for liquids which employs electronic circuits to monitor the amount of liquid that enters the container and eliminates major complications inherent in machines using mechanical means to control fill height, is available. Write, Beltron Corp., P.O. Box 893, Red Band, NJ 07701.

Homogenizers

Literature has been published which features a new line of in-line homogenizers that cover a wide variety of industrial uses. Highlighted are the homogenizer's uses, design, operations, and sizes. Contact Premier Mill Corp., New York, NY.

Attritor

The Q-100 Attritor which grinds and disperses materials in quantities of thousands of gallons at a time, much faster than a ball mill, is featured in recent literature. Advantages and design of the attritor are listed. For information, contact Union Process Inc., 1925 Akron-Peninsula Rd., Akron, OH 44313.

SSPC Painting Manual

Volumes 1 and 2 of the Steel Structures Painting Manual have been completely revised and are available from the Steel Structures Painting Council. Volume 1, "Good Painting Practice," which has for 30 years been the "bible" in protective anti-corrosive coatings, has been modernized. The renewal was carried out by a group of editors and individual authors who are among the outstanding leaders in coatings technology, surface preparation, and protective coatings practice throughout the industry. Each chapter, after preparation, has had further input from a separate industry panel, so as to represent the best available expertise in the technology. Volume 2, "Systems & Specifications," in its first major revision in the last 18 years, has been updated to replace the current edition. It has been streamlined and modernized with respect to guides and specifications for surface preparation, paint application, maintenance, safety, paints, and painting systems. It now represents combined performance/composition-oriented specifications for applicable types of coatings and provides a basis for choice among alternatives. These guides and specifications are the cooperative product of both the professional SSPC staff and of the open SSPC volunteer consensus committees chosen to represent the authorities in all of the affected areas. They can be ordered, either separately ($45 for each volume) or in combination ($78) from the SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213.

Fatty Amides

Composition, performance, and applications of an extensive line of fatty amides suited to the wide-ranging plastics and wax additive and lubricant needs of chemical industry users are discussed in a new four-color brochure. Individual products within primary and secondary amide and ethylenebisamide categories are described by composition, physical properties, and solubility. Major application areas for these fatty amides are detailed and illustrated. They include uses as slip, antiblock and mold release agents in plastic resins systems, defoamer and water repellent components in industrial and household applications, and lubricating and property-improving agents in printing inks, metals, waxes, asphalts, paints and coatings, petroleum products, textiles, detergents, and cleaners. FDA-accepted uses are listed in a reference table, and information on proper handling is also provided. Copies of the brochure are available from Humko Chemical Div., Witco Chemical Corp., P.O. Box 125, Memphis, TN 38101.

Directory of Governmental Air Pollution Control Agencies

The Air Pollution Control Association (APCA) has published the 1982 edition of its Directory of Governmental Air Pollution Control Agencies. The Directory provides current information on air pollution control agencies in the United States and Canada at the federal, state, provincial, and local governmental levels. The soft-bound publication lists full names, titles, addresses, and telephone numbers with the names of the heads of each agency housing the control program, heads of intermediate departments where relevant, and operating heads of control programs, as well as brief descriptions of supplementary personnel. Published annually, the Directory is produced in cooperation with the U.S. Environmental Protection Agency Office of Air Quality Planning and Standards. The 72-page publication is available to APCA members for $3 and to nonmembers for $4. All orders must be prepaid and mailed to: Publications Dept., APCA, P.O. Box 2861, Pittsburgh, PA 15230.

NPCA Brochures

Six, four-color brochures providing complete step-by-step information that can help the novice do-it-yourselfer achieve professional results are available from the National Paint and Coatings Association. Titles of these consumer aids include: "Painting Interiors," "Painting Exteriors," "Choosing Paint Colors," "Finishing Wood Furniture," "Preventing Moisture Damage," and "Paint Tricks, Techniques, and Treatments." For cost and ordering information, contact Kathy Haley, NPCA, 1500 Rhode Island Ave. NW, Washington, DC 20005.

Copolymers

Literature is available on a new line of copolymers for modification of portland cement coatings. Featured are their recommended uses and key advantages. Further information may be obtained from Henley & Co., 750 Third Ave., New York, NY.

Guide Rollers

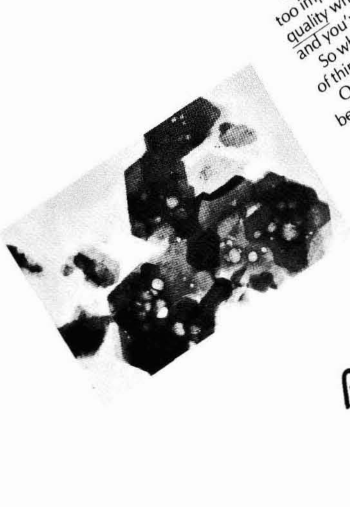
A new two-page bulletin entitled, "Ferro-Tic Rod Mill Guide Rollers," has been recently published. Described are the features, advantages, and characteristics of the guide rollers made from Ferro-Tic alloy bonded titanium carbide. To obtain a copy, contact the Sintercast Div., Chromalloy Metal Tectonics Co., 169 Western Hgwy., West Nyack, NY 10994.

"Powder Coatings Bulletin"

"Powder Coatings Bulletin," a monthly newsletter formerly published by Elsevier International, is now being published by S.T. Harris (P.C.C.) Ltd., The Old Rectory, Nether Whitacre, West Midlands, B46 2DU, England. Mr. Harris stated that the bulletin will contain up-to-date information on new developments and trends in the world-wide market and on-the-spot reporting from all geographical locations. A prompt information service will be provided to assist subscribers to locate sources of raw materials, equipment, toxicity data, and other market features. The subscription fee is $150 per year.

Coating Products

Updated information on the Liquinite® series of coating products has been issued. Included are new data sheets for coating powders based on polyphenylene sulfide (PPS), fluorinated ethylene-propylene (FEP), ethylene-tetrafluoroethylene (ETFE), modified ethylene-chlorotrifluoroethylene (ECTFE), ECTFE, and polyvinylidine fluoride (PVF_2). Data sheets on Liquichem® PVF_2 liquid Coatings and Liquituf® PPS and PPS/PTFE liquid systems also have been up-dated. Information on any or all of the Liquinite series is available from the Coating Products Dept., LNP Corp., 412 King St., Malvern, PA 19355.



Coming Events

FEDERATION MEETINGS

(Nov. 3–5)—60th Annual Meeting and 47th Paint Industries' Show. Sheraton Washington Hotel, Washington, D.C. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

1983

(Apr. 26–27)—Federation Seminar on "The Efficient Operation of an Up-to-Date Paint and Coatings Laboratory." Hilton Plaza Inn, Kansas City, MO. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

(May 19–20)—Spring Meetings. Society Officers on 19th; Board of Directors on 20th. Terrace Hilton Hotel, Cincinnati, OH. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

(Oct. 12–14)—61st Annual Meeting and 48th Paint Industries' Show. Queen Elizabeth Hotel, Montreal, Quebec, Canada. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

SPECIAL SOCIETY MEETINGS

1983

(Feb. 7–9)—10th Annual "Water-Borne and Higher-Solids Coatings" Symposium sponsored by the Southern Society for Coatings Technology and the University of Southern Mississippi. New Orleans, LA. (Dr. Gary C. Wildman, University of Southern Mississippi, Southern Station, Boxz 5165, Hattiesburg, MS 39406).

(Feb. 23–25)—16th Biennial Western Coatings Societies' Symposium and Show. Hyatt Regency, San Francisco, CA. (Ted Favata, Chairman, Triangle Coatings Co., 2222 Third St., Berkeley, CA 94710).

(Mar. 22–23)—"Advances in Coatings Technology." 26th Annual Technical Conference of the Cleveland Society for Coatings Technology. Baldwin-Wallace College, Berea, OH.

(Mar. 23–25)—Southern Society Annual Meeting. Peabody Hotel, Memphis, TN. (William E. Early, Piedmont Paint Mfg. Co., P.O. Box 6223, Stn. B, Greenville, SC 29606).

(Apr. 13–15)—Southwestern Paint Convention, Anatole Hotel, Dallas, TX.

(May 5–7)—Pacific Northwest Society Symposium. Thunderbird Inn, Portland, OR. (Chairman Gerry McKnight, Lilly Industrial Ctgs. Inc., 619 S.W. Wood St., Hillsboro, OR 97123).

(June 10–11)—Joint meeting of Kansas City and St. Louis Societies. Holiday Inn, Lake of the Ozarks, MO.

OTHER ORGANIZATIONS

(Oct. 17–21)—Nuclear Quality-Assured Coating Work Course sponsored by the Institute of Applied Technology, Pittsburgh, PA. (Carmen A. Rivera, IAT, P.O. Box 32331, Washington, DC 20007).

(Oct. 18)—"Fire Resistant Coatings: The Need for Standards" Symposium. Philadelphia, PA. (Symposium Chairman Dr. Morris Lieff, County College of Morris, Dover, NJ 07801).

(Oct. 18–21)—"Fundamentals of Chromatographic Analysis" Short Course. Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., KSU, Kent, OH 44242).

(Oct.18–22)—Scanning Electron Microscopy and X-Ray Microanalysis: Theory and Practice in Materials Science" Short Course. State University of New York, New Paltz, NY. (Dr. Angelos V. Patsis, Dept. of Chemistry, SUNY, New Paltz, NY 12561).

(Oct. 19–21)—"Strategy of Experimentation" Seminar. Toronto, Ont., Canada. (DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898).

(Oct. 21–22)—"Fundamentals of Color" Seminar. Denver, CO. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Oct. 25–29)—Hazardous Materials Workshops and Exposition. Cincinnati's Convention Center, Cincinnati, OH. (Hazardous Materials Management Association, 1406 Third National Bldg., Dayton, OH 45402).

(Oct. 26–27)—"New Coatings Systems for Bridges and Steel Structures" World Congress. LaGuardia Marriott Hotel, East Elmhurst, NY. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Oct. 26–28)—"Focus on Data" Seminar. Boston, MA. (DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898).

(Oct. 31–Nov. 2)—"Women in Coatings—Meeting the Challenges" Seminar. Washington, D.C. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, University of Missouri–Rolla, Rolla, MO 65401).

(Nov. 1–3)—National Paint and Coatings Association. 95th Annual Meeting. Washington Hilton Hotel, D.C. (Karen Welch, NPCA, 1500 Rhode Island Ave. N.W., Washington, D.C. 20005).

(Nov. 1–3)—"Water-Soluble Polymers: Synthesis, Structure, and Applications" Short Course. State University of New York, New Paltz, NY. (Dr. Angelos V. Patsis, Dept. of Chemistry, SUNY, New Paltz, NY 12561).

(Nov. 1–4)—"Understanding Polymer Science: Synthesis, Characterization, Properties" Short Course. State University of New York, New Paltz, NY. (Dr. Angelos V. Patsis, Dept. of Chemistry, SUNY, New Paltz, NY 12561).

(Nov. 3–4)—Resins and Pigments Exhibition. Hotel Nikko de Paris. Paris, France. (Polymers, Paint & Colour Journal, Queensway House, Redhill, Surrey, RH1 1Qs, England).

(Nov. 8–10)—Sixth International Technical Conference on Polymers sponsored by the Mid-Hudson Section of the Society of Plastics Engineers, Inc. Nevele Country Club, Ellenville, NY. (General Chairman Dr. Maung S. Htoo, IBM Corp., Dept. 350-001-1, P.O. Box 950, Poughkeepsie, NY 12602).

(Nov. 9–10)—"Electrocoat/82". Drawbridge Inn, Greater Cincinnati Airport Area, Cincinnati, OH. (*Products Finishing* Magazine, 600 Main St., Cincinnati, OH 45202).

(Nov. 9–11)—"Refresher for Painting Contractors, Maintenance Engineers and Inspectors" Short Course. Sheraton St. Louis Hotel, St. Louis, MO. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, University of Missouri–Rolla, Rolla, MO 65401).

(Nov. 9–11)—"Strategy of Formulations Development" Seminar. Houston, TX. (DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898).

(Nov. 10–12)—First International Technical Conference on Polyimides sponsored by the Mid-Hudson Section of the Society of Plastics Engineers, Inc. Nevele Country Club, Ellenville, NY. (General Chairman Julius M. Schiller, IBM Corp., D/2K3, B/032-1, Boca Raton, FL 33432).

(Nov. 12–14)—National Decorating Products Association 35th Annual Show. Superdome, New Orleans, LA. (Lillian Smysor, NDPA, 9334 Dielman Industrial Dr., St. Louis, MO 63132).

(Nov. 14–19)—"Basic Corrosion" Short Course sponsored by the National Association of Corrosion Engineers, Houston Dunfey Hotel, Houston, TX. (NACE, P.O. Box 218340, Houston, TX 77218).

(Nov. 14–19)—"Corrosion Prevention by Cathodic Protection" Short Course sponsored by the National Association of

Corrosion Engineers, Houston Dunfey Hotel, Houston, TX. (NACE, P.O. Box 218340, Houston, TX 77218).

(Nov. 14–19)—"Corrosion Prevention in Oil and Gas Production" Short Course sponsored by the National Association of Corrosion Engineers, Houston Dunfey Hotel, Houston, TX. (NACE, P.O. Box 218340, Houston, TX 77218).

(Nov. 15–19)—ASTM D33 Coatings for Power Generation Facilities and UNCWC Utilities Nuclear Coating Work Committee Meeting, Huntington Sheraton, Pasadena, CA. (Ken Pearson, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Nov. 16–18)—"Estimating Workshop for Painting Contractors" Short Course. Sheraton St. Louis Hotel, St. Louis, MO. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, University of Missouri–Rolla, Rolla, MO 65401).

(Nov. 16–18)—"Strategy of Experimentation" Seminar. Boston, MA. (DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898).

(Nov. 18–19)—"Fundamentals of Color" Seminar. Cincinnati, OH. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Nov. 29–Dec. 3)—"Principles of Industrial Coatings" Short Course. Sheraton St. Louis Hotel, St. Louis, MO. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, University of Missouri–Rolla, Rolla, MO 65401).

(Nov. 30–Dec. 2)—"Focus on Data" Seminar. Cincinnati, OH. (DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898).

(Dec. 7–9)—Fifth Annual Western Plastics Exposition. Long Beach Convention Center, Long Beach, CA. (Western Plastics Exposition, 1625 17th St., Unit 2, Santa Monica, CA 90404).

(Dec. 7–9)—"Strategy of Experimentation" Seminar. San Francisco, CA. (DuPont Statistical Seminars, Room X-39573, Wilmington, DE 19898).

(Dec. 14)—"Powder Coatings: How It Will Work for You" Workshop. Fort Worth, TX. (Susan Buhr, Technical Activities Dept., Society of Manufacturing Engineers, One SME Dr., P.O. Box 930, Dearborn, MI 48128).

1983

(Jan. 13–14)—"Fundamentals of Color" Seminar. Cincinnati, OH. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

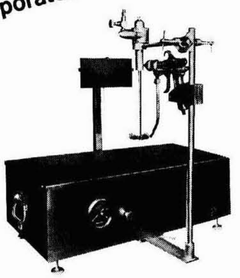
(Jan. 17–21)—"Design and Evaluation of Industrial Hygiene Ventilation Systems" Short Course. Rocky Mountain Center for Occupational and Environmental Health, University of Utah, Salt Lake City, UT. (K. Blosch, University of Utah, Bldg. 512, Salt Lake City, UT 84112).

(Jan. 23–24)—ASTM Committee E-13 on Appearance of Materials Meeting. Dutch Inn, Orlando, FL. (Kitty Riley, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Jan. 23–27)—Semi-Annual Meeting of the American Society for Testing and Materials Committee D-1 on Paint and Related Coatings and Materials. Dutch Inn, Orlando, FL. (ASTM, 1916 Race St., Philadelphia, PA 19103).

(Jan. 26)—ASTM Committee G-3 on Durability of Nonmetallic Materials Meeting. Dutch Resort Hotel, Orlando, FL. (Phil Lively, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Jan. 26)—"New Concepts for Coating Protection of Steel Structures" Symposium sponsored by ASTM Committee D-1 on Paint and Related Coatings and Materials and the Steel Structures Painting Council. Dutch Inn, Orlando, FL. (Cochairman R.F. Wint, Hercules Incorporated, 910 Market St., Wilmington, DE 19899).



(Feb. 3–4)—"Fundamentals of Color" Seminar. Miami, FL. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Feb. 6–9)—Conference on Color and Illumination sponsored by the Inter-Society Color Council and the Illuminating Engineering Society of North America. Colonial Williamsburg Lodge, Williamsburg, VA. (General Chairmen, Charles W. Jerome and William A. Thorton, Westinghouse Lamp Div., One Westinghouse Plaza, Bloomfield, NJ 07003).

(Feb. 24–25)—"Fundamentals of Color" Seminar. Houston, TX. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Mar. 1–4)—Fourth International Cadmium Conference. Bayerischer Hof Hotel, Munich, West Germany. (Cadmium Council Inc., 292 Madison Ave., New York, NY 10017).

(Mar. 10–11)—"Fundamentals of Color" Seminar. Birmingham, AL. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Mar. 24–25)—"Fundamentals of Color" Seminar. Charlotte, NC. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Apr. 12–14)—ASTM Committee C-22 on Porcelain Enamel and Related Ceramic-Metal Systems Meeting. ASTM/Philadelphia Centre, Philadelphia, PA. (Drew Azzara, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Apr. 14–15)—"Fundamentals of Color" Seminar. Seattle, WA. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(Apr. 18–22)—Corrosion/83 sponsored by the National Association of Corrosion Engineers. Anaheim, CA. (NACE, P.O. Box 218340, Houston, TX 77218).

(Apr. 20–22)—ASTM Committee C-3 on Chemical Resistant Nonmetallic Materials Meeting. Galt House, Louisville, KY. (Jim Dwyer, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Apr. 28–29)—"Fundamentals of Color" Seminar. Don Mills, Ont., Can. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(May 12–13)—"Fundamentals of Color" Seminar. Newton Lower Falls, MA. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(May 19–20)—"Fundamentals of Color" Seminar. Cherry Hill, NJ. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(May 23–25)—ASTM D-33 Coatings for Power Generation Facilities Committee Meeting. Galt House, Louisville, KY. (Ken Pearson, ASTM, 1916 Race St., Philadelphia, PA 19103).

(May 24–26)—8th Annual Powder and Bulk Solids Conference/Exhibition. World Congress Center, Atlanta, GA. (Cahners Exposition Group, 222 W. Adams St., Chicago, IL 60606).

(June 2–3)—"Fundamentals of Color" Seminar. Rosemont, IL. (Jeanne M. Dolan, Macbeth, Div. of Kollmorgen Corp., Little Britain Rd., P.O. Box 950, Newburgh, NY 12550).

(June 15–18)—Oil & Colour Chemists' Association Biennial Conference on "The Efficient Use of Surface Coatings." Viking Hotel, York, England. (R.H. Hamblin, Director and Secretary, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, HAO 2SF, England).

(June 19–22)—Dry Color Manufacturers' Association Annual Meeting. The Greenbrier, White Sulphur Springs, WV. (P.J. Lehr, DCMA, Suite 100, 117 N. 19th St., Arlington, VA 22209).

(Aug. 31–Sept. 8)—20th Commission Internationale de l'Eclairage Congress. RAI Congress Center, Amsterdam, The Netherlands. (U.S. National Committee, CIE, c/o National Bureau of Standards, Washington, D.C. 20034).

(Sept. 28–Oct. 1)—Oil & Colour Chemists' Association's Silver Jubilee Convention and Exhibition. Southern Cross Hotel, Melbourne, Australia. (O.C.C.A.A., 1983 Pacific Coatings Convention, C/- Tioxide Australis Pty. Ltd., Private Bag 13, Ascot Vale, Victoria, 3032, Australia).

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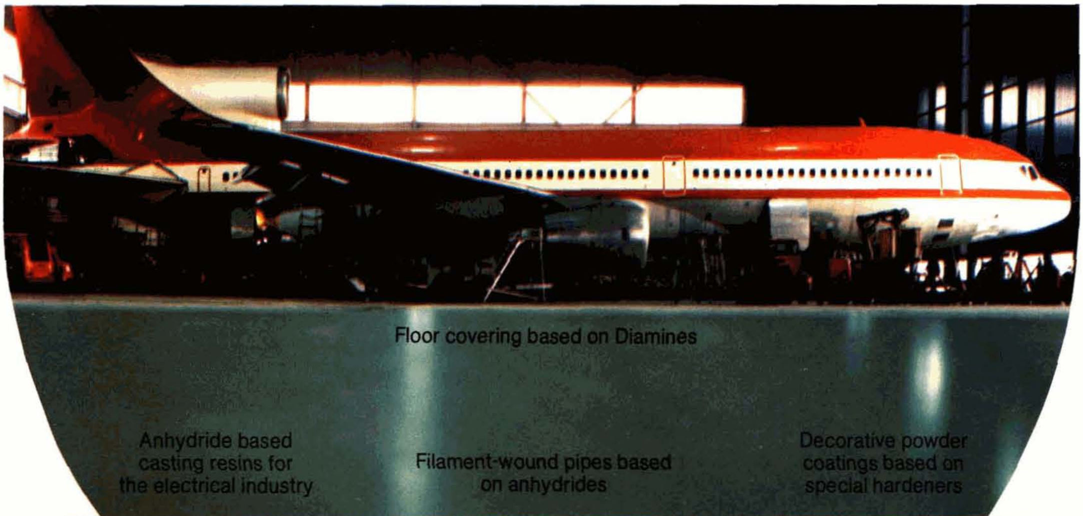
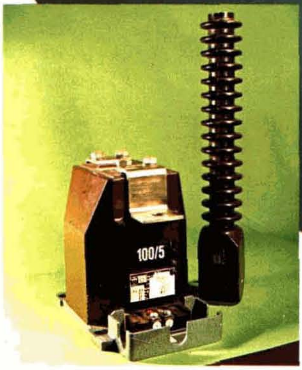
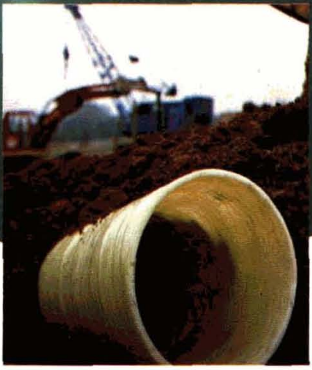


Floor covering based on Diamines

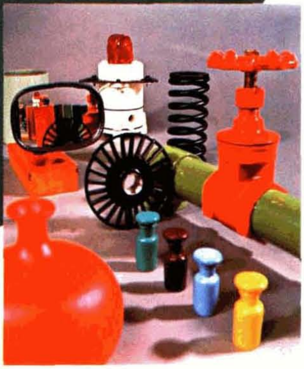
Anhydride based casting resins for the electrical industry



Filament-wound pipes based on anhydrides



Decorative powder coatings based on special hardeners



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hüls manufacture diamines and anhydrides for room temperature and heat curing, and also special hardeners for powder coatings

Diamines
IPD and TMD and hardener V 214 are colourless, low-viscosity liquids. They are characterised by their cycloaliphatic or aliphatic structure.

Anhydrides
HHPSA, THPSA and PMDA are white solids. MHHPSA is a low viscosity liquid.

Special hardeners
B 31, B 55, B 68, B 73 enable the production of highly reactive or normally curing powder coating systems with high-gloss or matt or dead-matt films.

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HHPSA = hexahydrophthalic anhydride
THPSA = tetrahydrophthalic anhydride
PMDA = pyromellitic dianhydride
MHHPSA = methyl-hexahydrophthalic anhydride

Epoxy resin curing agents

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