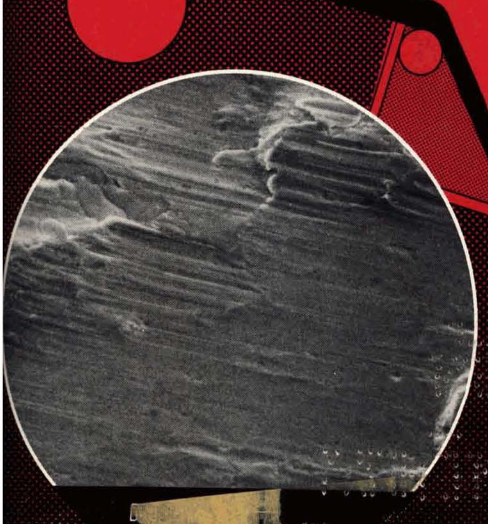
jct JOURNAL OF COATINGS TECHNOLOGY

JCTAX 54 (689) 1-84 (1982)

JUNE 1982

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



Measuring the Surface Quality of Steel and Zinc Phosphate

a lasting partnership

R. T. Vanderbilt's new VANTALC™ 6H is a highly efficient enamel dulling agent. It allows you to control the gloss of industrial paints and coatings without altering their color or performance.

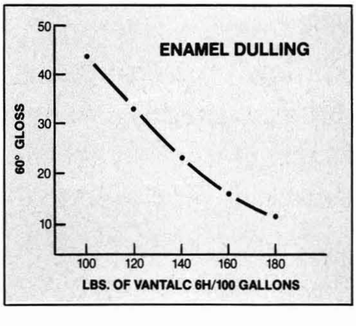
VANTALC 6H is a super fine magnesium silicate. Its extremely high purity and brightness assure your coatings of excellent clarity. Bright whites and clean tints.

Because of its exceptional oil absorption, only a small amount of VANTALC 6H is needed to provide significant gloss reduction. This helps enamels maintain their flexibility and durability without becoming brittle.

The ultra fine grade of VANTALC 6H (6 on the Hegman test) gives enamels a smooth, even film. And its platy texture keeps it in suspension indefinitely.

VANTALC 6H... a bright, new way to make your coatings dull.

For technical information and samples, contact the Paint Department, R. T. Vanderbilt Company, Inc., 30 Winfield St., Norwalk, CT 06855. (203) 853-1400. West Coast: 6279 E. Slauson Avenue, Los Angeles, CA 90040. (213) 723-5208.



R. T. Vanderbilt Company, Inc.
INDUSTRIAL MINERALS AND CHEMICALS

JUNE 1982

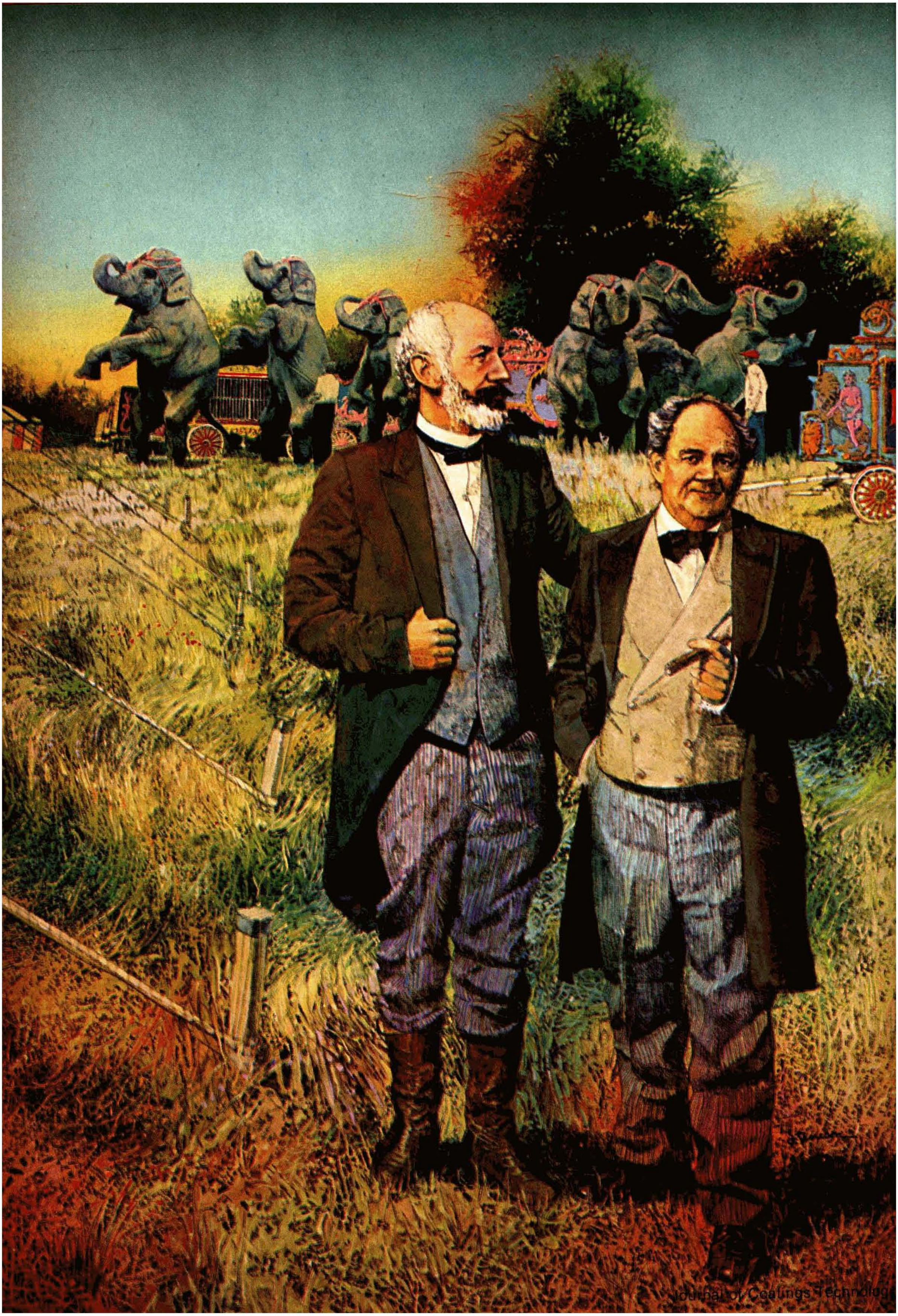
jct JOURNAL OF COATINGS TECHNOLOGY

VOLUME 54 NUMBER 689

THE JOURNAL OF COATINGS TECHNOLOGY (ISSN 0361-8773) is published monthly by the Federation of Societies for Coatings Technology, 1315 Walnut St., Philadelphia, PA 19107. Phone: (215) 545-1507.

Second class postage paid at Philadelphia, PA and at additional mailing offices. POSTMASTER: Send address changes to JOURNAL OF COATINGS TECHNOLOGY: 1315 Walnut St., Philadelphia, PA 19107.

Subscriptions: U.S. and Canada—1 year, $20; 2 years, $37; 3 years, $52. Europe (Air Mail)—1 year, $40; 2 years, $77; 3 years, $112. Other countries—1 year, $30; 2 years, $57; 3 years, $82.



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

Barnum had the brilliance, Bailey had the transport. When the two got together, they launched one of America's most successful institutions.

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.

We can help you over environmental hurdles. Leap to help you meet upcoming volume requirements right through the '80s. Even bend over backwards to give you technical assistance.

What's more, our Sales and Service, Research and Development people have been working closely with solvents and solvent users for more than fifty years. So we can pitch in whenever you need help. And with our network of distribution and sales facilities across the country, we can provide you with a proper balance of newest developments in solvent technology, as well as a dependable source of supply for proven products.

To learn how our capabilities can amaze and astound you, call your Union Carbide Sales Representative or contact one of the many Union Carbide distributors located throughout the nation. Or write to us at Dept. K4436, Old Ridgebury Road, Danbury, CT 06817.

Together, we could be the greatest show on earth.

UNION CARBIDE

SOLVENTS & INTERMEDIATES

jct JOURNAL OF COATINGS TECHNOLOGY

1315 Walnut St., Phila., Pa. 19107

THE JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology at 1315 Walnut St., Philadelphia, Pa. 19107. Phone: (215) 545-1507.

Annual dues for Active and Associate Members of the Federation of Societies for Coatings Technology is $15.00. Of this amount, $10.00 is allocated to a membership subscription to this publication. Membership in the Federation is obtained through prior affiliation with, and payment of dues to, one of its 26 Constituent Societies. Non-member subscription rates are:

	U.S. and Canada	Europe (Air Mail)	Other Countries
1 Year	$20.00	$ 40.00	$30.00
2 Years	$37.00	$ 77.00	$57.00
3 Years	$52.00	$112.00	$82.00

When available, single copies of back issues of the JOURNAL OF COATINGS TECHNOLOGY are priced as follows: $3.00 each for current calendar year issues; $4.00 each for all other issues.

Staff

FRANK J. BORRELLE .... PUBLISHER
ROBERT F. ZIEGLER .... EDITOR
THOMAS J. MIRANDA .... TECHNICAL EDITOR
THOMAS A. KOCIS .... CONTRIBUTING EDITOR
LORRAINE LEDFORD .... ASSOCIATE EDITOR
JANE MARIE PALUDA .... ASSISTANT EDITOR
RICHARD D. GROSS .... ART DIRECTOR

Publications Committee

THOMAS J. MIRANDA, Chairman
PAUL R. GUEVIN, JR., Vice-Chairman

FRANK J. BORRELLE
DARLENE BREZINSKI
JAMES HOECK
RUTH JOHNSTON-FELLER
THOMAS A. KOCIS
SIDNEY LAUREN
PERCY E. PIERCE
ROBERT F. ZIEGLER

Editorial Review Board

THOMAS J. MIRANDA, Chairman

D. BREZINSKI
G.D. CHEEVER
R. DOWBENKO
G.D. EDWARDS
F.L. FLOYD
J.L. GARDON
P.R. GUEVIN, JR.
H.E. HILL
L.W. HILL
J. HOECK
R. JOHNSTON-FELLER
J.V. KOLESKE
L. KUTIK
S.S. LABANA
S. LAUREN
H. LOWREY
M.J. McDOWELL
I.H. McEWAN
A. MERCURIO
P.E. PIERCE
H. SKOWRONSKA

The JOURNAL OF COATINGS TECHNOLOGY has first rights to the publication of papers presented at the Annual Meeting of the Federation and at local and regional meetings of the Federation's Constituent Societies.

A Guide for Authors is published in each January issue.

The JOURNAL OF COATINGS TECHNOLOGY is available on microfilm from University Microfilms, a Xerox Co., Ann Arbor, Mich. 48106.

The Federation of Societies for Coatings Technology assumes no responsibility for the opinions expressed by authors in this publication.

Copyright 1982 by the Federation of Societies for Coatings Technology. All rights reserved. No portion of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system without permission in writing from the publisher.

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY BOARD OF DIRECTORS 1981–1982

PRESIDENT

*HOWARD JEROME
Spatz Paint Industries, Inc.
1601 N. Broadway
St. Louis, MO 63102

PRESIDENT-ELECT

*A. CLARKE BOYCE
Nacan Products Ltd.
371 Wallace Ave.
Toronto, Ont. M6P 3P1, Can.

TREASURER

*TERRYL JOHNSON
Cook Paint & Varnish Co.
P.O. Box 389
Kansas City, MO 64141

*JOSEPH A. BAUER
Porter Paint Co.
Louisville, KY 40201

WILLY C.P. BUSCH
PPG Industries, Inc.
Houston, TX 77001

ALEX CHASAN
U.S. Navy - DTNSRDC
Annapolis, MD 21402

CARLOS DORRIS
Jones-Blair Co.
Dallas, TX 75235

*WILLIAM ELLIS
Chevron Research Co.
El Segundo, CA 90246

TOM FITZGERALD, SR.
Sterling Lacquer Mfg. Co.
St. Louis, MO 63139

WILLIAM F. HOLMES
DeSoto, Inc.
Garland, TX 75040

NORMAN HON
Cook Paint & Varnish Co.
Kansas City, MO 64141

BERGER JUSTEN
Justen Associates
Tampa, FL 33603

ROBERT F. KOPEREK
Mobil Chemical Co.
Azusa, CA 91702

ELDER C. LARSON
Shell Development Co.
Houston, TX 77001

STANLEY LeSOTA
Rohm and Haas Co.
Springhouse, PA 19471

DAVID LOVEGROVE
Carrs Paints Ltd.
Birmingham, B31 3PG, England

HUGH W. LOWREY
Perry & Derrick Co., Inc.
Cincinnati, OH 45212

HARRY B. MAJCHER
Standard Detroit Paint Co.
Detroit, MI 48238

GARY MARSHALL
Paint Products Co., Inc.
Walkertown, NC 27051

WILLIAM MIRICK
Battelle Memorial Institute
Columbus, OH 43201

JOHN J. OATES
Troy Chemical Corp.
Newark, NJ 07105

DERYK R. PAWSEY
Rohm and Haas Co.
Vancouver, B.C. V6J 3P7, Can.

JAMES E. PETERSON
Peterson Paints
Pueblo, CO 81002

*HORACE S. PHILIPP
Sherwin-Williams Co.
Montreal, Que. H3C 2T4, Can.

ANTONIO PINA
Mexicana de Pinturas Intl.
Ixtapalapa, Mexico

A. GORDON ROOK
The O'Brien Co.
S. San Francisco, CA 94080

*FRED G. SCHWAB
Coatings Research Group, Inc.
Cleveland, OH 44114

HELEN SKOWRONSKA
Consultant
Cleveland, OH 44112

SAUL SPINDEL
D/L Laboratories, Inc.
New York, NY 10003

JOHN STIGILE
Hockessin, DE 19707

LEE SVEUM
Honeymead Products Co.
Minneapolis, MN 55432

DANIEL TOOMBS
Lukens Chemical Co.
Cambridge, MA 02138

JOHN T. VANDEBERG
DeSoto, Inc.
Des Plaines, IL 60018

EDWARD VANDEVORT
PPG Industries, Inc.
Springdale, PA 15144

KURT WEITZ
Indusmin Ltd.
Don Mills, Ont. M6E 1N7, Can.

*Executive Committee Members

EXECUTIVE VICE-PRESIDENT

FRANK J. BORRELLE
FSCT Headquarters Office
1315 Walnut St.
Philadelphia, PA 19107

Comment

A Good Idea, Stan

Stanley LeSota, of the Philadelphia Society and Founding Father of the Federation's *Paint/Coatings Dictionary*, has come up with another good idea.

With all the evening Adult Education Courses being offered in our high schools today, why not one in "Household Paints & Painting," taught by Federation members.

The objectives of the program would be to:

(1) Make the consumer aware that the cost of paint is only a small part of the painting job.
(2) Spread the benefits of using quality paints.
(3) Teach painting techniques.
(4) Demonstrate that a lot of sophisticated technology goes into a can of paint.
(5) Sell more paint.

Stan has even offered a curriculum: Important Role of Paints in Our World; How to Identify Quality Paints; Anatomy of a Paint; Choosing the Right Paint for a Specific Job; Preparation Before Painting; Methods and Techniques of Application; Cleanup and Equipment Maintenance; Paint Problems, etc. Visual aids would be used.

The Federation has already opened up a dialogue with the consumer with its recent *Consumer Guide to Trade Paint Quality*. So why not go one step further and meet face-to-face with our buying public in the classroom.

Here's a project for the Technical/Educational Committees of our Societies to consider.

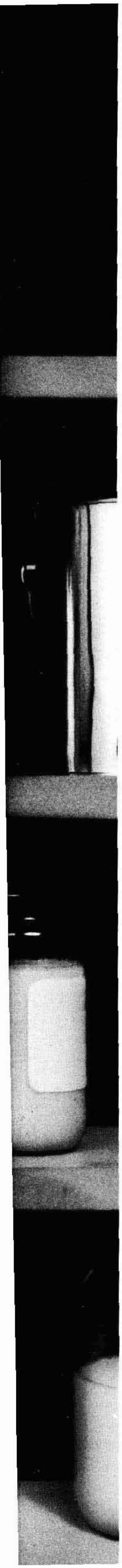
If anyone out there in Federationland has any ideas or experience along these lines, let us hear from you. We'll try to get something going.

Thanks, Stan. This one won't take 13 years.

Frank J Borrelle

Frank J. Borrelle,
Executive Vice-President


DOES YOUR LATEX PAINT NEED...
BETTER FLOW, LEVELING, FILM BUILD
HIGHER GLOSS
HIGHER EFFICIENCY THICKENING
BETTER HIDING
BETTER PIGMENT DISPERSION
VEHICLE FREE FROM MICROBIAL CONTAMINATION
BETTER MILDEW PROTECTION
WIDER FORMULATING LATITUDE
LOWER RMC



ROHM AND HAAS ADDITIVES PROVIDE THE PERFORMANCE IMPROVEMENTS YOUR PAINT NEEDS.

ACRYSOL® rheology modifiers
ACRYSOL acrylic alkali-soluble polymers help to develop the full performance capability of your gloss and flat latex paints by improving flow, leveling, film build, gloss, hiding, spatter resistance . . . on an attractive cost/performance basis. Dried paint films have rich, smooth appearance—with less roller texture, fewer lap marks.

Thickener CPE-15
Alkali-soluble acrylic emulsion polymer. Offers outstanding cost-efficiency versus low- and medium-molecular-weight HEC thickeners. Provides good spatter resistance. Easy to incorporate. High salt tolerance. Exceptional resistance to microbial growth. Helps reduce raw material cost . . . through lower biocide levels and high thickening efficiency.

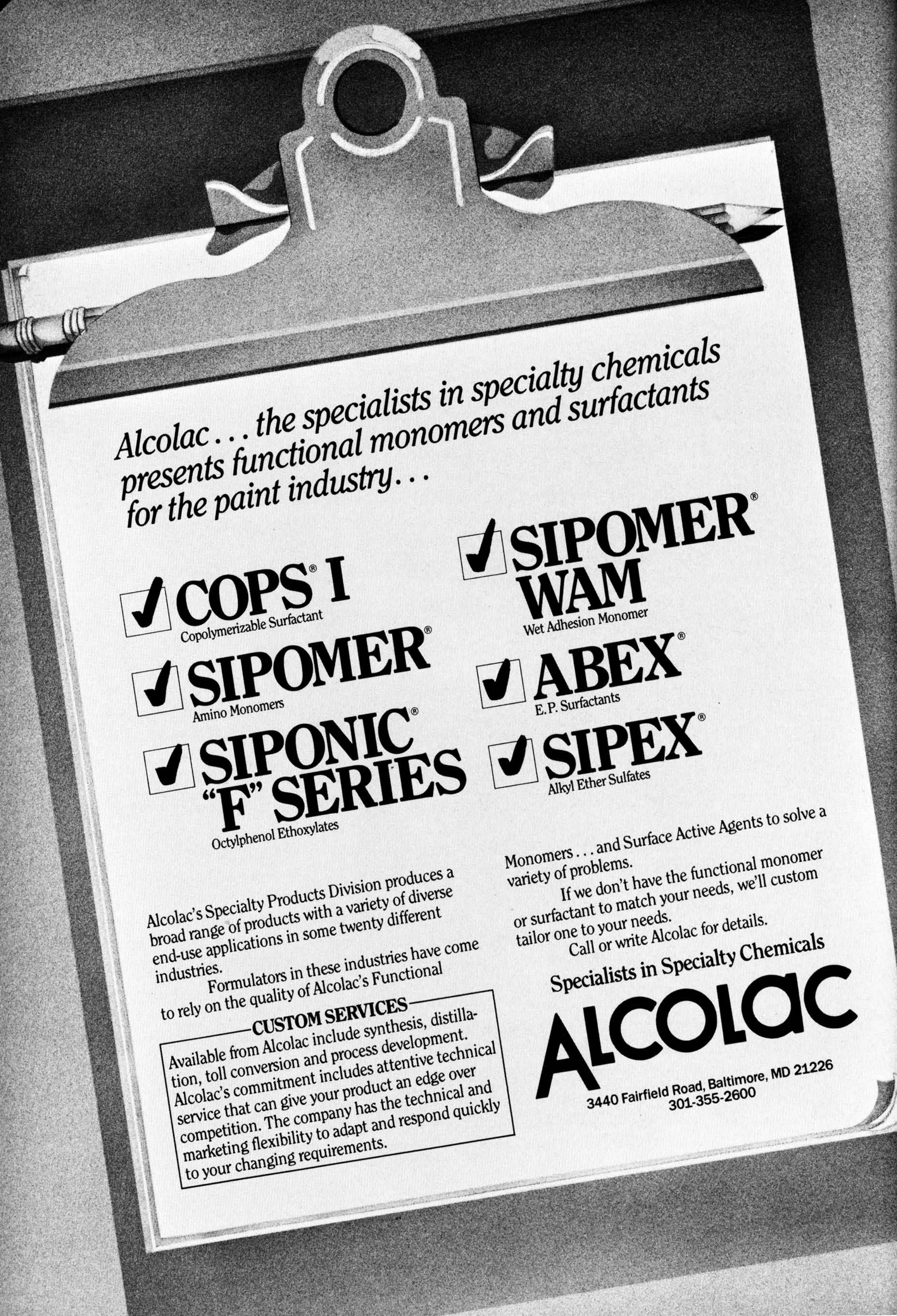
TAMOL® dispersants
The best selection of pigment dispersants available . . . including latest-technology products offering: attractive cost/performance, high solids, reactive-pigment stability, low foam, minimal effect on water sensitivity/adhesion, plus optimum gloss, color acceptance, and hiding.

KATHON® LX microbicide
Preservative for bulk storage of polymer latices. Broad spectrum activity against fungi and bacteria. Effective at low concentrations; substantial biocide cost reductions possible. Mild odor. High resistance to inactivation by organic matter. Good compatibility with surfactants and emulsifiers.

SKANE® M-8 mildewcide for paints
Proven mildew protection through many years of commercial use in all areas of the U.S.—in millions of gallons of paint. Easy-to-handle liquid; no dusting problem. Does not promote chalking, bleaching, fading, or color change. Excellent overall balance of properties. Exceptional cost/performance.

Our Chemistry Begins with You
We developed these additives in response to needs you expressed. Let us show you how our innovations can work for you . . . and how you can save through combination shipments with our RHOPLEX® acrylic vehicles. For information, literature, and samples, contact your Rohm and Haas technical representative or write to our Marketing Services Dept., Independence Mall West, Philadelphia, PA 19105.

ROHM
AND HAAS
PHILADELPHIA, PA. 19105



Alcolac . . . the specialists in specialty chemicals presents functional monomers and surfactants for the paint industry. . .

☑ **COPS® I**
Copolymerizable Surfactant

☑ **SIPOMER®**
Amino Monomers

☑ **SIPONIC® "F" SERIES**
Octylphenol Ethoxylates

☑ **SIPOMER® WAM**
Wet Adhesion Monomer

☑ **ABEX®**
E. P. Surfactants

☑ **SIPEX®**
Alkyl Ether Sulfates

Alcolac's Specialty Products Division produces a broad range of products with a variety of diverse end-use applications in some twenty different industries.

Formulators in these industries have come to rely on the quality of Alcolac's Functional Monomers . . . and Surface Active Agents to solve a variety of problems.

If we don't have the functional monomer or surfactant to match your needs, we'll custom tailor one to your needs.

Call or write Alcolac for details.

CUSTOM SERVICES

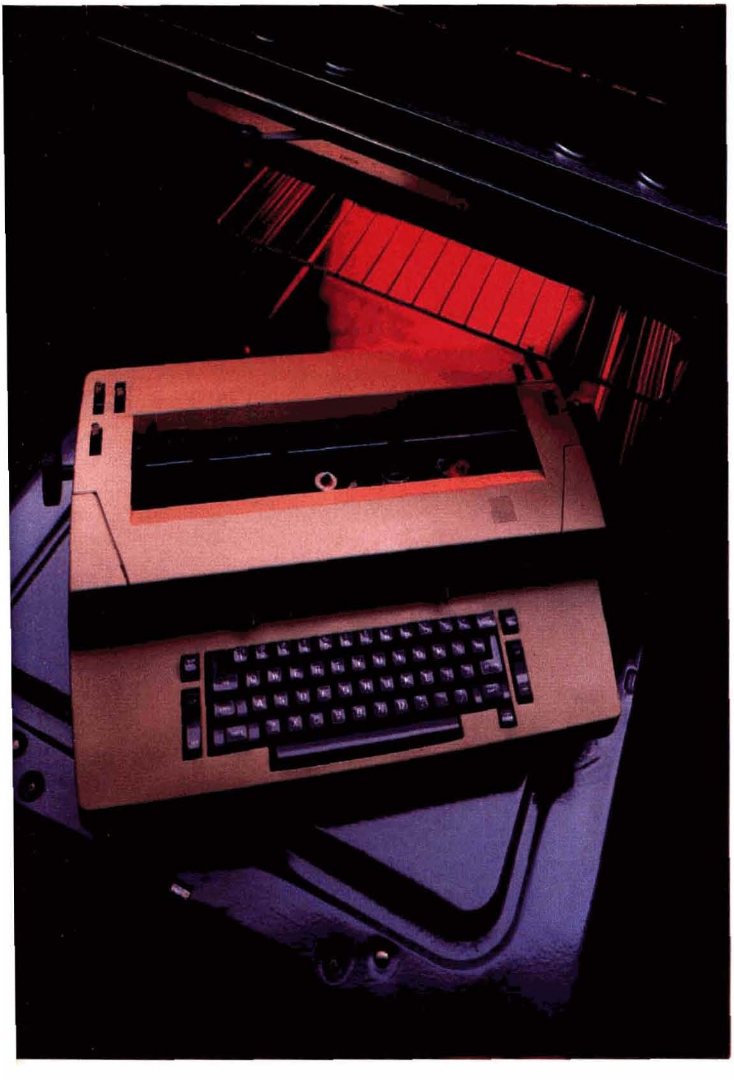
Available from Alcolac include synthesis, distillation, toll conversion and process development. Alcolac's commitment includes attentive technical service that can give your product an edge over competition. The company has the technical and marketing flexibility to adapt and respond quickly to your changing requirements.

Specialists in Specialty Chemicals

ALCOLAC

3440 Fairfield Road, Baltimore, MD 21226
301-355-2600

Thanks to our acrylic resins, typewriter manufacturers can get out of the baking business.



So can manufacturers of snowmobiles. Or garden tractors. Or automobiles. Or motor homes. Because urethane coatings based on our acrylic resin systems cure at room temperature. Or they can be brought to "handling" hardness at as little as 150°F for 10 minutes and finish curing outside the oven.

That makes them a great problem-solver for coating products that can't take heat. And a great energy-saver even for products that can.

And Henkel acrylic resin based coatings offer other advantages as well. They provide twice the coating life of alkyds. They match or surpass the adhesion and performance of other leading urethanes. But they cost less than a polyester/isocyanate system, because they take less of the high cost isocyanate component.

Henkel offers a line of acrylic systems based on three primary acrylic resins. G-CURE 867 acrylic resin provides unsurpassed gloss retention and excellent chemical resistance. G-CURE 868 acrylic resin is softer, more flexible, and can be used with harder isocyanates or melamines. G-CURE 869 acrylic resin based coatings are fast drying, making them particularly effective for factory applications and wood finishes.

If coatings based on Henkel acrylic resins can do so much for manufacturers of typewriters, garden tractors, snowmobiles, automobiles and motor homes, imagine what they can do for your customers' coating problems. For more information about Henkel resin capabilities, write Resins Division, Henkel Corporation, 4620 West 77th St., Dept. JCT 62, Minneapolis, MN 55437.

Resins Division

Henkel

Abstracts of Papers in This Issue

FACILE METHODS FOR MEASURING THE SURFACE QUALITY OF STEEL SUBSTRATES AND ZINC PHOSPHATE CONVERSION COATINGS—K.R. Buser

Journal of Coatings Technology, 54, No. 689, 29 (June 1982)

Wetting tension of cold rolled steel correlates with corrosion resistance of painted products. This correlation provides a simple, useful guide to the corrosion resistance potential of steel. Using this technique, the quality of steel substrates has been monitored and the effect of surface contaminants, cleaning methods, and aging effects on overall corrosion performance of painted products has been determined.

Results show that steel wetting tension should be high: > 80 dynes/cm. Surface contamination leads to poor performance. Extremely good cleaning (better than is normally done commercially) is necessary to insure good zinc phosphate quality and subsequent good salt spray resistance when painted. Wet abrasion makes bad steel into good steel. Wetting tension decreases rapidly on aging and the steel must be phosphated immediately for good corrosion protection.

A facile, nondestructive, dry, colorimetric method for estimating the quality of zinc phosphate coatings is also described. It should be adaptable as a line quality control test.

SYNTHESIS AND CHARACTERIZATION OF WATER-REDUCIBLE GRAFT EPOXY COPOLYMERS—J.T.K. Woo, et al.

Journal of Coatings Technology, 54, No. 689, 41 (June 1982)

The synthesis and characterization of an epoxy-acrylic graft copolymer is described. The grafting of acrylic monomers onto epoxy resin occurs in the presence of free radical initiator. The grafting is believed to be of a "grafting from" process. The graft copolymer when neutralized with base forms an excellent and stable dispersion in water. The stability of the dispersion is due to the absence of ester linkages in the polymer system which are susceptable to hydrolysis in water.

Characterization of the graft copolymer by solvent extraction indicated that the graft copolymer consisted of the following: (1) 47% of the epoxy resin is ungrafted; (2) 61% of the acrylic monomer polymerizes to form acrylic copolymer; and (3) 39% of the acrylic monomer is grafted onto 53% of the epoxy resin.

From ^{13}C nuclear magnetic resonance spectroscopy, grafting appears to take place at the aliphatic backbone carbon atoms of the epoxy resin.

CONDUCTIVITY CONTROL OF CATHODIC ELECTROCOATING—W. S. Springer, G. C. Strosberg, and J. E. Anderson

Journal of Coatings Technology, 54, No. 689, 57 (June 1982)

The conductivity of an automotive cathodic electrocoat bath was controlled by purging concentrate from a reverse osmosis (RO) unit. The RO unit separated ultrafiltrate into concentrate, which was segregated for waste treatment, and permeate, which was returned to the electrocoat system. This process reduced the volume requiring waste treatment by approximately 60%. Procedures were developed to reduce membrane fouling with its consequent decrease in permeate output. These included periodic chemical cleaning of the RO membranes and continuous pH control of the ultrafiltrate feed. Through the use of these procedures, the RO unit provided satisfactory performance during a year of operation.

BIS CYCLIC UREA COMPOUNDS AS MASKED ALIPHATIC ISOCYANATE CURING AGENTS FOR BAKING ENAMELS—P.W. Sherwood

Journal of Coatings Technology, 54, No. 689, 61 (June 1982)

Bis cyclic urea compounds dissociate upon heating without the release of volatile by-products to produce aliphatic diisocyanates. The use of these compounds as curing agents for baking enamels formulated from hydroxy-functional coating resins is currently being evaluated. Sprayable solution coatings have been formulated using N,N'-azelaoyl bis(trimethylene urea) ["azelaoyl BCU"] in combination with commercially available acrylic and epoxy resins. The properties of coatings cured with azelaoyl BCU are presented. The effects of catalysts, cure time, cure temperature, and urea concentration on coating properties are presented and discussed.

NOW! Lead-Free Implement Enamel Pigment Formulations by Pfizer

- **Meet Stringent OSHA Regulations**
- **Involve No Known Health Hazards**
- **For Solvent and Aqueous Systems**
- **Close Color Matches to Standards**
- **Excellent Weathering Properties**
- **Attractive Cost Comparisons**

Pfizer research has found the way for you to meet OSHA's demand for lead-free implement or heavy equipment enamels. Recommended formulae are primarily composed of Pfizer's high-purity synthetic oxides, secondarily of other lead-free pigments. They enable closely matching the most popular colors of the present implement and equipment enamels. Further, tests prove that paints made with Pfizer's pigment formulae equal or slightly surpass present lead-containing formulations for gloss and color retention properties.

SPECIFIC EXAMPLES—RECENT PRICE LEVELS

RED A—SOLVENT SYSTEMS ONLY

Pfizer Yellow (YLO-2288D)	30.5 lb.
Scarlet Red	21.0 lb.
TiO_2	1.5 lb.
Pigment Level	53.0 lb./100 gal.
Pigment Cost/Gallon	$1.55
Molyorange/BON Control	$1.50

RED B—SOLVENT & AQUEOUS

Pfizer Red (R-1599D)	27.3 lb.
Permanent Red	16.4 lb.
TiO_2	9.7 lb.
Pigment Level	53.4 lb./100 gal.
Pigment Cost/Gallon	$1.80
Molyorange/Per Red Control	$1.86

GREEN—SOLVENT & AQUEOUS SYSTEMS

Pfizer Yellow (YLO-2288D)	34.7 lb.
Phthalo Green	14.3 lb.
TiO_2	1.0 lb.
Pigment Level	50.0 lb./100 gal.
Pigment Cost/Gallon	$1.45
Med. Chrome Green Control	$1.30

Pfizer

MINERALS, PIGMENTS & METALS DIVISION

Dept. OC-2 • 235 E. 42nd Street
New York, N.Y. 10017
For Information by Phone Call 215-253-6261, Ext. 307

Please:
☐ Send me tech data on your implement enamel formulae.
☐ Have a Pfizer representative phone for an appointment.

Name & Title__________

Company__________

Address__________

City__________ State______ Zip______

Phone__________ Best Time______

Tentative Program Schedule Announced For 1982 Federation Annual Meeting

Three full days of technical sessions keyed to the theme, "Quality Designed/ Confidence Renewed," await registrants at the 1982 Federation Annual Meeting, November 3-5, at the Sheraton Washington, Washington, D. C., according to Program Committee Chairman John C. Ballard, of Kurfees Coatings, Inc., Louisville, KY, who has announced a tentative schedule of presentations.

The Opening Session will be held on Thursday morning, November 3, followed by the Keynote Address by Jules Bergman, Science Editor of ABC Network News. Two afternoon sessions will be held concurrently. One will be a symposium on "Insuring Quality Management and Technology Through Computer Utilization," the other will offer papers addressing various aspects of the theme topic.

On Thursday, morning and afternoon concurrent sessions will include a symposium on "Designing Quality Through Use of Scientific Instrumentation," a seminar on computer applications in the production area, PRI session honoring Research Director Dr. Raymond R. Myers, TISCO session on information retrieval, and Society and Roon Awards competition papers.

On Friday morning, concurrent sessions will feature an Education Committee presentation on developing a program to promote and publicize career opportunities in the coatings industry, along with papers from overseas organizations. These will be followed by the Joseph J. Mattiello Lecture by Dr. Shelby F. Thames, Vice-President for Administration and Regional Campuses at the University of Southern Mississippi, who will speak on "Bunte Salts as Crosslinking Agents in Thermosetting Water-Borne Polymers." The program will conclude with an afternoon session on "Performance of Non-Lead, Non-Chrome Pigments in Aqueous and Solvent-Based Coatings."

Paint Industries' Show

To be held in conjunction with the Annual Meeting, the Paint Show is the only national exhibit of raw materials and equipment used in the formulation, testing, and manufacture of coatings. A total of 157 supplier firms will occupy all available exhibit space in the Show.

Top technical representatives from participating supplier companies will be manning booths to discuss developments with personnel of the coatings manufacturing industry from around the world.

Show hours will be 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.

Headquarters Hotel

The Sheraton Washington will serve as headquarters hotel. Other hotels with blocks of rooms set aside for the Annual Meeting are the Shoreham, Washington Hilton, and the DuPont Plaza.

Room Reservations

All requests for rooms and suites must be sent to the Federation office on the official housing form which has been mailed to all members and is included in this issue (see pages 20-21). Additional housing forms are available from the Federation headquarters office.

NPCA Meets Same Week

The National Paint & Coatings Association will hold its annual meeting on November 1-3 at the Washington Hilton.

The back-to-back scheduling of Association and Federation events provides coatings industry personnel with a full week of programming.

Registration Fees

Regular "on-site" registration fees will be $50 for Federation members and $65 for non-members. Advance registration will be available for $40 for members and $55 for non-members. Fee for spouses' activities will be $35 on-site and $25 in advance.

Once again there will be a special registration fee of $20 each for retired members and their spouses. This applies to advance registration only.

In Washington, the registration hours will be: Tuesday, 1:00 p.m. to 5:00 p.m.; Wednesday, 8:00 a.m. to 5:30 p.m.; Thursday, 8:00 a.m. to 5:00 p.m.; and Friday, 8:00 a.m. to 4:00 p.m.

Registration form has been mailed to all members and is included in this issue (see pages 22-23).

Spouses' Activities

Included in the spouses' registration fee will be a "get acquainted" wine and cheese social on Wednesday afternoon; continental breakfast on Thursday and Friday at the Sheraton Washington; and a guided tour of Annapolis (with lunch) on Thursday.

Federation Luncheon

The Annual Federation Luncheon will be held on Friday 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) and the Flynn Awards (firms judged to have the best exhibit booths in the 1982 Paint Industries' Show).

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

Program Committee

Assisting Chairman Ballard on the Program Steering Committee are: Peter Hiscocks (Vice-Chairman), 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.

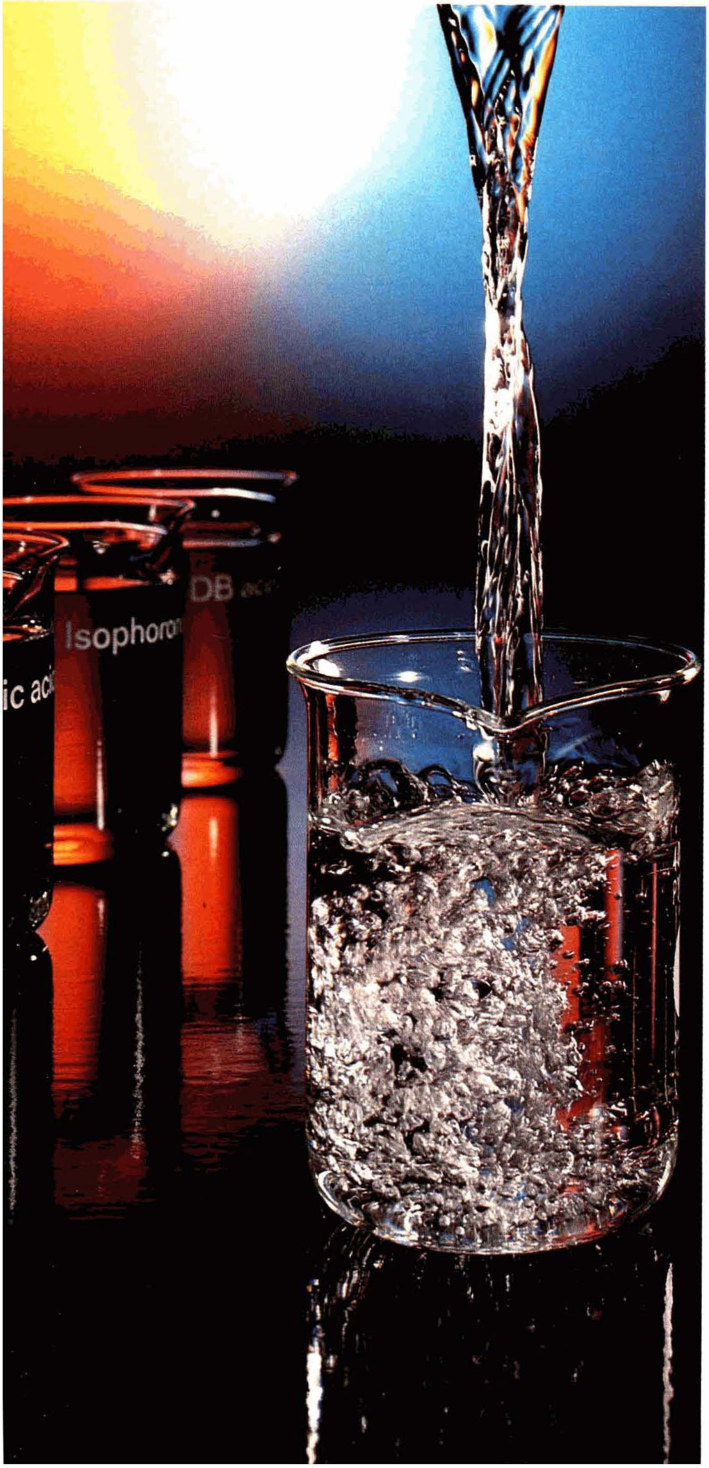
Mr. Hiscocks will be Chairman of the Program Committee for the October 12-14, 1983 Annual Meeting and Paint Show in Montreal, Que., Canada.

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.

Switch to DuPont DBE*...get major savings in solvent costs.



Coatings formulators have saved up to 45% with this readily available solvent.

Try Du Pont's Dibasic Ester solvent in place of glycol ethers, glycol ether acetates, and high-boiling ketones and aromatics to develop paint formulations that produce high performance finishes... formulations that can result in major savings in solvent costs.

You'll discover that DBE is compatible with most common resin systems. Also, Dibasic Ester solvent can give you higher solids formulations without adversely affecting paint rheology. In fact, DBE has been found to improve the rheology of high solids coating systems by reducing viscosity and improving leveling properties. This makes DBE suitable for a wide range of industrial and automotive coatings.

Along with cost reduction and versatility, DBE solvent is exempt from Rule 442 (photochemically nonreactive) and can be stored indoors without restriction.

Get assistance in your R&D evaluation.

Let us show you how you can use Du Pont's DBE in your coating application. We can help you formulate a DBE blend tailored to fit your existing paint system or a new paint line. For further information and samples, write:
Du Pont Company, Room G39261,
Wilmington, DE 19898.

*Mixed dibasic esters of adipic, glutaric and succinic acids.

DU PONT

REG. U.S. PAT & TM OFF

Committee Activities

Mildew Samples Sought for PRI Research Project

The Paint Research Institute Mildew Consortium is seeking to identify the various species that contaminate paint films. With the transition of formulations from predominantly oleoresinous to latex, there are indications that the types of micro-organisms causing film discoloration and disruption have changed.

Studies point to certain of the *Alternatia species* as a cause of film failure, and Dr. Paul F. Klens, of Lock Haven State College, has been assigned to undertake a study to determine the extent of such involvement by *Alternaria sp.*

Readers of the JOURNAL OF COATINGS TECHNOLOGY are invited to assist in this project by submitting mildew-supporting paint chips (2 sq. in. of mildew sample, with substrate), along with as much information as possible about the sample to assist Dr. Klens in his studies.

The form below can be used in reporting the information; also, any suggestions for the project are welcome.

Address samples and correspondence to Dr. Paul F. Klens, Lock Haven State College, Lock Haven, PA 17745.

Mildew Sample Data Sheet

Submittor: ______________________ Company ______________________

Address: ______________________________________ Phone: (   ) ____________

Type of Exposure:

Indoors ____________ Outdoors ____________

If *indoors*, conditions of exposure:

If *outdoors*, conditions of exposure:

Since outdoor exposure probably will be more common, please indicate the following:

Direction of exposure: ____________

Geographic area: ______________________________

Mean annual temperature: ____________ Temp. range ____________

Mean annual rainfall ____________ Average humidity ____________

— — — — — —

For either indoor or outdoor exposure, please indicate:

Kind of substrate: Wood ________ type ________; Masonite ________
Steel ________ Aluminum ________ Masonry ________
Plaster ________ Plaster board ________
Plastic ________ Asbestos Cement ________
Other ______________________

General description of film appearance

Please submit picture if possible.

Comments:

Federation of Societies for Coatings Technology

1982

60th ANNUAL MEETING

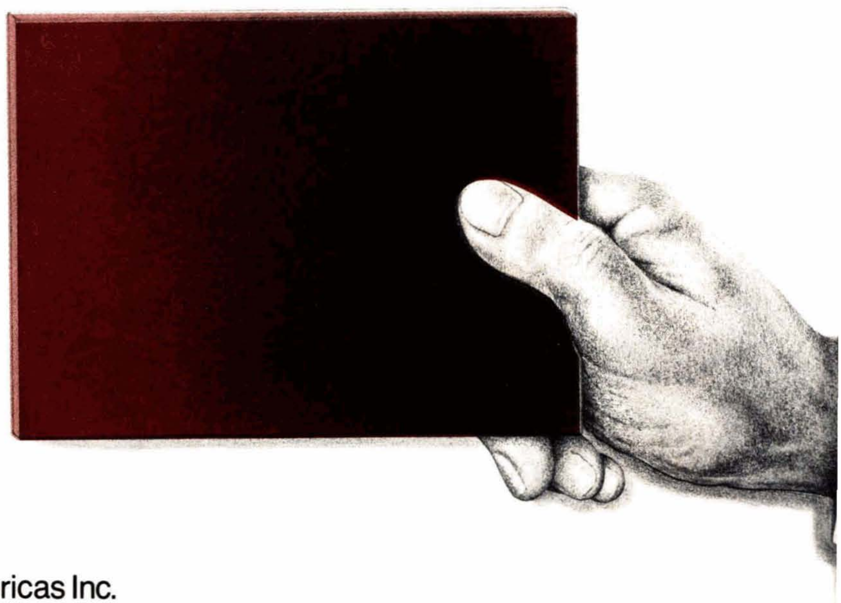
47th PAINT INDUSTRIES' SHOW

WASHINGTON DC

SHERATON
WASHINGTON
HOTEL

NOVEMBER 3, 4, 5, 1982

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



Government and Industry

Battelle Proposes Training Packages For Handling Hazardous Wastes

According to a recent survey conducted by Battelle's Columbus Division, companies need to provide better training for personnel who handle, treat, and dispose of hazardous and toxic chemical substances.

The survey revealed that most companies have limited training programs and that these programs often rely heavily on supervised on-the-job training.

Based on results of the survey, Battelle is proposing to develop training packages which companies can use as part of in-house educational programs.

They will provide the needed practical training, particularly in instructing employees in separating, packaging, labeling, and handling waste materials. Emphasis will be placed on motivating employees to follow procedures and use safety equipment.

In addition, Battelle's survey found that companies often lack necessary funds to upgrade their programs. Also, the firms believe quality courses and training material are not available to help them. The survey noted that companies are concerned about the need for improving training programs because of the sharp increases in the quantity of hazardous and toxic materials being generated. In the United States alone, estimates are that 300 to 400 pounds of hazardous wastes are generated per person on an annual basis. By the year 2000, this amount is expected to increase substantially.

During a nine-month study being proposed by Battelle, experts in both training and hazardous materials research will develop self-contained training packages. The packages will include texts, instructor guides, and graphics.

One package will cover the initial segregation, packaging, placarding, and handling of hazardous and toxic substances. The other package will cover worker safety, protective equipment and clothing, and basic safety in handling of hazardous and toxic materials. Both courses will focus on chemical substances. The training packages are designed to help companies improve worker skills and performance and reduce costly mishaps.

The research will be supported by a number of companies, and the resulting packages will be available to the sponsoring organizations at a cost of $3,600 each.

Additional information is available from George Rosinger, Battelle's Columbus Laboratories, 505 King Ave., Columbus, OH 43201.

Picture It Painted Professionally Contest Now in Progress

The first "Picture It Painted Professionally" Contractor Contest was announced by the National Paint and Coatings Association (NPCA) and the Painting and Decorating Contractors of America (PDCA). Jointly sponsored by NPCA and PDCA, the contest will provide a showcase for the decorative achievements of painting contractors, thereby increasing consumer awareness of the decorative possibilities of paint and of the professionals who help consumers achieve quality results.

Eligible entries are those completed by PDCA members between January 1 and October 1, 1982. Entries must be accompanied by a 35 mm slide(s) of the finished job. "Before" slides are encouraged, though not required. All photographs sent will become the property of NPCA and may be used for promotional purposes. Entries must be postmarked by October 1, 1982.

Contractors may enter as many times as they wish by submitting works in any of the following categories: Exterior—Residential; Interior—Residential; Interior—Commercial; and Exterior—Commercial.

A panel made up of NPCA and PDCA members will judge the entries in October prior to the NPCA annual meeting. Judging will be based on the following criteria: (1) The use of color as a primary design element, i.e. using paint to highlight architectural elements, to create a mood, to brighten, darken and enlarge; (2) The use of decorative paint techniques such as combing, stenciling, sponging, dry brushing, etc.; (3) The use of paint in unusual treatments such as stripes, patterns, supergraphics, etc.

Winners will be announced in November at NPCA's annual convention in Washington, D.C. First and second place winners in each category will receive plaques. Three "honorable mentions" in each category will also receive prizes. A special award ceremony will be held at PDCA's annual convention in 1983.

Entries should be mailed to: Dept. CC, 1500 Rhode Island Ave. NW, Washington, DC 20005.

(Please turn to page 26)

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
1982 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
SHERATON-WASHINGTON HOTEL, WASHINGTON, DC
NOVEMBER 3, 4, 5
(Wednesday, Thursday, Friday)

APPLICATION FOR HOTEL ACCOMMODATIONS

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

Please indicate below the type of accommodations requested and choice of hotels. All reservations will be processed by the Housing Bureau of the Washington Convention & Visitors Assn. Hotel assignments will be made in accordance with prevailing availability. The Housing Bureau will send you an acknowledgment, noting the hotel to which you have been assigned. The confirmation of your reservation will come to you directly from the hotel, to whom you must direct all inquiries. No reservations at cooperating hotels can be guaranteed after October 4.

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

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

NAMES AND ADDRESSES OF ROOM OCCUPANTS AND DATES OF ARRIVAL/DEPARTURE

Type of Room	Name	Address	Dates Arrive	Depart

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

SEND CONFIRMATION FOR ALL RESERVATIONS TO:

NAME ______________________________

COMPANY ______________________________

ADDRESS ______________________________

CITY ______________________ STATE ____________ ZIP ____________

TELEPHONE ______________________

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

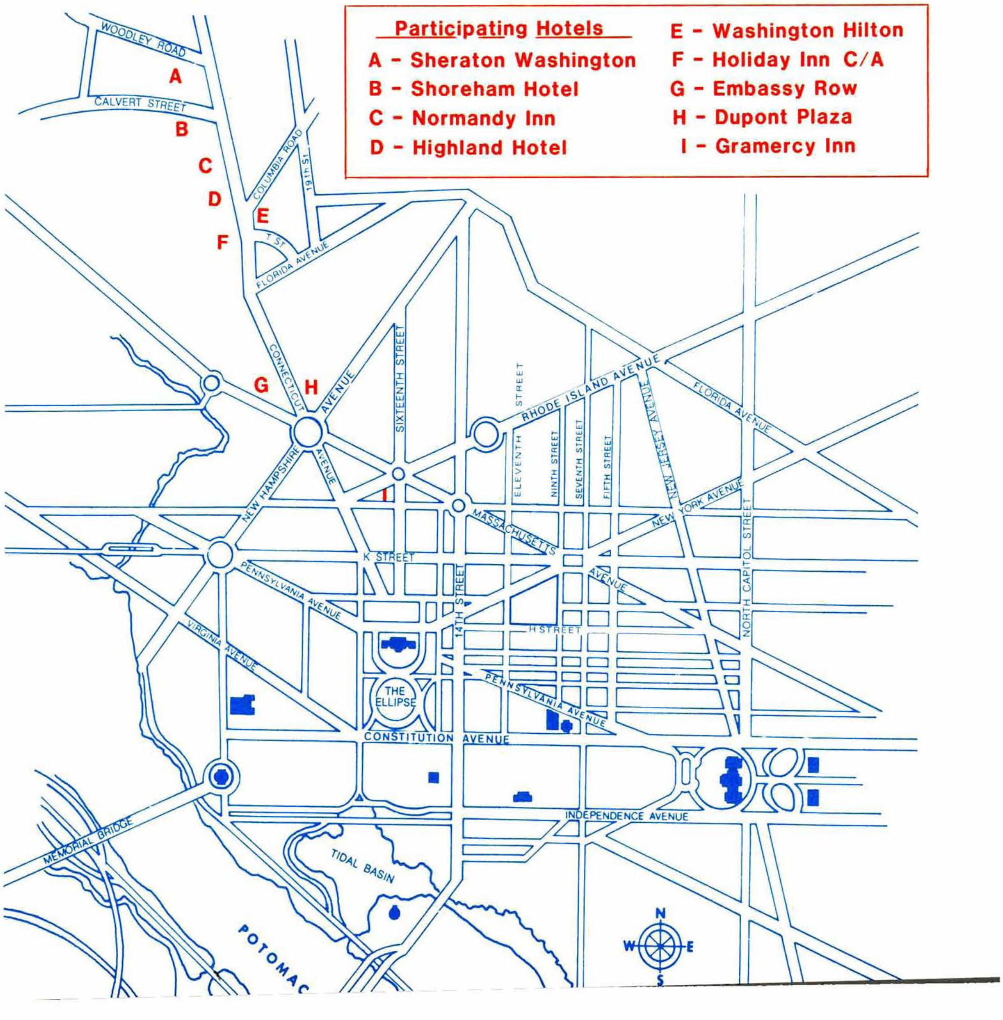
HOTEL INFORMATION AND RATES

All room rates in Washington, DC are subject to an additional Sales Tax of 10%, and .80¢ per night, per room occupancy tax.

Hotel	Singles	Doubles Twin	Parlor & 1 Bedroom	Parlor & 2 Bedrooms
SHERATON WASHINGTON* (see below)	$81/90/95	$95/105/109	$180/240 260/275	$265/325 345/360
SHOREHAM	$75/80	$87/92	$125/200	$225/400
WASHINGTON HILTON† (see below)	$60/80/90 100/110	$78/98/108 $118/128	$198/378 478	$326/506 606
DU PONT PLAZA	$65/76	$85/95	$170/200	$240/270
GRAMERCY INN	$64	$74	$130	—
EMBASSY ROW	$95	$115	$175	$250
HIGHLAND	$60/70	$80	$100	—
HOLIDAY INN	$57	$65	—	—
NORMANDY INN	$56	$66	$120	—

*Requests for accommodations at the Sheraton Washington will be limited to seven rooms per company. A parlor counts as one room. Additional reservations will be assigned to other cooperating hotels.

†Reservations for the Washington Hilton will be accepted for arrival beginning Wednesday, November 3, only.



PLEASE PRINT EXACTLY as you wish registration badge prepared

NICKNAME

FIRST NAME

LAST NAME

BUSINESS AFFILIATION

STREET

CITY

STATE *(U.S. onl*

ZIP (U.S. or CANADA)

COUNTRY (OTHER THAN U.S.)

Name of the Federation Society
Of which you are a paid member ______________________________

PLEASE CHECK ONE BLOCK IN EACH CATEGORY

YOUR COMPANY *(Check One)*:

- A ☐ Manufacturers of Paints, Varnishes, Lacquers, Printing Inks, Sealants, etc.
- B ☐ Manufacturers of Raw Materials
- C ☐ Manufacturers of Equipment and Containers
- D ☐ Sales Agent for Raw Materials and Equipment
- E ☐ Government Agency
- F ☐ Research/Testing/Consulting
- G ☐ Educational Institution/Library
- H ☐ Paint Consumer
- J ☐ Other

YOUR POSITION *(Check One)*:

- A ☐ Management/Administration
- B ☐ Manufacturing and Engineering
- C ☐ Quality Control
- D ☐ Research and Development
- E ☐ Technical Sales Service
- F ☐ Sales and Marketing
- G ☐ Consultant
- H ☐ Educator/Student/Librarian
- J ☐ Other

***Special registration for Retired Federation Members and their spouses $20.00 each in advance only.**

***IMPORTANT:* REGISTRATION AND FULL PAYMENT MUST BE IN THE FEDERATION OFFICE NO LATER THAN FRI., OCTOBER 1, 1982 TO QUALIFY FOR THIS OFFER.**

FSCT Annual Meeting and Paint Show Registration Fees

Federation Member	**ADVANCE REGISTRATION** **WASHINGTON, DC** **NOVEMBER 3-5, 1982**	**Non-Member**
$40.00		**$55.00**

MAIL TO: FSCT, 1315 WALNUT ST., PHILADELPHIA, PA 19107

REGISTER NOW! SAVE TIME AND $$$ TOO!!

This style badge available for *ADVANCE REGISTRATION ONLY*

NICKNAME OR FIRST NAME ON TOP LINE.
LARGE EASY TO READ LETTERING
ADVANCE REGISTRATION ONLY

ANNUAL MEETING 1982 PAINT SHOW

JOHN
JOHN DOE
John Doe Paint Co.
Washington, DC

Federation of Societies for Coatings Technology

This badge sample is actual size and lettering

IMPORTANT: **REGISTRATION AND FULL PAYMENT MUST BE IN THE FEDERATION OFFICE NO LATER THAN FRI., OCTOBER 1, 1982 TO QUALIFY FOR THIS OFFER.**

ANNUAL MEETING AND PAINT INDUSTRIES SHOW

REGISTRATION FEES

	Member	Non-Member	Spouses Activities
ADVANCE	$40.00	$55.00	$25.00
ON SITE (FULL TIME)	$50.00	$65.00	$35.00
ON SITE (ONE-DAY)	$30.00	$40.00	—

SPOUSES ACTIVITIES ▪ ADVANCE REGISTRATION

NICKNAME

$25.00

FIRST NAME

LAST NAME

STREET

CITY

STATE *(U.S. only)*

ZIP (U.S. or CANADA)

COUNTRY (OTHER THAN U.S.)

MAIL TO: FSCT, 1315 WALNUT ST., PHILADELPHIA, PA 19107

FEDERATION SERIES ON COATINGS TECHNOLOGY

Please enter my order for the following Units at the price of $2.50 each:

Number Of Copies	Unit	Title		Price (@ $2.50)
....	1	"Introduction to Coatings Technology"—W. R. Fuller. (Oct. 1964) (Revised May 1973)	$	....
....	2	"Formation and Structure of Paint Films"—W. R. Fuller. (June 1965)	$	....
....	3	"Oils for Organic Coatings"—F. L. Fox. (Sept. 1965)	$	....
....	4	"Modern Varnish Technology"—A. E. Rheineck. (May 1966)	$	....
....	5	"Alkyd Resins"—J. R. Blegen. (Mar. 1967)	$	....
....	6	"Solvents"—W. R. Fuller. (May 1967)	$	....
....	7	"White Hiding and Extender Pigments"—W. H. Madson. (Oct. 1967)	$	....
	8	"Inorganic Color Pigments"—W. R. Fuller and C. H. Love. (Mar. 1968)	Not available at this time; out of stock.	
....	9	"Organic Color Pigments"—J. G. Mone. (July 1968)	$	....
....	10	"Black and Metallic Pigments"—W. S. Stoy, E. T. Usowski, L. P. Larson, D. Passigli, W. H. Byler, R. Evdo, and W. von Fischer. (Jan. 1969)	$	....
....	11	"Paint Driers and Additives"—W. J. Stewart. (June 1969)	$	....
....	12	"Principles of Formulation and Paint Calculations"—W. R. Fuller. (June 1969)	$	....
....	13	"Amino Resins in Coatings"—W. L. Hensley and W. E. McGinty. (Dec. 1969)	$	....
....	14	"Silicone Resins for Organic Coatings"—R. W. Clope and M. A. Glaser. (Jan. 1970)	$	....
....	15	"Urethane Coatings"—D. Lasovick. (July 1970)	$	....
....	16	"Dispersion and Grinding"—M. H. Schaffer. (Sept. 1970)	$	....
....	17	"Acrylic Resins"—Gerould Allyn. (Mar. 1971)	$	....
....	18	"Phenolic Resins"—R. D. McDonald. (Mar. 1971)	$	....
....	19	"Vinyl Resins"—G. M. Powell. (Apr. 1972)	$	....
....	20	"Epoxy Resins"—R. A. Allen (Apr. 1972)	$	....
....	21	"Nitrocellulose and Organosoluble Cellulose Ethers in Coatings"—E. C. Hamilton and L. W. Early, Jr. (Sept. 1972)	$	....
....	22	"Plasticizers"—J. K. Sears (June 1974)	$	....
....	23	"Interior Finishes"—Murray Abriss and Oliver Volk (Apr. 1976)	$	....
....	24	"Exterior House Paint"—G. G. Schurr (May 1977)	$	....
....	25	"Automotive Finishes"—Ralph Williams (July 1977)	$	....
....	26	"Corrosion and the Preparation of Metallic Surfaces for Painting"—Clive H. Hare (Feb. 1978)	$	....
....	27	"Anti-Corrosive Barrier and Inhibitive Primers"—Clive H. Hare (Feb. 1979)	$	....

BINDER(S)

....	Handy flat back blade-type binders which will hold 18 units in the "Federation Series on Coatings Technology .... $10.00 each	$	....
	TOTAL	$	....

TERMS OF ORDER

→ PLEASE MAKE ALL CHECKS PAYABLE IN U.S. FUNDS ←

PREPAID ORDER:

Handling and Postage included in price.

ORDERS REQUIRING BILLING:

Minimum Order—$10.00. Postage and Handling Charges, Additional.

Name ______________________________

Company ______________________________

Address ______________________________

City ____________________ State ____________ Zip Code ____________

PLEASE MAKE ALL CHECKS PAYABLE IN U.S. FUNDS

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

Pennsylvania residents please add 6% sales tax

AVAILABLE IN THE U.K. FROM:

Birmingham Paint, Varnish and Lacquer Club
c/o Mr. Ray Tennant, Carrs Paints Limited, Westminster Works, Alvechurch Rd.
Birmingham B31 3PG, England

HOW TO SATISFY THE EPA, YOUR CUSTOMERS AND YOURSELF.

The Clean Air Act is a tough act to follow, especially when customers are demanding better and better performance. Fortunately, Dow Corning offers technology to everyone's satisfaction.

We've recently introduced an 80%-solids silicone blending resin that improves the heat and weathering resistance of a wide range of organic vehicles. Its inherent low solvent content provides greater freedom in formulating VOC compliant coatings.

New Dow Corning paint additives spell even more good news in the VOC area. These additives are definitive answers to formulating problems common with compliant coatings.

There's also a whole new technology now available to produce water-reducible, silicone-modified alkyd resins.

Interested? Then send us the coupon below. We'll help you develop coatings your customers will love. And the EPA won't turn its nose up at them, either.

"Dow Corning" is a registered trademark of Dow Corning Corporation.

DOW CORNING

DOW CORNING

Please send information about the following:

SILICONE PAINT ADDITIVES
☐ Product information ☐ Sample kit

HIGH SOLIDS SILICONE RESIN
☐ Product information ☐ Sample

WATER-REDUCIBLE TECHNOLOGY
☐ Performance summary and suppliers' list for sample

Name/Title

Company name

Address

City State Zip

Mail to: Dow Corning Corporation, P.O. Box 1767
Dept. B-2010, Midland, MI 48640.

Organic Finishes, Spray Painting Robots Are Subjects of Technical Mission to Japan

A 16-day international study mission departing from L.A. on October 2, 1982 will examine Japanese contributions to state-of-the-art of technology for application of industrial organic finishes and spray painting robots through visits to plants and discussions with industry, government and trade associations representatives.

Organized by Technology Transfer Institute (TTI) in New York, with the support of the Association for Finishing Processes of the Society of Manufacturing Engineers, the mission will study Japanese advances in end-use application in fourteen different areas of organic finishing technology: from spray painting robots, coatability of cold rolled and galvanized steels and metal cleaning and pretreatment processes to products and systems for plastic finishing, powder coating metal decoration applications, and processes and equipment for high-speed, electrostatic spray application.

Mr. Ralph E. Pike, a management consultant and prominent seminar leader on industrial coatings application, will lead the group. He is a past president of the InterSociety Color Council and the AFP/SME. During his 40-year career at duPont, he guided product development in automotive finishing systems, water-based consumer paints, Teflon II cookware and low-cost acrylic enamels for appliances. A research fellow at the duPont Experimental Station, he headed a successful task force on the causes of automobile corrosion.

The TTI delegation is scheduled to hold talks with the Japan Ministry of International Trade and Industry (MITI), meet with representatives of the Metal Finishing and Color Material Societies and with scientists at Osaka University, a major center for paint application and research and development.

They may also visit companies such as: Nippon Kokan K.K. (steel manufacturer); Nissan Motor Co., Ltd.; Mitsubishi Electric Corp. (air conditioner manufacturer); Kansai Paint Co.; Toyo Seikan Ltd. (metal decorating); Kawasaki Heavy Industries, Ltd. (shipbuilding); Hitachi Ltd. (painting robots); Mitsubishi Heavy Industries, Ltd. (painting robots); and Kobe Steel Ltd. (spray) robot).

Technology Transfer Institute is a Japanese management consulting firm with branches in New York, Los Angeles, London, Dusseldorf, and Singapore. TTI promotes the international exchanges of information in engineering, manufacturing, and science and has organized more than 900 seminars, forums, and international study missions.

For information on the mission contact: Rak Hun Choi, M.I.M., General Manager, Technology Transfer Institute, One Penn Plaza, Suite 1411, 250 W. 34th St., New York, NY 10119.

NL Industries Cited For Air Pollution Control

NL Industries, Inc., Hightstown, NJ, has won the 1982 National Environmental Industry Award for excellence in air pollution control. NL Industries' citation was for a new manufacturing procedure developed at its Sayreville, NJ facility, which produces titanium dioxide pigments.

The award, the nations highest for effectively curbing air pollution, is sponsored by the White House Council on Environmental Quality and the Environmental Industry Council. A panel of independent judges made the selection.

The NL manufacturing process is a unique, major technological achievement which reduces emissions by 99.6%, while significantly reducing energy consumption.

The Sayreville plant, in the late 1970s, was discharging particulate matter, and systems at the time were inadequate or impractical for controlling the emissions. Faced with the possibility of a plant shutdown, NL Industries responded by developing a digestion method involving continuous leaching of titanium ore, which eliminates violent chemical reactions causing air pollution.

EPA Delays Compliance Dates for RCRA Regs

The Environmental Protection Agency (EPA) has delayed the compliance dates for three requirements of the hazardous waste regulations issued under the Resource Conservation and Recovery Act (RCRA).

The three requirements affected by the Agency's February 23, 1982 *Federal Register* notice are: the annual report required by hazardous waste generators and owners and operators of treatment, storage and disposal facilities (TSD), the initial-year quarterly groundwater monitor parameter readings by treatment, storage and disposal facilities, and the preparation of groundwater quality assessment program outlines by treatment, storage and disposal facilities.

EPA delayed the date for submission of the 1981 annual report from March 1, 1982 to August 1, 1982 because it believes that it can meet its annual data needs by surveying small samples of the generator and TSD facility populations. Additionally, EPA is planning to propose replacing the annual report requirement with annual surveys permanently as it would be both less expensive and less burdensome for itself and the regulated community. Another reason for EPA's decision is that it will be conducting an extensive survey of hazardous waste generators and TSD facilities this spring to support its Regulatory Impact Analysis.

The delay of the first two quarterly groundwater monitoring parameter readings from March 6, 1982 and June 3, 1982 until August 1, 1982 applies to all TSD facilities except where parameters are observed at concentrations or values above the maximum contaminant levels listed in EPA's Interim Primary Drinking Water Standard. In those cases, owners and operators must report their quarterly parameter readings to EPA regional administrators within 15 days after completing each quarterly analysis. (NOTE: This action does not relieve owners and operators from the requirement to conduct the quarterly analyses and to keep records throughout the active life of their facilities and throughout the post-closure period for disposal facilities). EPA delayed this requirement because it is developing a proposal to institute an exception reporting system, and the delay will avoid imposing requirements which may later be changed.

The compliance date by which owners and operators of certain TSD facilities are required to have prepared an outline of a groundwater quality assessment program has been delayed from November 19, 1981 to August 1, 1982 because EPA is developing a proposal to eliminate the requirement entirely. [NPCA *Coatings*]


TENNECO
NUOSEPT 95

Facile Methods for Measuring The Surface Quality of Steel Substrates And Zinc Phosphate Conversion Coatings

Kenneth R. Buser
E.I. du Pont de Nemours and Company*

Wetting tension of cold rolled steel correlates with corrosion resistance of painted products. This correlation provides a simple, useful guide to the corrosion resistance potential of steel. Using this technique, the quality of steel substrates has been monitored and the effect of surface contaminants, cleaning methods, and aging effects on overall corrosion performance of painted products has been determined.

Results show that steel wetting tension should be high: >80 dynes/cm. Surface contamination leads to poor performance. Extremely good cleaning (better than is normally done commercially) is necessary to insure good zinc phosphate quality and subsequent good salt spray resistance when painted. Wet abrasion makes bad steel into good steel. Wetting tension decreases rapidly on aging and the steel must be phosphated immediately for good corrosion protection.

A facile, nondestructive, dry, colorimetric method for estimating the quality of zinc phosphate coatings is also described. It should be adaptable as a line quality control test.

INTRODUCTION

It has long been known that dirty steel phosphates badly, paints poorly, and corrodes rapidly. In 1956, Wirshing and McMasters, of General Motors, showed that salt spray performance of different lots of cold rolled steel varied widely even though the panels were phosphated and painted in the same system.[1]

Since that time, several laboratories have shown that the condition and quality of cold rolled steel (CRS) substrates have a significant effect on the quality of phosphate coatings and corrosion resistance of painted products.[2–7] Organic carbon deposits have been suggested as major surface contaminants which interfere with quality phosphate coating formation.[8–10] More recent studies suggest a possible connection between the extent of carbonaceous contamination and the thickness of the oxide layer on CRS.[11]

In our laboratory, we have found that the presence of this contaminant layer can be readily detected and its effect on corrosion performance of the steel anticipated by measuring the wetting tension, γ_w, of the steel surface.[12]

However, the quality of a steel surface is only one parameter responsible for good or bad corrosion performance. Another is the quality of the phosphate coating. A bad phosphate coating can result because the steel surface is contaminated or because the phosphate operation is out of control.

For years, salt spray exposure has been the accepted method for evaluation of accelerated corrosion performance of coatings. Several different test methods, all of which are time consuming and destructive, use this concept. There has long been a need for a quick, convenient, nondestructive test to measure the quality of phosphate. Such a test would provide fast data feedback for quality control.

In recent years, several papers have appeared describing simpler, less destructive ways for testing pretreatment quality. These wet methods, one chemical,[13] two electrochemical,[10,14] measure the porosity of the zinc phosphate coating. An infrared spectrophotometric method for measuring coating weight is also described in the literature.[15] None of these methods are sufficient by themselves to distinguish phosphate quality. In addition, the electrochemical methods do not lend themselves to

---

*Fabrics & Finishes Dept., Experimental Station Lab., Wilmington, DE 19898.

Presented at the 24th Annual Technical Conference of the Cleveland Society for Coatings Technology, March 24–25, 1981, Baldwin-Wallace College, Berea, OH.

A part of this paper, "A Facile Method for Measuring the Surface Quality of Steel" was presented at the Symposium on Advances in Coating Metals for Corrosion Protection, Division of Organic Coatings and Plastics Chemistry, 180th National Meeting of the American Chemical Society, Las Vegas, NV, August 27, 1980.

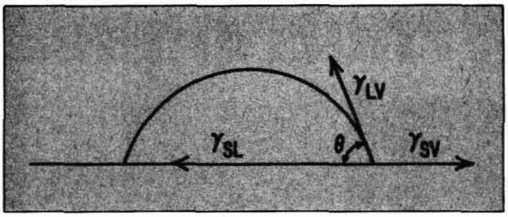


Figure 1—Contact angle of a sessile drop

on-line measurements. In this paper, a facile, nondestructive, dry, colorimetric method is described which is capable of estimating the quality of zinc phosphate conversion coatings and has potential as an on-line quality control test.

EXPERIMENTAL

Materials

COLD ROLLED STEEL PANELS OF VARIABLE CORROSION PERFORMANCE:

(1) Half-Hard; Rockwell B Hardness = 70–85. Cleaned, but unpolished paint test panels.

(2) CQ Rimmed Steel; Rockwell B Hardness = 50–65. Oiled steel from two different sources. Samples were designated by suppliers as varying significantly in corrosion performance.

(3) DQ Steel; AK and Rimmed; Rockwell B Hardness = 35–50. Oiled steel obtained from seven different sources. Samples were designated by suppliers as varying significantly in corrosion performance.

CONVERSION COAT: All panels were zinc phosphated in our laboratory using chemicals and procedures obtained from commercial suppliers.

ABRASIVE CLEANING PADS: Scotch Brite® UF three-dimensional abrasive pads (3M Company) composed of nonwoven nylon web, bonding resin, and mineral.

PRIMER: Conventional automotive sheet metal black dip alkyd.

Cleaning Methods

(A) 5 min dip in tetrachloroethylene at ambient room temperature (~22–24° C).

(B) 5 min dip in tetrachloroethylene at 70° C.

(C) Solvent spray with VM&P naphtha/xylene (1/1) at ambient room temperature.

(D) Solvent spray with VM&P naphtha/ethylene glycol monoethyl ether (3/1) at ambient room temperature.

(E) 5 min vapor degrease with tetrachloroethylene.

(F) 5 min vapor degrease with toluene.

(G) Step 1—60 sec × 165° F × 12 psi power spray with conventional commercial, aqueous alkaline cleaner (Basicity = 0.10–0.12N).

Step 2—60 sec × 140° F × 20 psi power rinse with city water.

Step 3—20 sec × 65° F × 12 psi power rinse with deionized water.

(H) Step 1—90 sec × 165° F × 12 psi power spray with aqueous alkaline cleaner (Basicity = 0.10–0.12 N).

Step 2—90 sec × 140° F × 20 psi power rinse with city water.

Step 3—30 sec × 65° F × 12 psi power rinse with deionized water.

(I) Step 1—As above in (G).

Step 2—As above in (G).

Step 3—Wet abrasion with Scotch Brite® UF three-dimensional abrasive pad using city water as lubricant and coolant.

Step 4—60 sec × 65° F × 20 psi power rinse with city water.

Step 5—30 sec × 65° F × 12 psi power rinse with deionized water.

Measurement of Wetting Tension (γ_w)[16]

PRINCIPLE: When a drop of liquid rests at equilibrium on the surface of a solid in a gaseous atmosphere, the forces acting at the interfaces must balance, as shown in *Figure* 1, and as described by the Young equation:[17]

$$\gamma_{LV} \cos \Theta = \gamma_{SV} - \gamma_{SL},$$

where Θ = angle of contact of the edge of the drop with the solid surface
γ_{LV} = surface energy of liquid-vapor interface,
γ_{SV} = surface energy of solid-vapor interface,
γ_{SL} = surface energy of solid-liquid interface.

When the vapor is air saturated with vapors of the liquid, γ_{LV} is the surface tension of the liquid. If the liquid spontaneously wets the solid, Θ is zero degrees and Cos Θ equals one. The surface tension of the liquid is then described by:

$$\gamma_{LV} = \gamma_{SV} - \gamma_{SL}$$

at $\Theta = 0°$.

The right side of this equation has been defined as the wetting tension of the solid surface.[16] It is also called the critical surface tension for spontaneous wetting. Thus,

$$\gamma_w = \gamma_{LV} = \gamma_{SV} - \gamma_{SL}$$

at $\Theta = 0°$.

However, since surface contaminants such as adsorbed vapors lower the effective surface energy, this equation is not suitable for working with many surfaces. For this reason, Fowkes has suggested a modification of the Young equation to take into account the adsorption of vapor on the surface:[18]

$$\gamma_{LV} \cos \Theta = \gamma_{SV} - \gamma_{SL} - \pi_e,$$

where π_e = the equilibrium film pressure of adsorbed vapor on the solid surface.

This modification may then be applied to the special conditions existing at wetting:

$$\gamma_w = \gamma_{LV} = \gamma_{SV} - \gamma_{SL} - \pi_e$$

at $\Theta = 0°$.

This equation was used as the basis for developing a method to predict the quality of CRS substrates in terms of their wetting tensions.

EQUIPMENT: (1) Two burets, 50 mL; (2) 23, 2 oz bot-

Table 1—Standard Solutions For Determining Wetting Tensions of Substrates

Solution Number	% By Volume Water	% By Volume EtOH	$\gamma_{LV} = \gamma_w$ at 25°C Dynes/cm
1	0.0	100.0	22.3
2	2.5	97.5	22.8
3	10.5	89.5	24.2
4	19.0	81.0	26.1
5	26.5	73.5	27.5
6	35.0	65.0	29.5
7	42.5	57.5	31.5
8	48.5	51.5	33.0
9	54.0	46.0	34.7
10	59.0	41.0	36.9
11	63.5	36.5	39.3
12	67.5	32.5	42.5
13	71.5	28.5	46.0
14	74.7	25.3	48.8
15	78.0	22.0	51.7
16	80.3	19.7	53.7
17	83.0	17.0	56.0
18	87.0	13.0	59.5
19	90.7	9.3	62.7
20	93.7	6.3	65.7
21	96.5	3.5	68.7
22	99.0	1.0	71.0
23	100.0	0.0	72.0

tles, with caps; and (3) Pasteur disposable pipets and rubber bulbs.

PROCEDURE: Twenty-three solutions in two ounce bottles having the compositions given in *Table* 1 were prepared. The surface tensions of these solutions were determined at 25 ± 2°C and 50 ± 5% relative humidity using ASTM method D 1590. The bottles were lined up in a suitable rack according to increasing surface tension.

The substrate to be examined was placed in front of the rack on a well illuminated, dry, flat, horizontal surface. A drop of liquid from one of the bottles was placed on the substrate using a Pasteur disposable pipet. The pipet was then discarded. If the drop beaded, a second bottle of lower surface tension was picked and the operation was repeated using a new clean disposable pipet. Care was taken to deliver about the same volume of liquid each time and to place the drop on an adjacent virgin surface of the substrate. If the initial drop wetted spontaneously, one moved up the scale of surface tension values instead of down. The operation was continued until a pair of solutions was found which just bracketed the change from spontaneous to incomplete wetting. The midpoint between the surface tensions of these two solutions was taken as the wetting tension of the substrate, γ_w. The single-laboratory, multi-operation precision was about ± 1.5 dynes/cm.

Measurement of Color of Zinc Phosphate Coatings

Green (G) and blue (B) color reflectance values of phosphated panels were determined by using a DuColor® Model 220 instrument. The Whiteness (W.I.) and Yellowness Indices (Y.I.) were calculated from average G and B values using the appropriate equations of Paragraphs 4.5 and 4.7 of ASTM E 313-67.

Table 2—Salt Spray Corrosion Performance Rating System

Rating Number	Description	Hours Exposure	Points, 64th of Inch Creep
10	Excellent	168	0
		336	0–1
		504	0–1
		Max. Total	2
9	Very Good	168	0–1
		336	2 or less
		504	4 or less
		Max. Total	7
8	Good	168	0–1
		336	4 or less
		504	8 or less
		Max. Total	13
7	Moderately Good	168	0–2
		336	6 or less
		504	12 or less
		Max. Total	20
6	Fair	168	0–4
		336	8 or less
		504	16 or less
		Max. Total	28
5	Poor	168	0–6
		336	12 or less
		504	24 or less
		Max. Total	42
4	Very Poor	168	0–8
		336	16 or less
		504	32 or less
		Max. Total	56
3	Bad	168	0–12
		336	24 or less
		504	48 or less
		Max. Total	84
2	Very Bad	168	0–16
		336	32 or less
		504	64 or less
		Max. Total	112
1	Terrible	168	0–24
		336	64 or less
		504	>64 (call all greater than 64)
		Max. Total	152
0	Catastrophic	Max. Total	>152

General Experimental Procedure

CLEANING: Panels were cleaned by one of the methods (A) through (I) listed in *the Cleaning Methods Section.* After cleaning, each panel was dried by blowing a stream of nitrogen gas over it. The wetting tension was then measured using the procedure outlined in *the Measurement of Wetting Tension Section.* A maximum of three panels was cleaned at a time so that the drying and

---

DuColor is a registered trademark of NEOTEC Instruments, Inc.

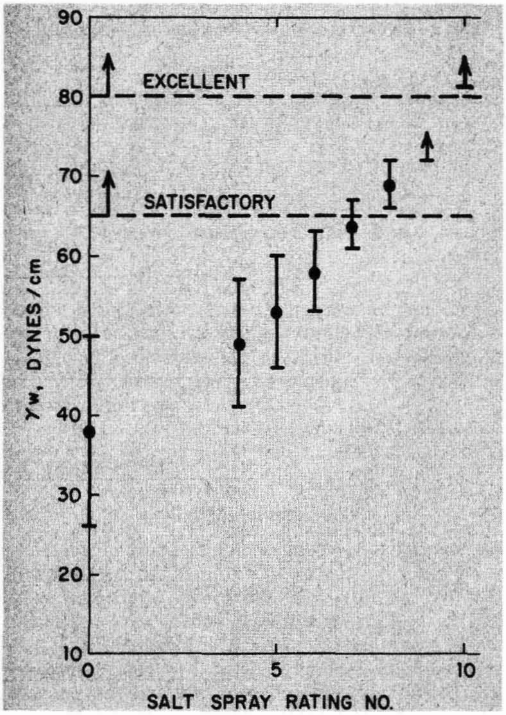


Figure 2—Effect of pre-phosphate surface energy on corrosion performance of zinc phosphated/black alkyd primed CRS

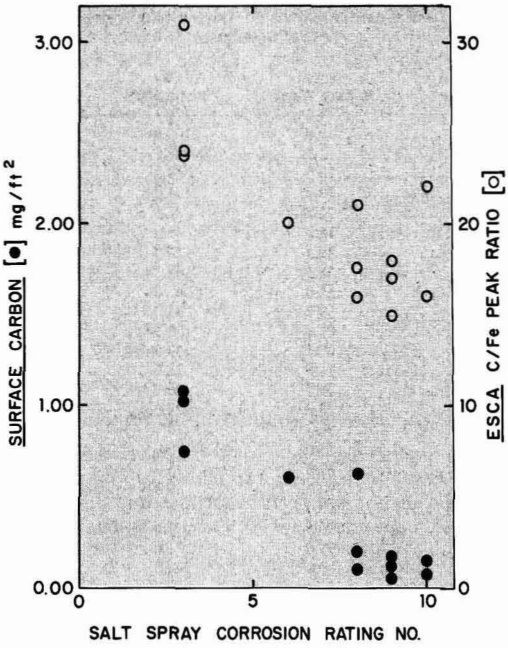


Figure 3—Effect of surface carbon on salt spray corrosion performance

Steel Source = Single Supplier, Different Coils
Steel Type Quality = Rimmed DQ
Cleaning = Alkaline Power Wash
Conversion Coat = Zinc Phosphate
Paint = Black Alkyd Primer

measurement of γ_w could be accomplished in less than 15 minutes. In some cases, freshly cleaned dry panels were stored in deep freeze at $<(-)\,20$°C until they could be further processed. When this was done, each panel was placed in a Kraft paper envelope and this, in turn, was placed in a sealed polyethylene bag. This bag was sealed in another polyethylene bag containing Drierite®. Storage in deep freeze has been found to preserve the condition of the surface for at least one month.

PHOSPHATING: After wetting tensions had been measured, panels were power spray rinsed with deionized water at 13 psi for 10 sec at ambient room temperature. The panels were then phosphated without further cleaning.

PAINTING: Each panel was dip primed with 0.5–0.7 mil of a conventional black automotive sheet metal primer.

SALT SPRAY CREEP CORROSION: Each panel was scribed down the center according to the procedure outlined in ASTM D 1654-Paragraph 3. Panels were exposed in the salt spray cabinet according to the general instructions given in ASTM B 117. Salt spray creep from the scribe in 64th of an inch was determined using Procedure Method B in ASTM D 1654, Paragraph 5. Scribe creep values were determined at 168, 336, 504, and 672 hours of exposure. Scribe creep values were converted to salt spray corrosion performance rating numbers using the criteria listed in *Table* 2.

RESULTS AND DISCUSSION

Correlation of Steel Surface Quality, as Measured by γ_w with Corrosion Performance

Steel panels (150), carefully selected to provide significant variation in type, quality, and corrosion performance, were cleaned, evaluated for γ_w, zinc phosphated, primed, scribed, and evaluated for salt spray creep corrosion according to the procedures outlined in the *Experimental Section.* Results are summarized in the wetting tension-salt spray rating plot in *Figure* 2. The dots are mean values of wetting tensions having the same salt spray rating number. The bar limits are standard deviations from the mean. The data show a good correlation between cleanliness, as measured by γ_w, and salt spray corrosion performance. We conclude that γ_w should be >80 dynes/cm for most reliable anticorrosion performance.

Identity of Surface Contaminants

Carbonaceous materials and iron oxide deposits are major surface contaminants that interfere with phosphatization and cause poor salt spray corrosion performance.[8-11] Our data, relating surface carbon and iron oxide contamination to salt spray ratings, are consistent with this conclusion (*Figures* 3 and 4).

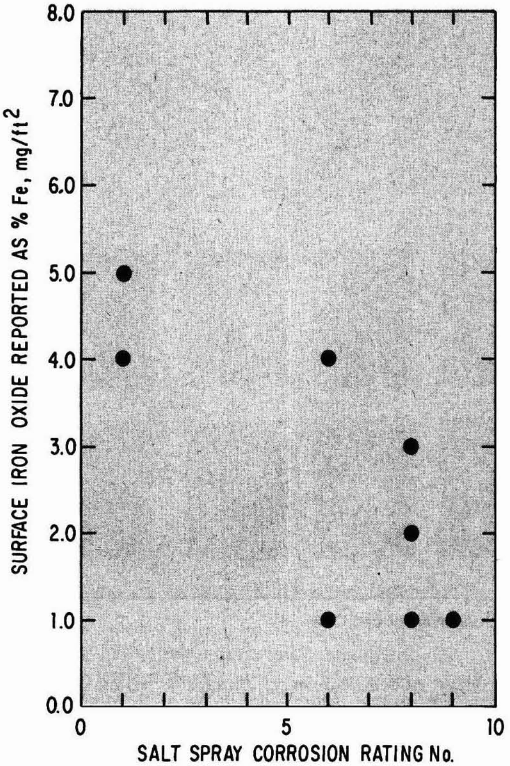


Figure 4—Effect of surface iron oxide on salt spray corrosion performance

Steel Supplier = Single Source, Different Coils
Type Quality = AKDQ

Our work also suggests that micro-cavities, produced in melt, cold roll, anneal, and temper roll stages of steel manufacture also play a role. Scanning electron microscope (SEM) photographs show that steels with bad corrosion behavior have numerous crevices, craters, and fissures (compare 1 and 2; *Figure* 5).

Microprobe of these fissures shows strong evidence of extraneous elements which persist even after cleaning by conventional alkaline power wash. Maps of these elements in typical crevices are shown in *Figure* 6. The relative concentration of each is indicated by the intensity, size, and number of white spots seen on the photographs. What is seen in the crevices is what remains after cleaning. The high concentration of chloride ion is especially significant because it has been reported that it accelerates corrosion.[19]

Effect of Cleaners and Cleaning Methods On Surface Cleanliness

As noted above, surface contaminants are tenaciously held. *Table* 3 summarizes the effects of various cleaners and cleaning methods on half-hard, unpolished, standard CRS paint test panels. All of these panels were taken from the same lot. Thus, the effect of cleaners could be

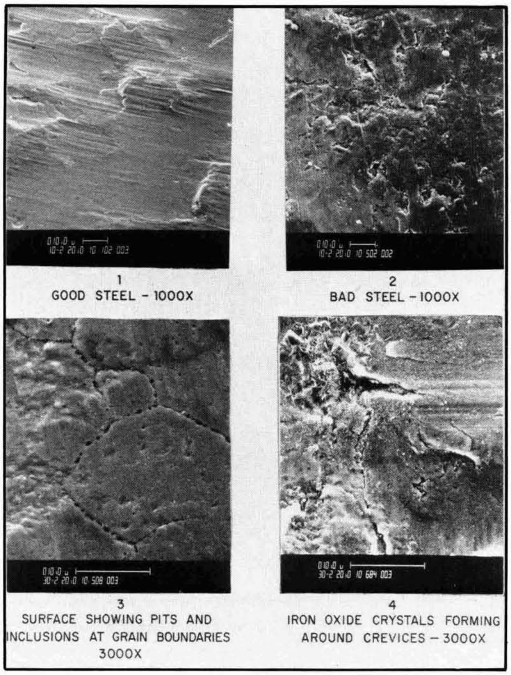


Figure 5—SEM photos of typical variability found in CRS surfaces

measured with minimal interference from variability of surface quality.

We found that conventional CRS paint test panels, even though factory precleaned and packed in inhibitor paper, had low wetting tension values as received (26 dynes/cm). The salt spray corrosion performance of these panels when phosphated and painted was catastrophically bad. It was not improved by typical solvent cleaning methods (A through F; *Table* 3). Conventional commercial alkaline cleaners gave better results, but adequate performance depended on conditions (Compare G and H; *Table* 3). Wet abrasion with three-dimensional abrasive pads was the only method that significantly improved the corrosion performance of all steels, good or bad. Corrosion performance of cold rinsed (75° F or less), freshly abraided steel was excellent (I, *Table* 3).

Cleanability varies significantly with the surface quality of the steel. The age of the steel after cleaning is also a factor. CRS panels from five different sources differing significantly in surface quality were cleaned by Cleaning Methods G and I. The panels were dried at ambient conditions using a jet stream of nitrogen gas. The cleaned panels were stored at ambient laboratory conditions for more than a month. The wetting tension was measured periodically. *Figure* 7 shows that γ_w decreases with time.

Using alkaline power wash alone, the difference in ease of cleaning of the five steels is apparent (dashed lines 1 through 5). The AKDQ* steel designated as giving bad

---

*AKDQ = Aluminum Killed Drawing Quality.

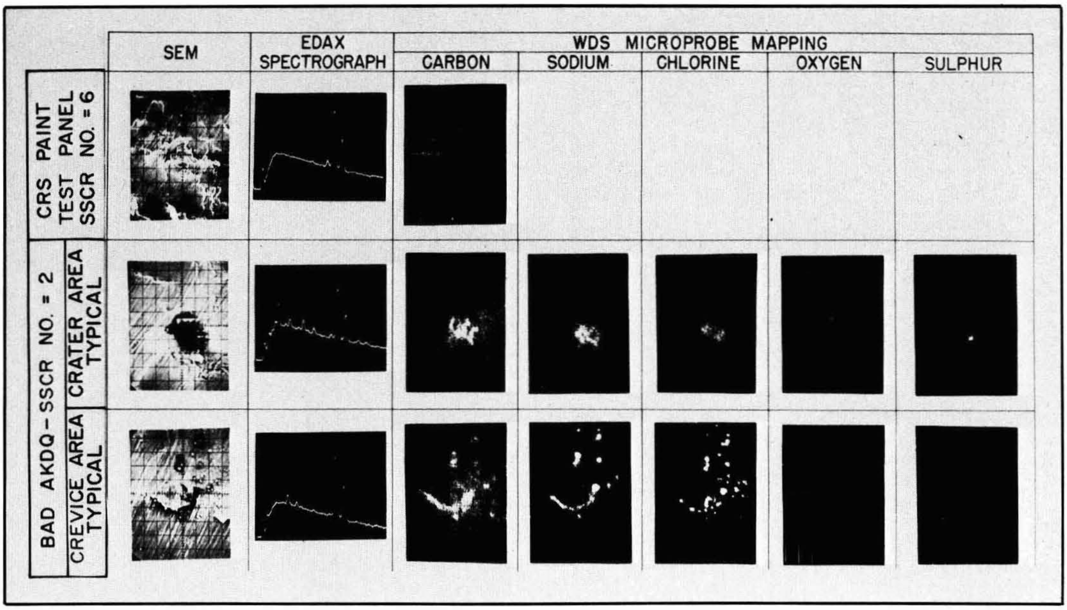


Figure 6—Electron probe x-ray microanalysis of bad CRS

corrosion performance was the most difficult to clean (No. 5, dashed line). Again, however, the wetting tensions of all five steels were significantly improved by three-dimensional abrasive pad cleaning which converted "bad" steel to "good" (see *Table* 4). This indicates that the main causative agents of poor corrosion performance are on the surface and in crevices and not deeply imbedded in the steel composition.

Figure 8 is a SEM picture of a steel surface that has been cleaned by wet abrasion with a three-dimensional abrasive pad. The terrain has been significantly altered. The crevices, bumps, and much of the debris are gone. There appears to be no technical reasons why the corrosion performance of "bad" steels cannot be significantly improved by surface regeneration.

Table 3—Effect of Cleaners and Cleaning Methods On Surface Cleanliness

Cleaning Method (Experimental Details, Section 2)	γ_w, Dynes/cm	Salt Spray Corrosion Performance Rating Number
None, as received	26 ± 1.5	0
A	30 ± 1.5	0
B	36 ± 3	0
C	36 ± 3	0
D	42 ± 3	0
E	40 ± 3	0
F	50 ± 3	0
G	54 ± 3	5–6
H	68 ± 4	6–9
I	>72	9–10

Substrate = Unpolished, but Supplier Cleaned Paint Test Panels
Conversion Coat = Zinc Phosphate
Primer = Automotive Black Dip Alkyd

Aging effects, however, present a major obstacle. Figure 7 shows that the activity of the freshly cleaned surface deteriorates rapidly. In less than 15 minutes at dry ambient conditions, the wetting tension of each abraided steel dropped from a value of ≫80 dynes/cm to about 72 dynes/cm. After the initial drop, the wetting tension of each remained constant for about one-half to two hours depending on the type of steel. In 10 hours, the wetting tensions of all of the panels dropped well below 50 dynes/cm. In one month, the values of all decreased to the same level; 26–27 dynes/cm. This is the value obtained for CRS paint test panels as received from suppliers (*Table* 3). Thus, optimum corrosion performance requires not only an effective cleaning technique but also immediate phosphatization.

Effect of Steel Surface Quality On the Crystal Morphology and Porosity Of Zinc Phosphate Coatings

A good zinc phosphate coating is essential for good corrosion performance. Contaminants on the surface of the steel increase corrosion by interfering with the phosphatization process. This is illustrated by *Figure* 9 which is a collection of SEM photographs of zinc phosphate coatings on CRS substrates varying significantly in surface quality and corrosion performance.

No. 1 has the typical topography and crystal morphology representative of zinc phosphate coatings giving good corrosion performance. The prephosphated wetting tension of steel was >80 dynes/cm. The Salt Spray Corrosion Rating Number (SSCRN), when painted, was 10. The phosphate crystals are mostly flat platelets ranging from about 5 to 30 μ in diameter. They are tightly

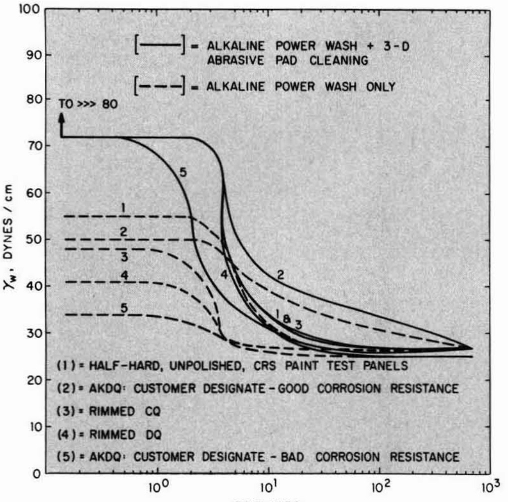


Figure 7—Effect of cleaning, initial surface quality and aging on wetting tension (γ_w) of cold rolled steels

Storage Environment = Ambient Lab Conditions

packed in a random pattern, uniformly distributed over the entire surface of the panel.

The rest of the photographs in *Figure* 9 show typical surface morphologies found on phosphated steels having regressive prephosphated surface energies; γ_w varies from 26 to 54 dynes/cm. The phosphate crystal size enlarges (Nos. 2 & 3), the porosity and unprotected metal areas increase (Nos. 4 & 5), and the salt spray corrosion performance of painted panels decreases from 6 (No. 2) to 0 (No. 5) as γ_w decreases. A fine, heavy, porous iron oxide coating forms on exposed metal (No. 6).

Zinc Phosphate Chemistry

The surface chemistry of zinc phosphatizing is complex, but the generally accepted mechanism is as follows.[22] It is based on the fact that zinc dihydrogen phosphate is soluble in water, whereas zinc phosphate tetrahydrate is not. When steel is sprayed with or dipped in an aqueous solution of zinc dihydrogen phosphate, a localized electrochemical reaction takes place. Iron dissolution occurs at anodic areas:

$$Fe \longrightarrow Fe^{+2} + 2e$$

Oxidizing agents, such as chlorates and nitrates, depolarize cathodic areas on the steel and greatly reduce or eliminate the hydrogen evolution that would be expected at the cathodes. The overall cathodic reaction then is:

$$O + H_2O + 2e \longrightarrow 2OH$$

Nitrite accelerators are added to more rapidly supply oxygen atoms for the cathodic reaction. The localized increase in pH at the cathodic area interface between metal and solution causes precipitation of zinc phosphate at cathodic sites.

Table 4—Effectiveness of 3-Dimensional Pad Abrasive Cleaning On Corrosion Performance of Phosphated and Primed Good And Bad CRS

Cleaning Method (Experimental Details, Section 2)	Good CRS		Bad CRS	
	γ_w	SSCR No.	γ_w	SSCR No.
G	54 ± 3	5–6	34 ± 2	0
I	$\geqslant 80$	9-10	$\geqslant 80$	9–10

Good CRS = Half-Hard, unpolished paint test panels. No. 1, *Figure* 7.
Bad CRS = No. 5 AKDQ, *Figure* 7.
SSCR NO. = Salt Spray Corrosion Rating Number.

$$3Zn^{+2} + 2H_2PO_4^- + 4OH^- \longrightarrow Zn_3(PO_4)_2 \cdot 4H_2O_{(s)} \downarrow$$

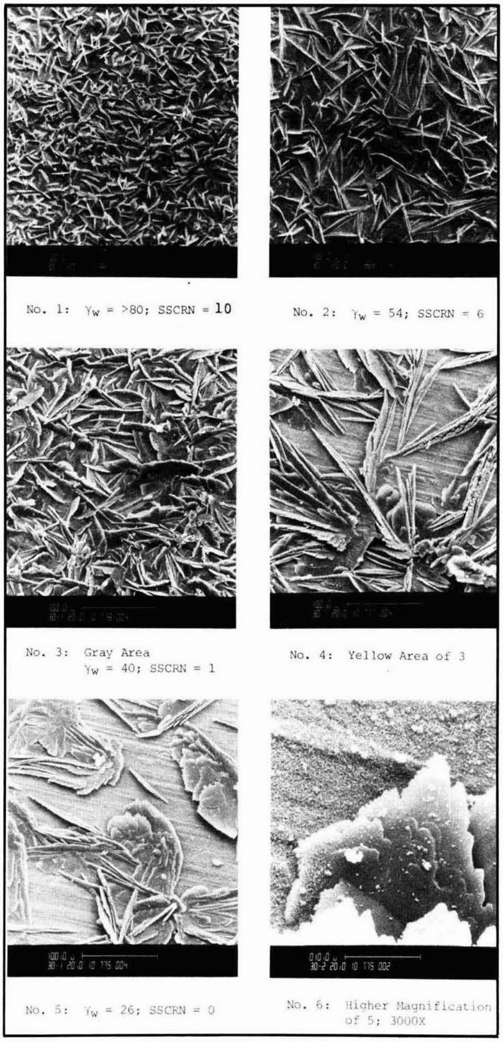
Zinc phosphate crystal growth starts at the cathodic sites and progresses from there.

Some ferrous ion produced by the anodic dissolution reaction often co-precipitates with the zinc phosphate giving phosphophyllite, $Zn_2Fe(PO_4)_2 \cdot 4\,H_2O$. Most ferrous ions are oxidized by nitrites and chlorates or nitrates to ferric ions which precipitate as ferric phosphate. This forms sludge which settles at the bottom of the phosphate bath.[22]

$$2Fe^{+2} + O + 2H_2PO_4^- + 2OH^- \longrightarrow 2\,FePO_{4(s)} \downarrow + 3H_2O$$

It is probable that in highly accelerated surface reactions, a considerable amount of ferric phosphate ends

Figure 8—Typical surface of CRS panel wet abraided with 3-dimensional abrasive pad. SEM Magnification = 3000×



No. 1: Y_w = >80; SSCRN = 10

No. 2: Y_w = 54; SSCRN = 6

No. 3: Gray Area
Y_w = 40; SSCRN = 1

No. 4: Yellow Area of 3

No. 5: Y_w = 26; SSCRN = 0

No. 6: Higher Magnification of 5; 3000X

Figure 9—Effect of steel surface quality on the crystal morphology and porosity of zinc phosphate coatings

up in the coating and a considerable amount of zinc phosphate ends up in the sludge.[22] It would be expected that the presence of mixed phosphates and oxides in the crystal growth phase of the reaction would have a significant effect on the quality of crystal morphology.

Zinc and ferric phosphate form white, opaque crystals. Ferrous phosphate is light blue to gray. Ferric oxide crystals are yellow to red orange depending on morphology and amount of combined water. It stands to reason, then, that the purer the zinc phosphate coating, the smaller the crystal size and the completeness of surface coverage, the lighter and bluer the color should be. Conversely, the more contaminated the coating, the larger the crystal size, the more porous the structure, the more incomplete the coverage, the darker and yellower the color should be.

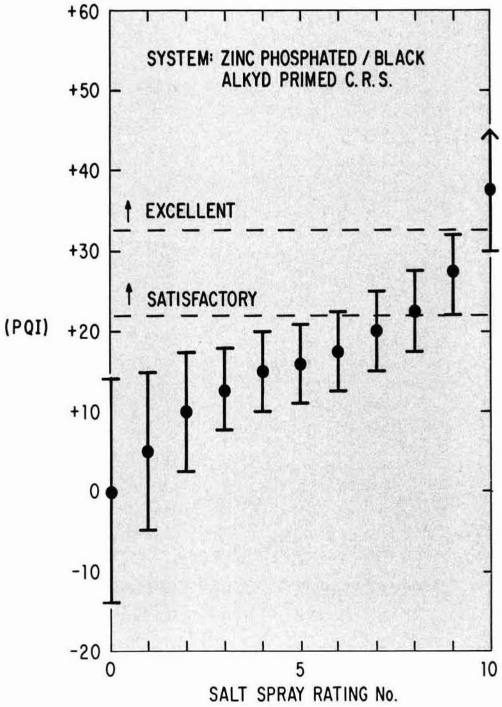


Figure 10—Plot of zinc phosphate quality (PQI) against salt spray corrosion resistance number (SSCRN) of painted panels

The Phosphate Quality Index (PQI)

In accordance with the above reasoning, the whiteness index (W.I.), defined in paragraph 4.7 of ASTM E 313-67, should correlate positively with increasing phosphate quality. The yellowness index (Y.I.), defined in paragraph 4.5 of ASTM E 313-67, should correlate negatively with increasing phosphate quality. Both postulates were found to be true. Thus, the difference between the two indices has been defined as the Phosphate Quality Index (PQI).

$$(PQI) = (W.I.) - (Y.I.)$$

The (PQI) values of 150 phosphated panels varying significantly in quality are plotted versus salt spray creep corrosion rating numbers of painted derivatives in *Figure* 10. The dots are mean values of (PQI) having the same salt spray rating number. The bar limits are standard deviations of the mean. The data show a good correlation between (PQI) values and salt spray corrosion performance. We conclude that (PQI) should be greater than (+)30 for most reliable performance.

The determination of (PQI) is relatively simple and nondestructive. It should be readily adaptable as a line quality control tool.

Anisotropy of Phosphate Coatings

Phosphate coatings follow the contours of temper roll and unidirectional grind lines on steel. These are usually along the length of a coil, and thus, along the length of a

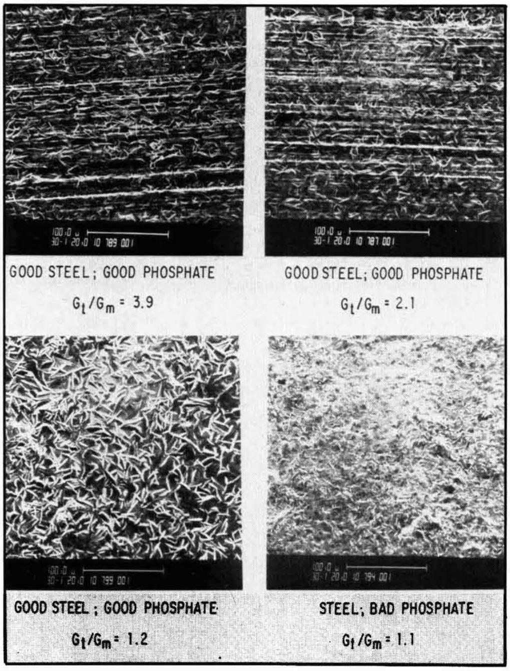


Figure 11—SEM pictures showing degree of unidirectional prephosphate working of steel surfaces

CRS test panel cut from the coil. Because of this, color reflectance (G, R & B) and (PQI) values are significantly different in transverse and machine directions of unidirectionally worked steel. They are higher in the transverse direction than in the machine direction. The ratio, G_t/G_m, is an excellent measure of the degree of unidirectional prephosphate working of steel. A high ratio indicates anisotropy; compare SEM photographs 1, 2, 3, and 4 in *Figure* 11. Since the (PQI) value in the transverse direction is always larger than in the machine direction, the value in the transverse direction must always be used to determine the quality of a coating.

SUMMARY AND CONCLUSIONS

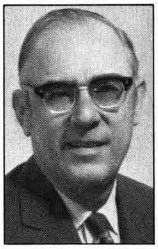
(1) Wetting tension of cold rolled steels correlates with corrosion resistance of painted products. Wetting tension measurements are quick and easy. This correlation, therefore, provides a simple, useful guide to the corrosion resistance potential of coated steel.

(2) Generally, wetting tension should be >80 dynes/cm for most reliable corrosion resistance performance.

(3) Surface contaminants (carbonaceous deposits, iron oxide, and inorganic salts) are responsible for poor corrosion performance. Therefore, good cleaning is absolutely necessary.

(4) Cleanability of the steel surface is a function of the cleaning method and the quality of the steel. Typical commercial cleaners and cleaning processes cannot assure satisfactory corrosion resistance for all qualities of steel. A great deal of phosphating is wasted due to poor cleaning.

DR. KENNETH R. BUSER is a Staff Chemist with the Fabrics and Finishes Department of E. I. du Pont de Nemours and Co. at the Experimental Station Laboratory in Wilmington, DE. He received the A.B. Degree in Chemistry from Wabash College in 1950 and the Ph.D. Degree in Organic Chemistry from Purdue University in 1954. He joined du Pont in 1954. His research background covers a variety of disciplines. He has worked on moisture permeable films, comfort of Corfam® poromeric materials, adhesives, automotive powder coatings, Corian® building products, cathodic electrodeposition of finishes, and paintability of steel and corrosion. He is the author and coauthor of several patents in the areas of poromeric materials, adhesives, and decorative building products.



(5) The best cleaning method is wet abrasion. This raises the corrosion resistance of bad steels to the level of good steels.

(6) The wetting tension of clean steel deteriorates rapidly on aging. The steel must be phosphated immediately for good corrosion protection.

(7) A colorimetric method for determining the quality of zinc phosphate coatings on cold rolled steel has been developed. This measurement of Phosphate Quality Index (PQI) is facile and nondestructive and should be adaptable as a line quality control test.

ACKNOWLEDGMENTS

The excellent interactions, responsiveness, creativeness, and technical contributions of the following people are gratefully acknowledged: R. E. Pike, retired from Fabrics and Finishes Department, E. I. du Pont de Nemours and Co., Inc.; Dr. H. K. Herglotz, ESCA, Engineering Department, E. I. du Pont de Nemours and Co., Inc.; M. L. Van Kavelaar, SEM, Central Research Department, E. I. du Pont de Nemours and Co., Inc.; D. R. Britton, Technician, E. I duPont de Nemours and Co., Inc.; V. E. Kazmers, Research Technician, E. I. du Pont de Nemours and Co. Inc.; and J. F. Ficca, Jr., EDAX and Elemental Distribution Imaging, Micron, Inc.

References

(1) Wirshing, R.J. and McMaster, W.D., "Problems in the Finishing of Automobiles," *Paint Varnish Prod.*, *46*, September, 1956.
(2) Grossman, G.W., Jr., "The Influence of Cold Rolled Steel Surfaces on Paint Performance and Paint Testing," *Official* DIGEST, *31*, No. 1688-1714 (1959).
(3) Machu, W., "Interface Conversion for Polymer Coatings," P. Weiss and G.D. Cheever, Editors, Pgs. 128-149, American Elsevier Publishing Co., 1968.
(4) Laukonis, J.V., Ibid., pp. 182-202.
(5) Umegaki, T., Okabe, T., and Omori, K., *Bull. Chem. Soc. Japan*, *42*, 1304-7 (1969).
(6) Ghali, E.L. and Potvim, R.J.A., *Corrosion Sci.*, *12*, 583-94 (1972).
(7) Jackson, P.L., "Effect of Steel Surface Quality on Primer Adhesion and Corrosion Resistance," Paper presented at Society of

Manufacturing Engineers, Finishing '77 Conference, Detroit, October, 1977.
(8) Wojtkowiak, J.J. and Bender, H.S., *General Motors Research Publication GMR-2446*, June, 1977, Paper presented at the 17th Annual North Dakota State University Coatings Symposium.
(9) Hospadaruk, V., Huff, J., Zurilla, R.W., and Greenwood, H.T., "Paint Failure, Steel Surface Quality and Accelerated Corrosion Testing," Paper 780186, National SAE Meeting, Detroit, March, 1978.
(10) Zurilla, R.W. and Hospadaruk, V., "Quantitative Test for Zinc Phosphate Coating Quality," Paper 780187, National SAE Meeting, Detroit, March, 1978.
(11) Claus, J.J., Wenz, R.P., and Pocius, A.V., "The Surface Chemistry and Corrosion Performance of Cold Rolled Steel Conditioned with 3-Dimensional Abrasives," Technical Paper, Building Service and Cleaning Products Division, 3M Company, 3M Center, St. Paul, Minnesota 55101.
(12) Buser, K.R., "The Energetics of Clean Surfaces," AFP/SME Technical Paper FC78-574.
(13) Cheever, G.D., JOURNAL OF PAINT TECHNOLOGY, *41*, No. 531, 259 (1969).
(14) Chance, R.L. and France, W.D., Jr., *Corrosion*, *25*, 329 (1969).
(15) Cheever, G.D., JOURNAL OF COATINGS TECHNOLOGY, *50*, No. 640, 78 (1978).
(16) ASTM Method D-2578.
(17) Young, T., *Phil. Trans. Roy. Soc. London*, *95*, 65 (1805).
(18) Fowkes, F.M., "Advances in Chemistry Series," Chapter 6, Pgs. 102-3, ACS Monograph No. 43, Washington, DC (1964).
(19) Bresle, A., *Ind. Fin. & Surface Ctgs.*, June 1976, pp. 15, 17 & 18.
(20) Somerjai, G.A., *Science*, *201*, 489 (1978).
(21) Blickwede, D.J., "New Knowledge About Sheet Steel," Materials and Process Engineering Bookshelf, American Society for Metals, 1970.
(22) Woods, K. and Spring, S., *Metal Finishing*, *77*, pp. 24–28 (1979).

United Kingdom Orders of FSCT Educational Literature

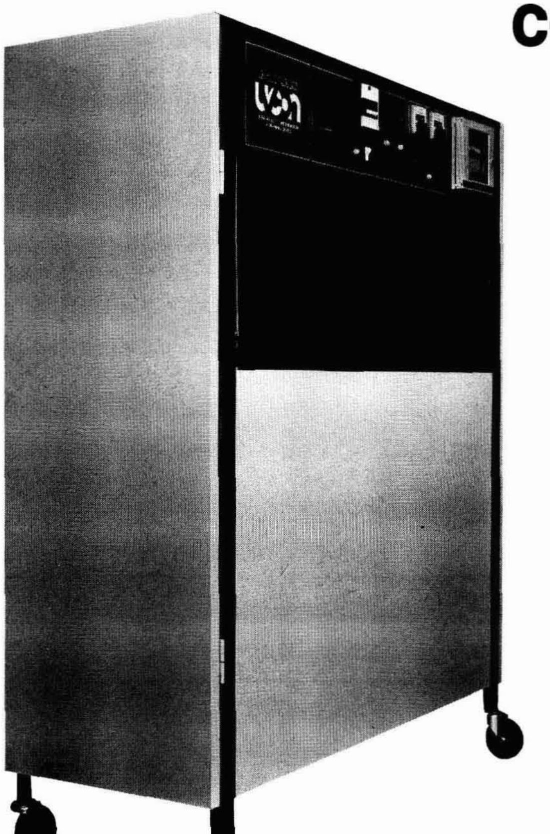
In the United Kingdom, Federation publications and other industry aids are available from the Birmingham Paint, Varnish and Lacquer Club. Please contact: Mr. Ray Tennant, Carrs Paints Limited, Westminster Works, Alvechurch Rd., Birmingham B31 3PG, England.


NOW ON-LINE
WORLD SURFACE COATINGS ABSTRACTS
Annual Index
NASHUA
6250 BPI

Atlas UVCON T.M.

weathering tester

...*better* than its better known competitor



See why the second generation Atlas UVCON is the technology leader in low cost, ultraviolet condensation testing.

Better – UVCON operates up to 95C to cover the latest automotive and ASTM test specifications.

Better – Solid-state temperature controls give UVCON no-guess precision.

Better – Temperature recorder available for accurate test documentation.

Better – UVCON has easy to use digital control settings and temperature readouts.

Better – Preset timing and automatic shut-off.

Better – UVCON no mistake program control for UV/condensation cycles.

Better – Only the Atlas UVCON is backed by a world-wide sales and service organization. Call or write:

FREE BONUS

Natural outdoor weathering tests at South Florida Test Service with each purchase. Ask for details.

ATLAS
ELECTRIC
DEVICES
COMPANY

4114 North Ravenswood Avenue
Chicago, Illinois 60613 U.S.A.
Phone: 312/327-4520 · Telex: 25-4328

Synthesis and Characterization Of Water-Reducible Graft Epoxy Copolymers

J.T.K. Woo, V. Ting,† J. Evans,**
R. Marcinko, G. Carlson, and C. Ortiz
Glidden Coatings and Resins Division of SCM Corporation*

The synthesis and characterization of an epoxy-acrylic graft copolymer is described. The grafting of acrylic monomers onto epoxy resin occurs in the presence of free radical initiator. The grafting is believed to be of a "grafting from" process. The graft copolymer when neutralized with base forms an excellent and stable dispersion in water. The stability of the dispersion is due to the absence of ester linkages in the polymer system which are susceptable to hydrolysis in water.

Characterization of the graft copolymer by solvent extraction indicated that the graft copolymer consisted of the following: (1) 47% of the epoxy resin is ungrafted; (2) 61% of the acrylic monomer polymerizes to form acrylic copolymer; and (3) 39% of the acrylic monomer is grafted onto 53% of the epoxy resin.

From ^{13}C nuclear magnetic resonance spectroscopy, grafting appears to take place at the aliphatic backbone carbon atoms of the epoxy resin.

INTRODUCTION

Graft and block copolymers have been known for many years for their unique properties which can not be obtained from the homopolymer alone. This paper is concerned with development of a new graft copolymer for water-reducible systems.

Graft and block copolymers, because of the incompatible nature of the constituent blocks or graft, form micelles in solution. The micellization behavior is very dependent on the chemical nature and size of the blocks or graft, on concentration, on molecular weight and composition of the copolymer, on the nature of the solvent, and on the temperature. The effort herein described carries this concept into realm of water-dispersible coatings. The graft copolymer is a high molecular weight epoxy resin (~10,000 molecular weight) onto which acrylic monomers have been grafted. It is then dispersed in water. Grafting is done by free radical means.[1]

In free radical grafting,[2] there are two possible processes taking place:

(a) An active site is generated on a preformed polymeric backbone and subsequently it initiates the polymerization of monomers to produce branches. This process is termed "grafting from."

(b) An active site forms a polymeric material that has an active site associated with it. This active material attacks another preformed polymer, attaches itself to it, thereby producing a branch of the preformed backbone. This process is termed "grafting onto."

With a few exceptions,[3] most graft copolymers from free radical induced grafting processes usually not only lead to the desired graft polymers but also to homopolymers and other side reactions. Consequently, the exploration and detailed characterization of grafts produced by free radical methods are often cumbersome or sometimes impossible even by present day analytical techniques.

---

*16651 Sprague Rd., Strongsville, OH 44136.
† Dr. Ting is presently associated with IBM Corp., Boulder, CO.
** Dr. Evans is now employed by Sylvachem Corp., Panama City, FL.

Table 1—Precipitation Results with Various Solvents

	I	II	III
Resin (blend) (56% NV)	30	30	30
N-methyl pyrol (NMP)	45	45	45
Toluene	155	—	—
Mineral spirits	—	25	—
2-Butoxyethanol-1	—	—	25
Deionized water	—	—	25
Weight of top layer	220	25	94
Solids in top layer	14.21	0	5.23
Acid number (NVM) of top layer	41.6	—	276
Weight of bottom layer	4.2	75	29.5
Solids in bottom layer	1.55	18	11.12
Acid number (NVM) of bottom layer	396.4	85	0

Table 2—Precipitation with Increasing Toluene Levels

Wt. Toluene	Wt. Upper	Solids in Upper	A.N. (N.V.) of Upper
150	240	20.59	50.46
207	302	20.29	37.05
300	390	18.68	30.70
500	590	18.88	23.80

EXPERIMENTAL

Example I: Preparation of Graft Epoxy-Acrylic Copolymer By Carbon-Carbon Bond Formation

Commercial grade liquid epoxy resin DER-333® (~95% diglycidyl ether of Bisphenol A, 5% xylene and trace amount of water) and epoxy resin grade Bisphenol A were used. Monomers and solvents used were of commercial grade and were not purified.

A high molecular weight epoxy resin was prepared from reacting 995g of DER-333 with 536g of Bisphenol A in the presence of 310g of 2-butoxyethanol-1. The molecular weight of the epoxy resin was calculated to be about 8000 from epoxide value. A blend of 2-butoxyethanol-1 (281g) and n-butanol (888g) was then added. This solution was heated to 116°C, and a monomer mixture consisting of 283g of methacrylic acid, 87g of styrene, 285g methyl methacrylate, and 30g of benzoyl peroxide was added dropwise through an addition funnel. The system was reacted for three hours at 116° C. The acid number on solids was 85.

The grafted copolymer mixture was then fed into an agitated reducing vessel containing water and dimethylethanolamine. The dispersion was formed easily. The temperature of the resulting dispersion was ~70°C, and the dispersion was agitated for ~one hour. Sufficient deionized water was added so that the dispersion had the following properties: nonvolatiles—20%; pH—7.8; and viscosity (Ford #4 Cup)—22 sec.

Viscosity remained at 22 sec after one month in an oven at 100°F.

Example II: Preparation of Graft Epoxy-Acrylic Copolymer In the Absence of Epoxy Functionality

An agitated, nitrogen-purged reaction vessel was charged with 1,079g of the liquid epoxy resin DER 333, 310g of 2-butoxyethanol-1, and 676g of Bisphenol A. The contents were heated to 140°C, and the heat turned off. Temperature rose to 170°C, at which temperature the reaction was held for five hours. At the end of this time the oxirane content was 0.074%. Then 701g of n-butanol were added, and the contents were allowed to cool overnight.

The Bisphenol A terminated epoxy resin was heated to 117°C and then reacted with a monomer mixture that was slowly added to the terminated epoxy resin over a two-hour period. The monomer mixture was made up of 365g of methacrylic acid, 191g of styrene, 48g of wet benzoyl peroxide (78% benzoyl peroxide in water), and 157g of 2-butoxyethanol-1. After this period the acid number of the product on solids was 104.

A neutralizing solution of 4248g of deionized water, 132g of dimethylanolamine, and 120g of 2-butoxyethanol-1 was used. At that point, the nonvolatile content of the emulsion was 27.1% and the viscosity as measured by a No. 4 Ford Cup at 25°C was 105 sec.

Example III: Synthesis of Epoxy-Styrene Graft Copolymer

Into a four-neck, five-liter round bottom flask was charged 1141g of liquid epoxy resin DER 333, 614g of Bisphenol A, and 310g of 2-butoxyethanol-1. Through the four necks of the flask were placed the following: thermometer, nitrogen inlet, mechanical stirrer, water-cooled condenser, and a dropping funnel. The reaction mixture was heated to ~150°C under a 20-inch vacuum and 20 cc/min N_2 sparge to remove ~24g of volatile material (consisting mostly of water and xylene from DER 333).

At 150°C, heating was stopped and an exotherm was observed. The temperature increased to 176°C and was held there for approximately two hours. The Gardner-Holt viscosity of the advanced epoxy resin was Z_2 (40% N.V. in 2-butoxyethanol-1). At that time 170g of 2-butoxyethanol-1 was added to the reaction mixture followed by 826g of n-butanol. The temperature of the reaction mixture was stabilized at 115°C, and a monomer solution of 431g of styrene, 38.5g of wet benzoyl peroxide, and 62g of n-butanol was slowly added to the epoxy resin. The addition of monomer took about two hours, and the reaction mixture was held at 115°C for three more hours. At the end of this grafting stage, a sample was taken for nonvolatile (N.V.) and acid number (A.N.) determinations. The N.V. was 55.5% and A.N. was 5 on N.V. The A.N. was attributed to the benzoic acid formed from the decomposition of benzoyl peroxide. If all the benzoyl peroxide decomposed to form benzoic acid, the A.N. should be 6.5. Therefore, 77% of the benzoyl peroxide decomposed followed by hydrogen abstraction to form benzoic acid.

DER-333 is a registered trade name of Dow Chemical Co.

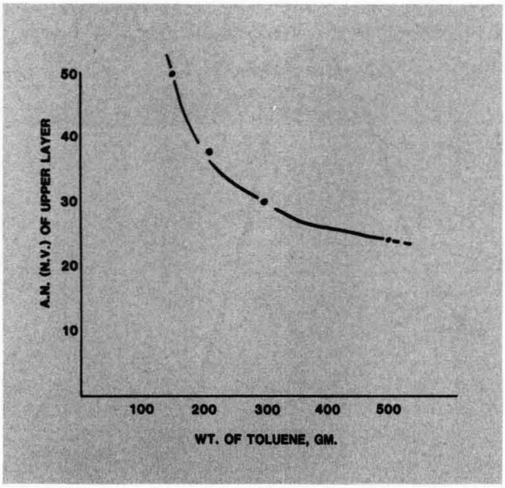


Figure 1—Fractional precipitation of physical blend of epoxy resin, acrylic copolymer, weight of toluene added vs the A.N. (N.V.) of the upper level

Fractional Precipitation

A physical blend of 80% epoxy resin (1535.5g, 57.37 N.V. in 2-butoxyethanol-1) and 20% acrylic copolymer (428g, 51.4% N.V. in n-butanol) of methacrylic acid-styrene, 2:1 mole ratio was made. A solution of 100g of physical blend and 150g of N-methylpyrrol (NMP) was made (22.4% N.V. solution). To the first was added 155g of toluene (which should precipitate the acrylic); to the second was added 25g of mineral spirits (which also should precipitate the acrylic); and to the third was added 25g of 2-butoxyethanol-1 and 25g of deionized water (this is for precipitation of the epoxy.) The results are listed in *Table* 1.

If there is complete separation of the two blend components—i.e., the epoxy resin is formed only in the top toluene rich layer and the acrylic copolymer in the bottom layer—there should be 13.44g of epoxy in the top layer and 3.36g of acrylic copolymer in the bottom layer.

Therefore, in experiment I, with toluene, about 50% of the acrylic copolymer is found in the toluene rich upper layer. Based on the acid number of 396.4, the bottom layer gave a fairly good precipitation of the acrylic copolymer. (Theoretical A.N. of the pure acrylic copolymer is 424). The experiment using mineral spirits in place of toluene gave no separation of the two components. The third experiment using 2-butoxyethanol-1 and water gave a good precipitation of epoxy resin, as evidenced by A.N. = 0 in the bottom layer. The 11.12g corresponds to ~83% recovery of the epoxy resin.

To optimize the toluene fractionation, increasing amounts of toluene were added. A solution of two parts of the blend to three parts NMP was prepared. To 100g* of this solution was added to 150, 207, 300, and 500g of toluene. The results are given in *Table* 2 and plotted in *Figure* 1.

Table 3—Fractional Precipitation Data Replacing Blend with Graft Copolymer

Blend/Graft Copolymer	% N.V. Upper	A.N. (N.V.) Upper	Wt. Acrylic In Upper	Acrylic From Resin	Acrylic Adj. To 100%	Increased Acrylic Solubility
100/0	2.82	24.89	0.98	—	—	—
80/20	2.73	27.07	1.03	0.246	1.23	0.25
50/50	3.12	27.83	1.21	0.720	1.60	0.62
20/80	2.94	35.05	1.43	1.234	1.54	0.56
0/100	2.89	38.80	1.56	1.560	1.56	0.58

It is evident from the data that a complete separation of free epoxy resin did not occur. Very large amounts of toluene would be needed for complete separation of the epoxy resin from the blend and the A.N. of the upper layer to be nil.

For the blend, when 500g of toluene are used the acrylic is soluble to the extent needed to give an acid number of 23.8.

In the grafted copolymer, the presence of the graft, especially epoxy resin grafted with a small amount of methacrylic acid would behave like epoxy resin, and would migrate to the toluene layer, thus raising the acid number of the toluene layer.

In the next series of experiments, different amounts of the blends were replaced by the graft copolymer mixture and the increase of acid content in the upper layer of toluene was recorded. The data is given in *Table* 3.

As expected, the acid content of the upper toluene layer did increase with more replacement of the blend with the grafted copolymer mixture.

The weight of the acrylic in the upper is found by multiplying the N.V. by 590 to give the weight of solids and then multiplying this by the acid number on N.V. and dividing by 424. As an example for the 50/50 trial:

$$\text{Wt. Acrylic in Upper Toluene Layer} = \frac{590 \times 0.0312 \times 27.83}{424} = 1.21$$

The weight of acrylic from the graft polymer is found by subtracting the acrylic which would be expected to be in the upper layer from the blend based on the 100% blend trial. There should be 0.98g contribution from the blend; in our 50/50 trial we would expect 0.49g to be contributed from the blend and the rest from the grafted copolymer. In the 50/50 trial, the actual acrylic is:

$$\text{Acrylic from grafted copolymer} = 1.21\text{g} - 0.49\text{g} = 0.72\text{g}$$

This value is then adjusted to 100% graft by dividing by 0.5 to give 1.44g. But we would expect 0.98g to be soluble from the blend so the increased solubility which may be due to grafting is 0.46g.

The total weight of acrylic is 4.48g. Initially, we can calculate the percent increased acrylic solubility (PIAS) to be

$$(0.46/4.48)(100\%) = 10.3\%$$

This PIAS is a figure that can represent the amount of graft epoxy acrylic copolymer present in a mixture where epoxy resin, acrylic copolymer, and graft epoxy-acrylic copolymer are present.

---

* Each 100g of the epoxy acrylic blend solution contains 22.40g solid determined by nonvolatile analysis, 17.92g of the 22.40g is epoxy resin and 4.48g is acrylic copolymer.

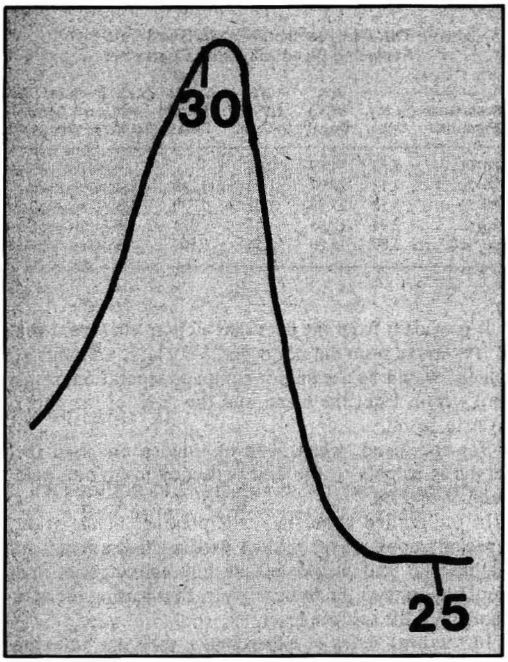


Figure 2—Gel permeation chromatogram of Bisphenol A epoxy resin

RESULTS AND DISCUSSION

Molecular Weight Data

Gel permeation chromatograms were obtained for the epoxy resin, acrylic copolymer of styrene-methacrylic acid prepared in the absence of epoxy resin, a blend of epoxy resin and styrenemethacrylic acid copolymer, and the graft copolymer (see *Figures* 2-5). As can be seen, the molecular weight of the graft copolymer is slightly higher than the epoxy resin, and this is confirmed from computer printout, shown in *Tables* 4 and 5. This data will be important when the structure of the grafted copolymer is discussed.

The molecular weight of the graft copolymer with different levels of free radical initiator is shown in *Table* 6. Except for the one percent initiation level data, the molecular weight tends to increase especially in the case of weight average molecular weight and Z-average molecular weight. The increase in the molecular weight from higher levels of initiator is probably due to increased chain coupling.

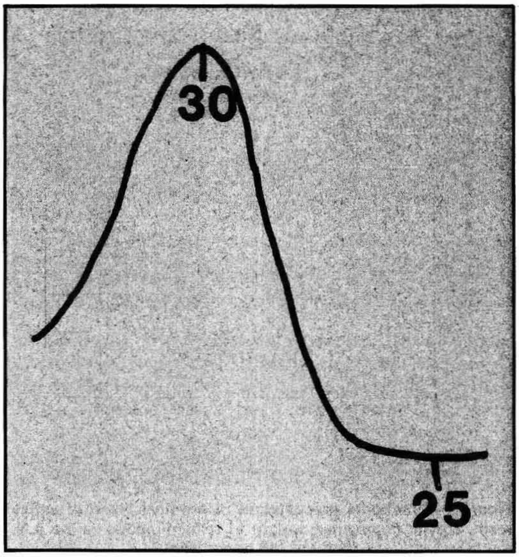


Figure 4—Gel permeation chromatogram of (epoxy resin) (styrene-methacrylic acid copolymer) blend

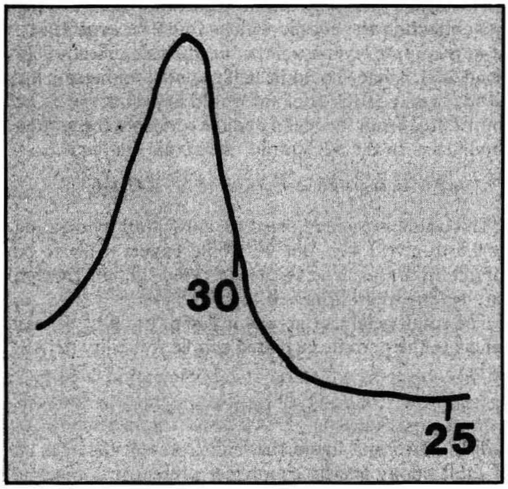


Figure 3—Gel permeation chromatogram of styrene-methacrylic acid copolymer

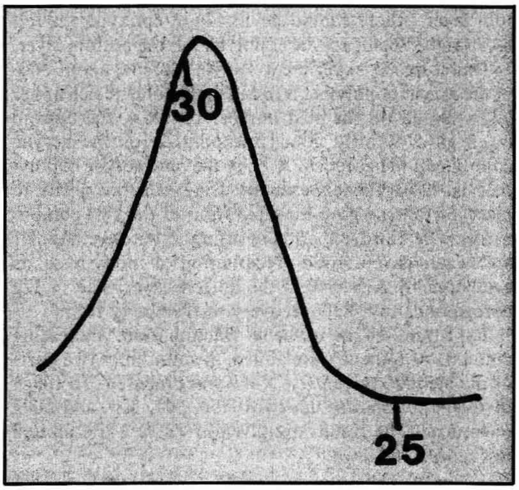


Figure 5—Gel permeation chromatogram of epoxy-acrylic graft copolymer

Table 4—GPC Data of Starting Epoxy Resin Component

	Molecular Weight Distribution		
	Number Avg. Mol. Wt.	Weight Avg. Mol. Wt.	Z Avg. Mol. Wt.
Mean	0.161×10^4	0.805×10^4	0.252×10^5
Variance	0.104×10^8	0.138×10^9	0.759×10^9
Skewness	0.814×10^1	0.455×10^1	0.282×10^1
Kurtosis	0.147×10^3	0.375×10^2	0.128×10^2

Table 5—GPC Data of Graft Epoxy-Acrylic Copolymer

	Molecular Weight Distribution		
	Number Avg. Mol. Wt.	Weight Avg. Mol. Wt.	Z Avg. Mol. Wt.
Mean	0.186×10^4	0.801×10^4	0.309×10^5
Variance	0.114×10^8	0.183×10^9	0.186×10^{10}
Skewness	0.101×10^2	0.710×10^1	0.405×10^1
Kurtosis	0.293×10^3	0.104×10^3	0.230×10^2

Glass Transition Temperature Data

Glass transition temperature of various components are listed in *Table* 7 together with the blend and graft copolymer. The significant drop in T_g of the graft copolymer seems to indicate that the grafted chains are quite efficient in increasing the degree of mobility of the epoxy polymer backbone.

When the glass transition temperature of the graft copolymers prepared with different amounts of free radical initiator were obtained, the data showed a distinct narrowing trend in the glass transition temperature range (see *Figure* 6). If there was no grafting, then the T_g range of these epoxy-acrylic blends made with different amounts of free radical initiator should be identical (assuming there is no significant molecular weight contribution). The fact that the T_g range is decreasing with increasing level of free radical initiator seems to indicate that the copolymers are becoming more homogeneous, which is probably caused by increased amount of graft copolymer present. In other words, with higher level of free radical initiator the epoxy-acrylic graft copolymers are becoming more compatible due to increased level of grafting.

Particle Size Data

The particle size of the aqueous dispersion made with increasing levels of free radical initiator show a significant decrease. The particle size data is summarized in *Table* 8.

Aqueous dispersions of epoxy-acrylic graft copolymer made with different levels of free radical initiator are listed in *Table* 9. There does not seem to be any correlation between the free radical initiator concentration with the Ford #4 cup viscosity of the aqueous dispersion.

Separation of Graft Copolymer

This acrylic composition of ~2 parts of methacrylic acid and ~1 part of styrene polymerizes azeotropically. Except towards the end of the polymerization, there is a nearly random distribution of the two monomers throughout the acrylic polymer chain. This means that there is very little homopolymer of methacrylic acid or styrene. In the graft copolymer mixture after separation, a polymer having an acid value of solids of 424 would be the free acrylic copolymer, a polymer of acid value zero is pure epoxy, and a polymer with an intermediate acid value can be assumed to be a graft copolymer of epoxy acrylic. To separate any free acrylic or free epoxy it is necessary to find solvents which will act as a solvent for one component while being a nonsolvent for another. The acrylic is very polar while the epoxy is also polar but to a lesser degree. Any graft copolymer would be intermediate in polarity. Most solvents which dissolve one component will also dissolve the other two.

There are some solvents which were selective. Ketones (methyl ethyl ketone and methyl isobutyl ketone) dissolve only the epoxy; toluene and chloroform also dissolve only epoxy. The acrylic copolymer is soluble in n-butanol, water/N-methylpyrrolidone (NMP) mixtures. NMP, alcohols, tetrahydrofuran, and dimethylformamide all tend to dissolve both epoxy and acrylic. It would seem that the graft copolymer should exhibit a solubility dependent on the relative amounts of acrylic grafted onto the epoxy. A molecule with large amounts of acrylic grafted onto the epoxy would be expected to resemble the acrylic in solubility. A molecule with a small amount of acrylic grafted onto the epoxy will resemble the epoxy in solubility. For a start, a physical blend of epoxy resin and acrylic copolymer was made. The composition of this blend is the same as the graft copoly-

Table 6—GPC Data of Grafted Copolymers Made with Different Levels of Free Radical Initiator

	% Free Radical Initiator	Number Avg. Mol. Wt.	Wt. Avg. Mol. Wt.	Z-Avg. Mol. Wt.
(1)	1	8,480	26,680	64,800
(2)	2	4,400	12,960	32,120
(3)	3	4,000	12,880	35,080
(4)	5	4,200	13,240	35,160
(5)	7	3,904	13,000	40,400
(6)	10	4,120	14,120	42,400
(7)	15	4,920	17,720	72,400

Table 7—Glass Transition Temperature Data From DSC

	T_g
Epoxy resin	80–85°C
Styrene-MAA copolymer	110°C
Blend	75–80°C[a]
Graft copolymer	50–65°C

(a) Note: The calculated T_g of the copolymer (assuming composition of 80% epoxy, 20% acrylic) is

$$\frac{0.8}{273.2 + 82.5} + \frac{0.2}{273.2 + 110} = T_{g1,2} = 360.9°\text{K or } 87.7°\text{C}$$

A small amount of residual solvent probably caused the lowering of the T_g for the blend.

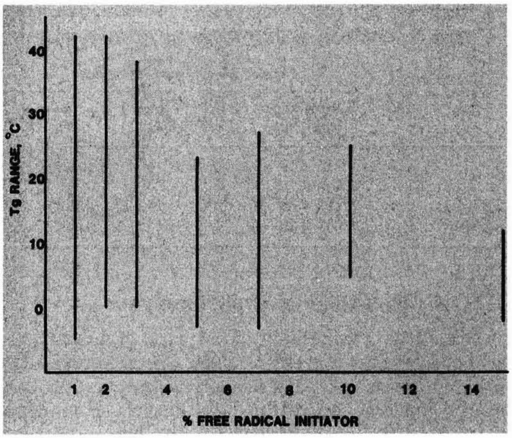


Figure 6—T_g range vs free radical initiator concentration

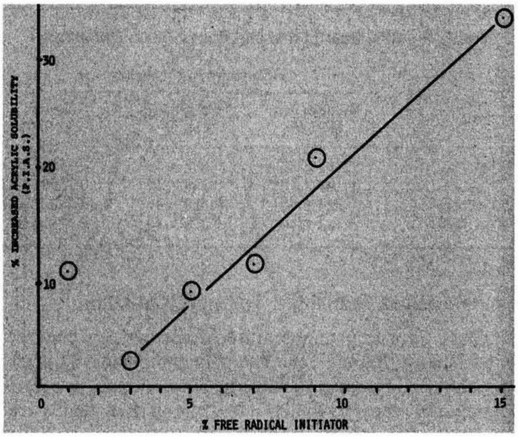


Figure 7—Solubility data of graft copolymers prepared with different levels of free radical initiator

mer except the blend contains no graft components. The acrylic copolymer was prepared similarly as in the graft copolymer except without the presence of the epoxy resin. Several solvent extraction techniques were used.

FRACTIONAL PRECIPITATION: In this experiment, the idea was to dissolve the graft epoxy-acrylic copolymer in a solvent that would dissolve all three components, i.e. free epoxy resin, free acrylic copolymer, and grafted epoxy-acrylic copolymer. A nonsolvent for one of the components was added to selectively precipitate one component.

This technique did not separate the various components but was important in showing that the epoxy is not totally grafted. It also provided data showing that the amount of grafting is dependent on the initiator level (see *Figure* 7).

A physical blend of 80 parts high molecular weight epoxy resin and 20 parts acrylic copolymer of styrene-methacrylic acid was prepared. This mixture was dissolved in a common solvent, N-methylpyrrolidone. By adding toluene (a nonsolvent for the acrylic copolymer), based on acid value, (see *Table* 1), the fractionation gave a fairly good separation of the acrylic copolymer. (Theoretical A.N. of the acrylic copolymer is 424, A.N. of the bottom layer using toluene as solvent was 396.4.) Other solvents such as mineral spirits and 2-butoxyethanol-1/H_2O mixture did not work well.

To optimize the toluene fractionation, increasing amounts of toluene were added, as can be seen from *Table* 2 and *Figure* 1. With increasing amounts of toluene added, the A.N. of the upper layer decreases, but never approaches zero, whereby a complete separation of the epoxy resin would have occurred. Perhaps, with an experiment where repeated extractions with toluene were used, a better separation of the epoxy resin from a blend of epoxy resin and styrene-methacrylic copolymer would have been obtained.

In the next series of experiments, different amounts of the blends were replaced by the graft copolymer, and the increase of acid content in the upper layer of toluene was recorded (see *Table* 3). This increased acid value (called increased acrylic solubility) is due to the presence of epoxy resin grafted with a very small amount of styrene-methacrylic acid. The solubility of this type of graft copolymer would resemble that of the epoxy resin. This increased acrylic solubility was then calculated to be percent increased acrylic solubility PIAS. This technique was used on the graft copolymer samples prepared with different levels of free radical initiator concentration.

The PIAS is plotted vs free radical level in *Figure* 7. The values are seen to lie in a fairly straight line with the exception of the 1% free radical initiator which had a low monomer conversion. This linear increase in PIAS with an increase in free radical initiator level may repre-

Table 8—Particle Size Distribution of Dispersion From Grafted Copolymers Made with Different Levels Of Free Radical Initiator Concentration

% Free Radical Initiator Concentration	Surface Diameter μ	Volume Diameter μ	Specific Surface cm²/g	Wt. Avg. Diameter μ
(1) 1	2.5675	2.7826	18000	2.1953
(2) 2	1.6910	1.8393	27030	2.6304
(3) 3	0.8716	0.9537	51530	2.8190
(4) 5	0.5529	0.5761	94060	1.6759
(5) 15	0.3108	0.3158	180400	1.1457

Table 9—Aqueous Dispersion of Epoxy Acrylic Graft Copolymer With Different Levels of Free Radical Initiator

% Free Radical Initiator	Ford #4 Cup Viscosity Seconds	N.V.	A.N.
(1) 1	47	22.8	85.9
(2) 2	60	22.5	85.7
(3) 3	69	23.1	90.5
(4) 5	32	22.4	88.1
(5) 7	62	23	85.6
(6) 10	26	21.5	90.6
(7) 15	26	22.6	93

Table 10—Solvent Extraction Results with Toluene/NMP/Water

Layer	Wt. of Acrylic	Wt. of Epoxy
Upper (toluene rich)	1.66	18.08
Middle	2.05	1.63
Lower (water rich)	0.93	0.0

sent the relative amount of grafting in this epoxy-acrylic graft copolymer system.

SOLVENT EXTRACTIONS: To obtain a pure sample of "free" acrylic copolymer or "free" epoxy resin, a solvent extraction technique was used. In this procedure attempts were made to find a solvent pair which was immiscible, and each solvent had to be a good solvent for one component and a nonsolvent for the other.

It was found that a mixture of 40g of the epoxy-acrylic graft copolymer mixture, 160g NMP, 160g toluene, and 60g of deionized water separated into three clear, distinct layers. The analysis of each layer is given in *Table* 10.

Initially, there was 4.48g of acrylic of which 0.93g is free; therefore, at least 20.8% of the acrylic is ungrafted.

When butyl acetate/NMP/water and MIBK/NMP/water mixtures were used, 1.48g of free acrylic were obtained indicating about a 33% level of free acrylic was obtained.

Optimizing the MIBK extraction gave a value of 60.7% of the acrylic being free. *Figure* 8 is the GPC curve of the acrylic copolymer used to prepare the blend. *Figure* 9 is the GPC of the free acrylic copolymer separated by solvent extraction from the grafted mixture. It is seen that the acrylic extracted from the grafted mixture is higher in molecular weight. This could be due to a viscosity effect, such as the Trommsdorf effect in making the grafted copolymer, or the procedure may be more selective towards removing high molecular weight acrylic.

SOXHLET EXTRACTION: The Soxhlet extraction technique has been used to isolate[4] epoxy from poly(methyl methacrylate-g-epoxy) using petroleum ether as the solvent. An attempt was made to isolate free epoxy resin from the epoxy-acrylic graft copolymer mixture.

A solution of 300g of the graft copolymer in 2-butoxyethanol-1 and n-butanol, ~60% N.V. was dissolved in 400g of THF and precipitated in n-heptane. The solids were redissolved in 400g of THF and reprecipitated in n-heptane. The isolated solids were then placed in a vacuum oven at 40° C overnight at 28 in. of mercury. The final resin was a white solid. It was pulverized in a Waring blender before extraction.

No epoxy was removed after refluxing overnight using petroleum ether. Chloroform was too good a solvent and did not give a pure sample of epoxy.

The use of toluene extracted 3.78g of solids with an acid number of only six on solids after three days of extraction. This is essentially pure epoxy. This weight is 47.2% of the epoxy initially present. The infrared spectrum of the isolated resin showed no presence of carbonyl. The spectrum was almost identical to a refer-

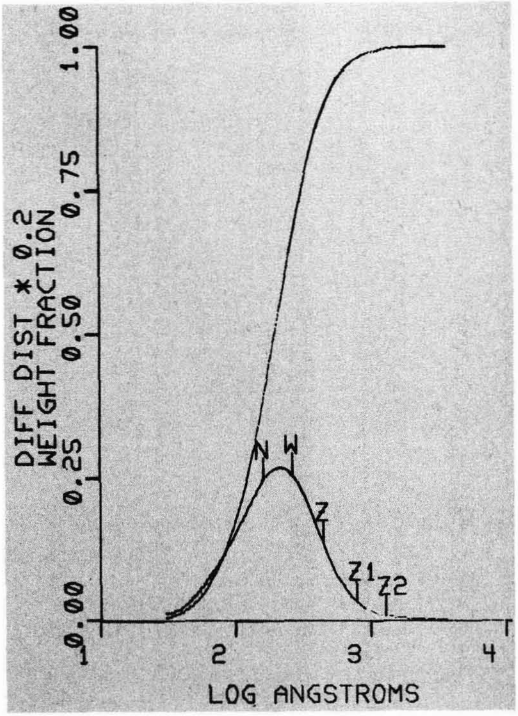


Figure 8—GPC curve of the acrylic copolymer prepared under the same condition as in grafting but in the absence of epoxy resin

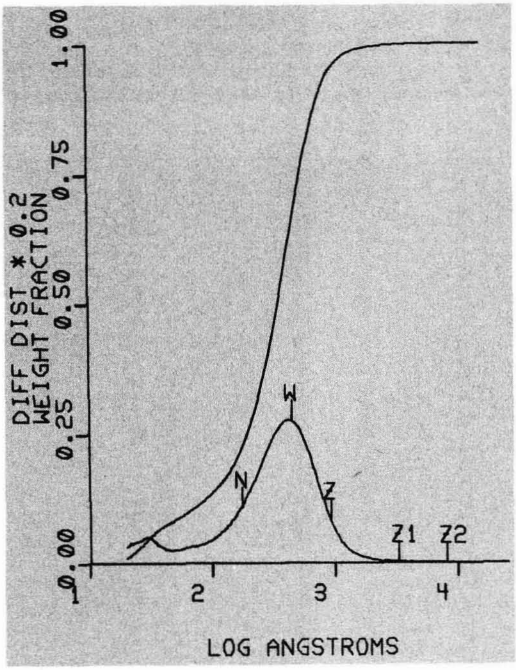


Figure 9—GPC curve of the acrylic copolymer isolated by solvent extraction

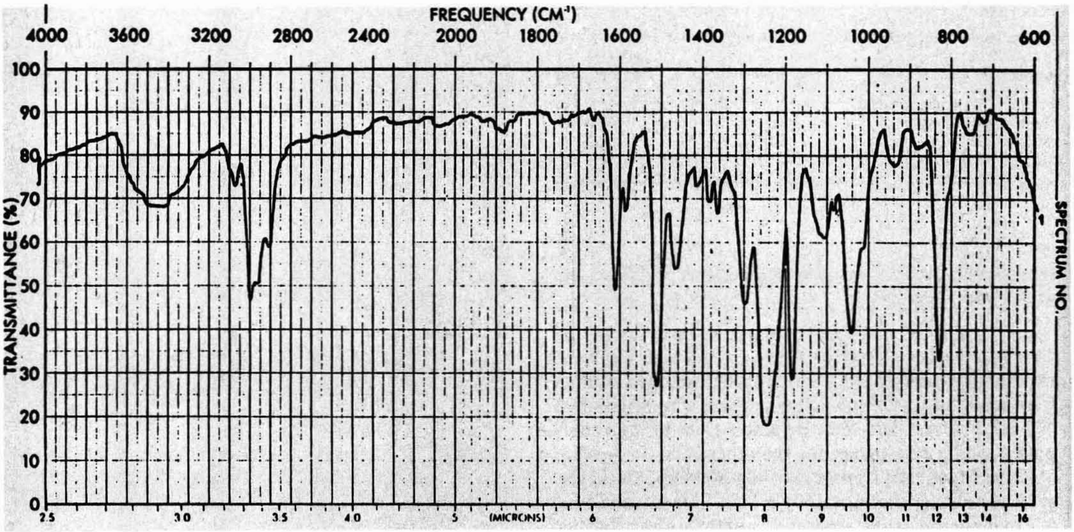


Figure 10—IR curve of extracted epoxy resin

ence spectrum of DER 669 epoxy resin (see *Figures* 10 and 11).

Figure 12 is a GPC curve of the epoxy used before the acrylic grafting. *Figure* 13 is a GPC of the extracted epoxy. It is evident that the molecular weight of the extracted epoxy is lower than the molecular weight of the initial epoxy. This may indicate one of two possibilities: (1) the higher molecular weight epoxy has a greater chance of being grafted; or (2) toluene is a better solvent for the low molecular weight epoxy.

To determine if the toluene is selective towards the low molecular weight epoxy, a Soxhlet extraction of DER 669® using toluene was carried out. DER 669 has approximately the same molecular weight as the epoxy used in preparing the graft copolymer. After three days of extraction all of the epoxy had been removed, indicating that toluene is not selective towards low molecular weight epoxy and that the higher molecular weight epoxy has a greater chance of becoming grafted.

Preferential grafting with higher molecular weight epoxy resin is in contrast with grafting on polystyrene.[5]

DER 669® is a solid epoxy resin, trademark of Dow Chemical Co.

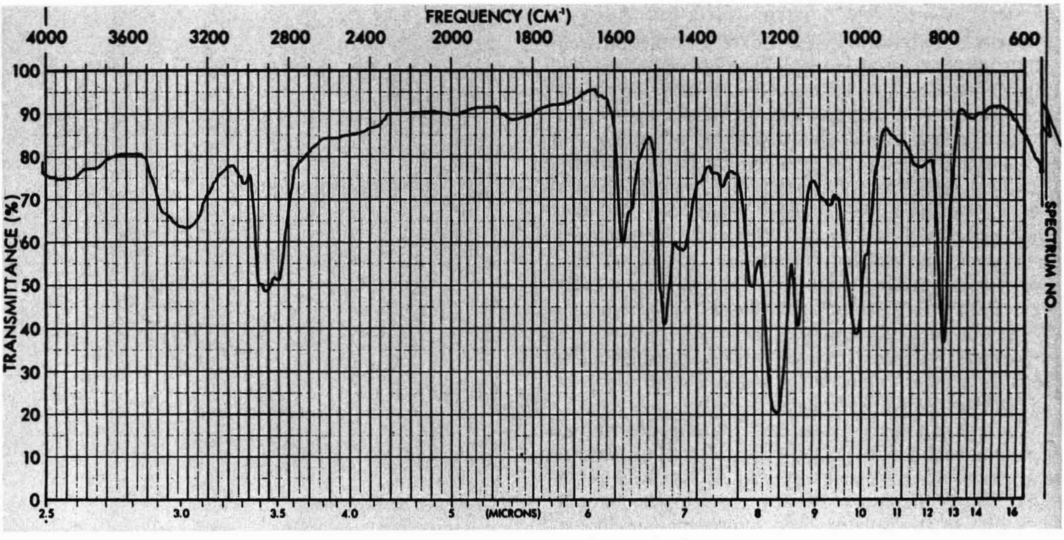
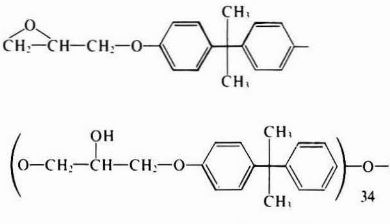


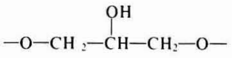
Figure 11—IR curve of DER-669 epoxy resin

The relative reactivity of polystyrene was found to increase with decreasing molecular weight and with dilution of the solution with benzene. These results suggest that the reactivity of polystyrene depends mainly on the nature of its coiled conformation in solution. In the epoxy resin case, the molecular weight of the epoxy resin is low compared to that of polystyrene. The higher molecular weight epoxy resin tends to have greater reactivity towards grafting. One of the reasons could be that there are more grafting sites available in a higher molecular weight epoxy resin. This can be demonstrated as followed: In a high molecular weight epoxy resin (Mn ~10,000)



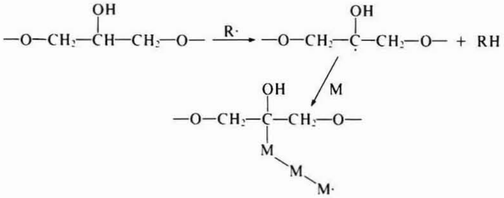
Mn = 9996

there are roughly 34 repeating units of



$$-O-CH_2-\overset{\overset{\displaystyle OH}{|}}{C}H-CH_2-O-$$

in the backbone. There are, therefore, also 34 × 5 = 170 hydrogens that can be abstracted by free radicals to form a radicals site where initiation of monomers can occur.



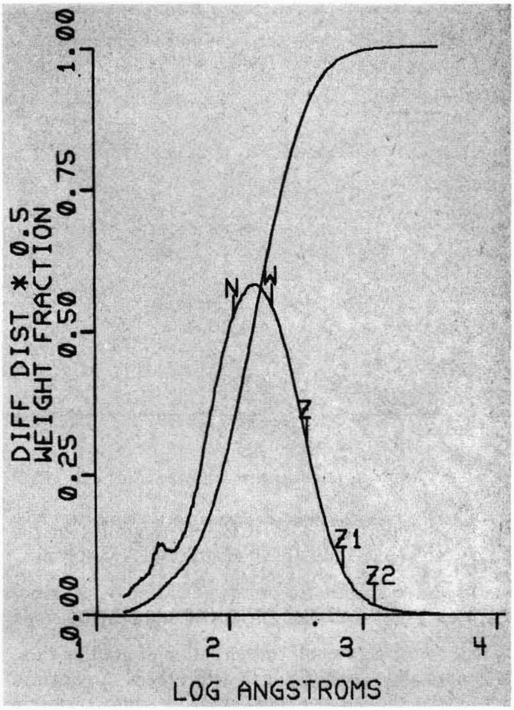
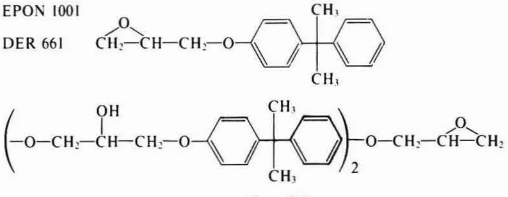


Figure 12—GPC curve of extracted epoxy resin

Now if a low molecular weight epoxy resin is used, e.g. Mn ~ 1000, Epon 1001 or DER 661 there are two repeating units



Mn = 908

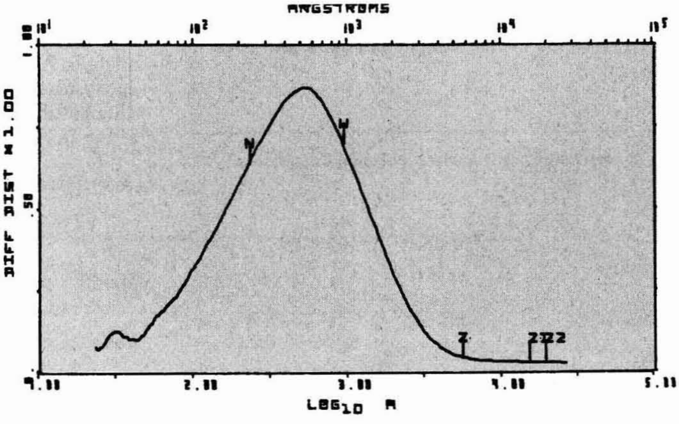
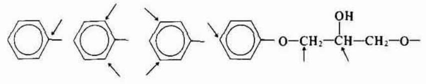


Figure 13—GPC curve of epoxy resin used before grafting

ERRATA

In the article, "Synthesis and Characterization of Water-Reducible Graft Epoxy Copolymers," by J.T.K. Woo, et al., appearing in the June issue: in discussing the peak assignments shown in Table 13, the peak positions reported in ppm are downfield from DMSO *and not from TMS*, as stated in the article.

Table 11—^{13}C NMR Analysis of Model Compound, *Phenyl Glycidyl Ether*



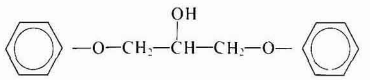
Model Compound	118.247[a] 28[b]	88.734 99	80.086 51	74.211 92	29.011 55	27.371 32
Model Compound + Acrylic	118.249 44	88.786 201	80.096 98	74.229 201	29.009 93	27.327 67

(a) Peak positions downfield from DMSO, ppm.
(b) Intensity of peak.

with two $-O-CH_2-\overset{OH}{\overset{|}{C}}H-CH_2-O-$ groups in the epoxy backbone and only 10 abstractable hydrogens.

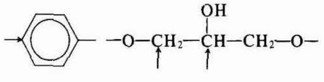
CHARACTERIZATION OF GRAFTING SITE

Due to the very small concentration of grafting sites, it is normally very difficult to detect them. An attempt was made to find out what were the most probable grafting sites on epoxy resin. Carbon 13 nuclear magnetic resonance (NMR) spectroscopy was used,[6] in which experiments were run in such a way that the carbons on the epoxy resin were magnified at the expense of the acrylic type carbons. Before going to the actual graft copolymer, a model compound was prepared. The model compound had the following structure:



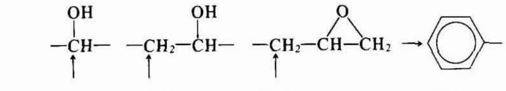
This was prepared by reacting phenol with phenyl glycidyl ether. The ^{13}C spectra were run in DMSO (dimethyl sulfoxide) which also acts as the internal standard. The peak positions and peak intensities of the various carbons in the model compound are listed in *Table* 11.

Table 12—^{13}C NMR Analysis of Model Compounds



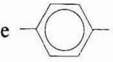
Model Compound	1	0.6	0.33
Model Compound + Acrylic	1	0.46	0.33

Table 13—Peak Assignment in Epoxy Resin

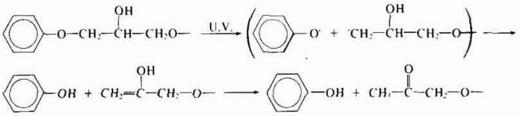


PPM	27.180	28.894	28.228	73.501

To estimate the extent of reaction at each carbon, the peaks were normalized with the para-carbon of the phenyl group as unity (see *Table* 12).

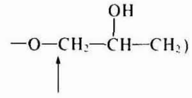
There is a significant decrease of about 30% in the peak height of the  $O-CH_2-$. For the model compound, the grafting appears to take place at the $-O-CH_2-$ carbon.

It is surprising to see that in the model compound, there is no decrease in the peak height in the carbon bearing the tertiary hydrogen (tertiary carbon). The tertiary hydrogen is probably more reactive than the secondary hydrogen, but statistically there are four times as many secondary hydrogens. Under photolytic conditions, the degradation of model compounds for epoxy resin is known[7] to take place at the phenoxy-carbon bond, as shown in the following:



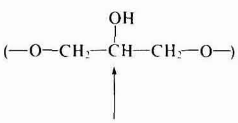
The assignment of these peaks in the epoxy resin is shown in Table 13. There is a small shift from those of the model compound (see *Table* 11). The peak positions reported in ppm are downfield from TMS.

Previously, a series of experiments with different level of free radical initiator were run. It was shown that by fractional precipitation there was a straight line relationship between the increase acrylic solubility or relative percent grafting with the percent free radical initiator (see *Figure* 7). These samples, made with different levels of free radical initiator, were submitted for ^{13}C NMR analysis. Assuming that there is the same amount of acid-epoxy reaction in these graft copolymers prepared with different levels of free radical initiator, the peak heights at the 28.9 ppm, due to



$$-O-\underset{\uparrow}{C}H_2-\overset{OH}{\overset{|}{C}}H-CH_2)$$

and 27.2 ppm, due to the tertiary carbon



$$(-O-CH_2-\underset{\uparrow}{\overset{OH}{\overset{|}{C}}}H-CH_2-O-)$$

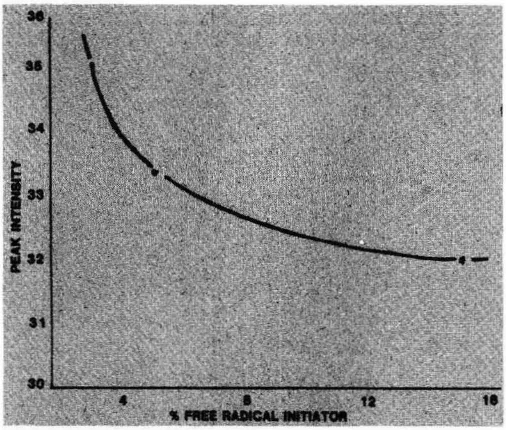


Figure 14—Peak intensity of the $-O-\underset{\uparrow}{C}H_2-\overset{OH}{\overset{|}{C}}H-CH_2-O-$ peak vs free radical initiator concentration (from ^{13}C NMR data)

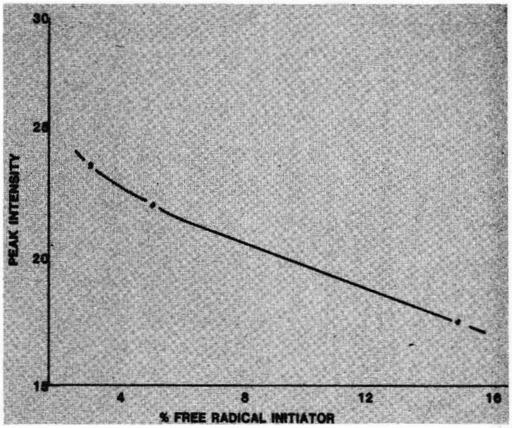
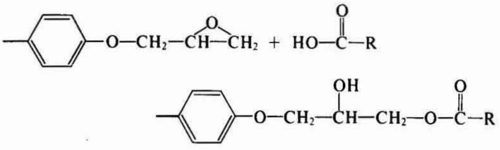


Figure 15—Peak intensity of the $-O-CH_2-\underset{\uparrow}{\overset{OH}{\overset{|}{C}}}H-CH_2-O-$ peak vs free radical initiator concentration (from ^{13}C NMR data)

were plotted against the free radical initiator concentration (see *Figures* 14 and 15). Clearly, the peak height of both $-O-CH_2-$ and $\overset{OH}{\overset{|}{-CH-}}$ decreased with increased concentration of free radical initiator, confirming the solvent fractionation to data.

In one experiment, where grafting was carried out without solvent, there was a significant decrease in the peak height at the methylene carbon α to the epoxide group (peak at 28.2 ppm). A plot of free radical initiator level vs the peak height of the 28 ppm peak using one of the phenoxy carbon peak (73.6 ppm) as internal standard was made (see *Figure* 16). In contrast, the peak at 28 ppm actually increased with free radical initiator content, indicating that there is probably no significant carbon-carbon bond grafting at that carbon atom.

The decrease in the peak for the methylene carbon α to the epoxide group (peak at 28.2 ppm) after grafting is probably due to the following reaction.



The ^{13}C NMR spectra of the epoxy resin and the graft copolymer are shown in *Figures* 17 and 18.

MECHANISM OF GRAFTING

From classical polymerization scheme, there is initiation, propagation, chain transfer, and termination.

In an idealized case, where transfer mechanism only occurs to a "Foreign Polymer," that is to say transfer to monomer is negligible, an equation can be derived to show that the rate of grafting is:

$$V_r = k_r [Pr] [R] [M]$$

Where

[Pr] is the concentration of growing polymer chains formed from the initiator.
[R] is the transfer polymer added to the system
[M] is the concentration of monomer.

Therefore, the highest yields of grafted copolymer should be obtained under the following conditions:

(1) Increasing concentration of transfer polymer to a limiting value;

(2) High rates of initiation obtained by (a) increasing initiator concentration and (b) increasing the polymerization temperature.

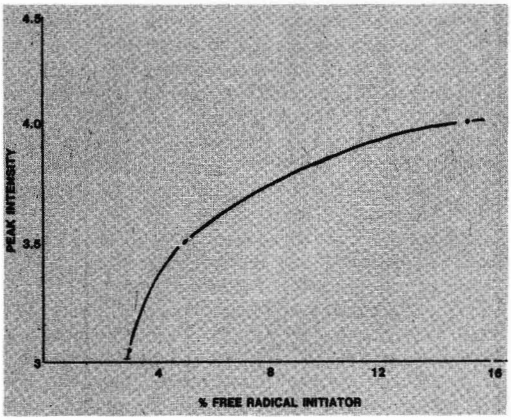


Figure 16—Peak intensity of the $-O-\underset{\uparrow}{C}H_2-\overset{O}{CH-CH_2}$ peak vs free radical initiator concentration (from ^{13}C NMR data)

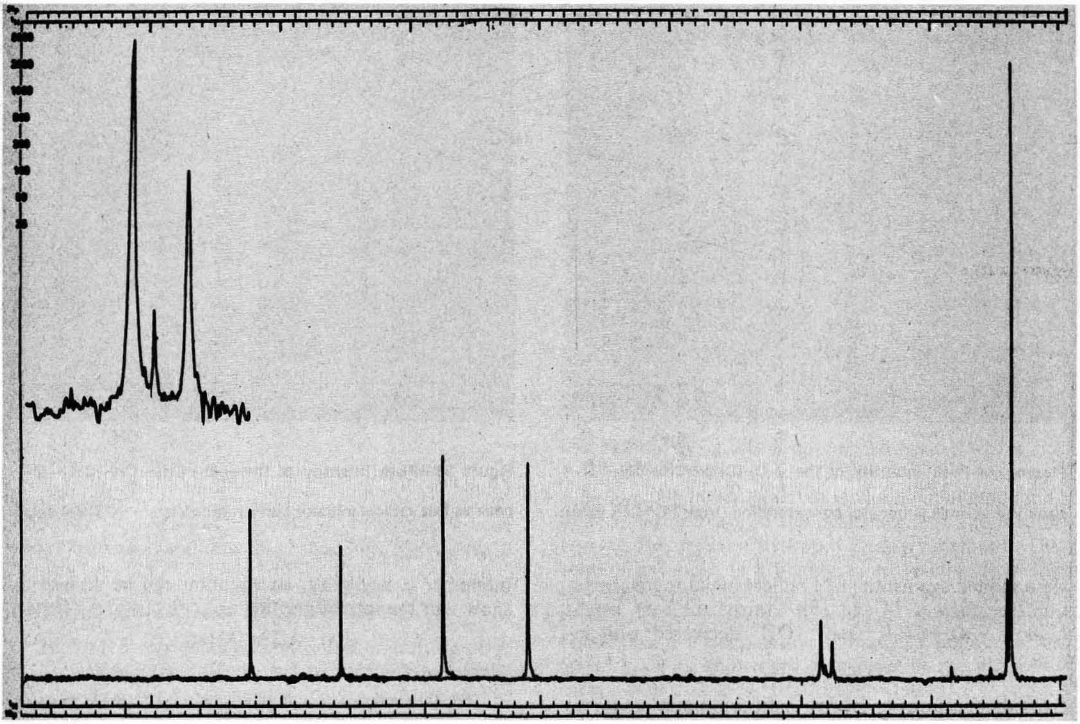


Figure 17—^{13}C NMR epoxy resin

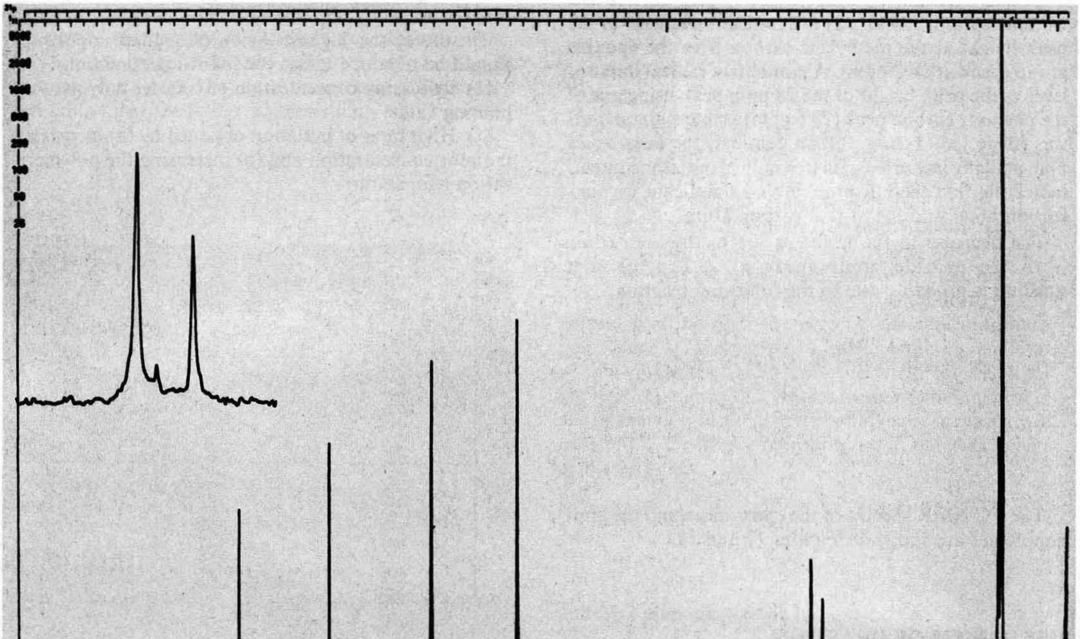
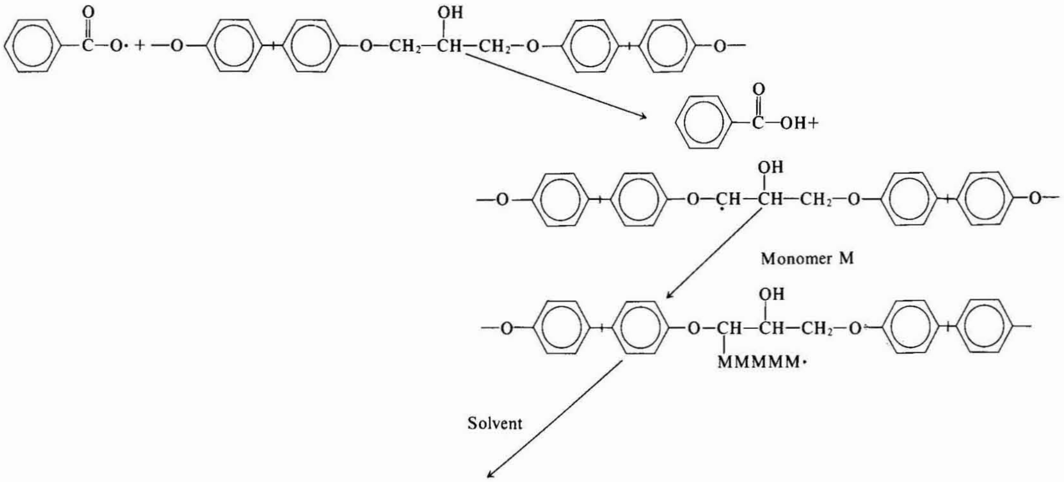


Figure 18—^{13}C NMR graft copolymer

Scheme A—Transfer with Epoxy Resin Backbone Initially

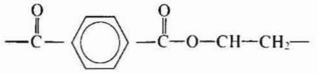


Termination by chain transfer with solvent or epoxy resin.

The latter is probably more likely due to proximity
and concentration of the aliphatic hydrogens of the epoxy backbone.

In practice it is not usually possible to take advantage of these conditions since the majority of polymers have limited solubility in "foreign" monomer solutions, particularly at elevated temperatures where the high initiation rates lead to gelation and phase separation. However, substitution of a resin of low molecular weight for the conventional backbone polymer of high molecular weight enables these difficulties to be overcome to a large extent. Low molecular weight polymers such as conventional epoxy resins, poly(ethylene glycols), poly(methoxy acetals), etc., are readily soluble in such monomers as methyl methacrylate, styrene, vinyl acetate, etc., to give high concentrations of "grafting polymer." Even at comparatively high rates of initiation these systems in many cases remain completely compatible and polymerization can be taken to complete conversion without phase separation on a macroscale.

There are numerous examples in the literature[1,8,9,12] where free radicals are generated on the polymer backbone followed by grafting of monomer onto the polymer, i.e., initiation of monomer occurring after chain transfer reaction. For example,[8] in grafting monomer onto polyester fiber, active centers seem to be created by direct hydrogen abstraction from the polyester molecules by the primary free radical species benzoyloxy radical or by the secondary free radical species phenyl radical. Benzoyl peroxide (BPO) was used as initiator. There was no mention of benzoic acid or benzene formation. The other mechanism mentioned was by oxidizing the polyester to hydroperoxide at several points along the chain in a random manner. The hydroperoxide decomposes into the active form at high temperature to produce ultimately macroradicals, one of which may be represented as



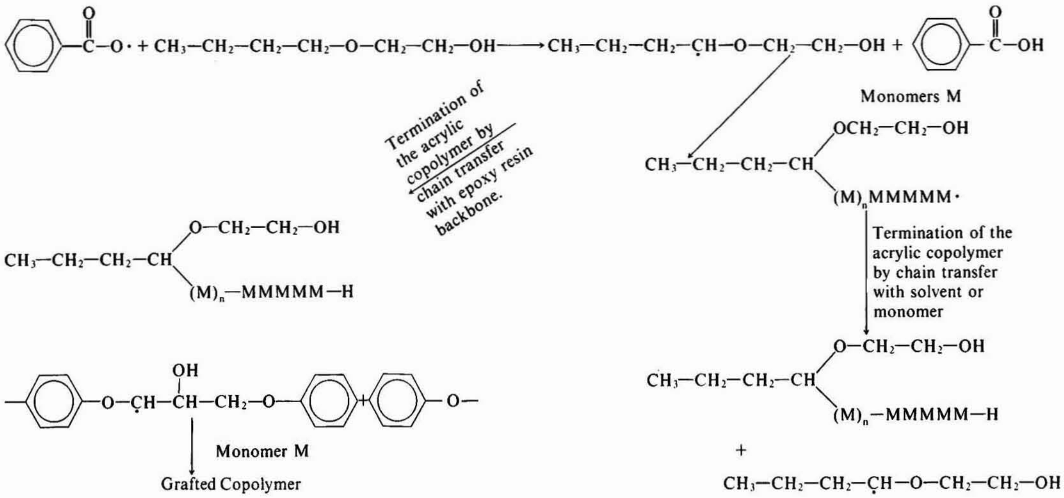
$$-\overset{O}{\overset{\|}{C}}-C_6H_4-\overset{O}{\overset{\|}{C}}-O-\dot{C}H-CH_2-$$

These radical sites permit attachment of monomer molecules which may grow into short chains. This is an example of "grafting from"[2] process where the free radical (or other active site) is generated on the backbone and subsequently it initiates the polymerization of monomers to produce branches. The other grafting process is the "grafting onto" where a growing free radical (or other active species) attacks another preformed polymer preferentially carrying suitable substituents and, thereby, producing a branch on the preformed backbone.

Graft epoxy-acrylic copolymer prepared with free radical initiator is an example of the "grafting from" process. In the case where benzoyl peroxide was used as the free radical initiator, it is determined that about 77% of the free radical initiator instead of causing initiation of monomers, chain transfer with the epoxy resin backbone, followed by the "grafting from" of monomers onto the epoxy resin. Benzoyl peroxide is known[10] to decompose mostly (90%) to the benzoyloxy radical and (10%) phenyl radical. Mechanisms of grafting can be demonstrated in Schemes A and B.

There is probably a very small amount of Scheme B present as the aliphatic protons of the epoxy resin are

Scheme B—Transfer with Butyl Cellosolve Initially



much more activated towards free radical abstraction than the hydrogen of the 2-butoxyethanol-1.

The 23% of the benzoyl peroxide that did not chain transfer would initiate polymerization of monomers to form ungrafted styrene methacrylic acid copolymer. This could be part of the reason that the ungrafted or free styrene methacrylic acid copolymer is of higher molecular weight than that of the styrene methacrylic acid copolymer made under the same conditions in the absence of the epoxy resin. This lower amount of free radical initiator would result in a higher molecular weight copolymer. The other reason is possibly due to viscosity effect, such as Trommsdorf effect where higher molecular polymer is obtained due to lesser chance of termination in a more viscous medium (i.e., in the presence of high molecular weight epoxy resin).

From the data generated so far, an attempt was made to determine the epoxy-acrylic graft copolymer composition.

Seventy-seven percent of the benzoyl peroxide formed benzoic acid by hydrogen abstraction. (From Example III in Experimental)

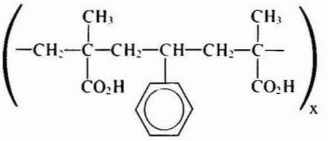
$11.6 \times 0.77 \cong 9$ mmol of BPO is involved in grafting

About half of the epoxy resin and about two-thirds of the acrylic are free; the grafted composition is now calculated and listed in *Table* 14.

Table 14—Epoxy-Acrylic Graft Copolymer Composition

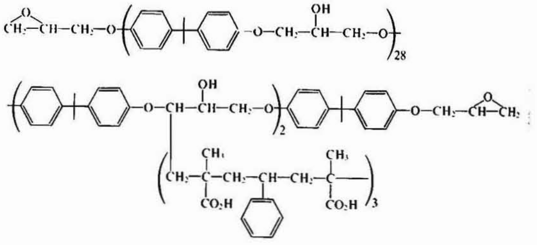
	Starting Composition mmol	Graft Composition mmol	Ratio
Epoxy	10	5	1
Acrylic	218	87	17
Benzoyl peroxide	11.6	9	2

Therefore, there are about two grafting sites per epoxy molecules and each grafted chain consists of ~9 acrylic units. The composition of the acrylic units are roughly 2:1 methacrylic acid; styrene or.



x here is roughly equal to 3.

The composition of the grafted copolymer is thus shown in the following:



Percent grafting efficiency can be calculated to be:

$$\% \text{ grafting efficiency} = \left(\frac{\text{monomer grafted}}{\text{monomer grafted} + \text{free copolymer}}\right)(100\%)$$
$$= (8/20)(100\%) = 40\%$$

The apparent degree of grafting[11] is defined as:

$$G = [(W\text{-}Wo)/Wo] \times 100$$

G: apparent degree of grafting as a percent
Wo: weight of sample before grafting
W: weight of sample after grafting

For the epoxy-acrylic graft copolymer, the apparent degree of grafting is:

$$G = \left[\frac{\text{(free epoxy + graft epoxy-acrylic copolymer)} - \text{epoxy before grafting}}{\text{epoxy before grafting}}\right](100\%)$$

$$= \left(\frac{88-80}{80}\right)(100\%) = 10\%$$

Anchor/graft ratio based on molecular weight is:

$$A/G = \frac{8858}{828} = 10.7$$

SUMMARY

Synthesis of epoxy-acrylic graft copolymer using free radical means was described. Characterization of the graft copolymer by solvent extraction indicated that the graft copolymer is consisted of the following: (1) 47% of the epoxy resin is ungrafted; (2) 61% of the acrylic monomer polymerizes to form acrylic copolymer; and (3) 39% of the acrylic monomer is grafted onto 53% of the epoxy resin.

Characterization of grafting sites on the epoxy resin by NMR spectroscopy indicated that grafting takes place at the aliphatic carbon atoms of the epoxy resin.

The mechanism of grafting was discussed. The mechanism follows the "grafting from" process in which a free radical is generated on the epoxy backbone and subsequently it initiates the polymerization of monomers to produce branches. The composition of the epoxy-acrylic graft polymer is also discussed. For each epoxy resin molecule, ~8000 molecular weight, there are about two grafting sites. Each grafted acrylic chain consists of 828 molecular weight.

The epoxy functionality is not necessary for grafting, as a graft copolymer can be made with a Bisphenol-A terminated epoxy resin.

ACKNOWLEDGMENT

The authors wish to thank Glidden Co., Div. of SCM Corp. for permission to publish this work.

References

(1) Ceresa, R. J., *The Chemistry of Polymerization Processes,* A.C.S. Monograph No. 20, pp. 249–260, 1966.
(2) Kennedy, J. P., *Polymer Symposium, 64,* 117 (1978).
(3) Mino, G. and Kaizerman, S., *J. Polymer Sci., 31,* 242 (1958).
(4) Ceresa, R. J., *J. of Polymer Sci., 53,* (1961), p. 9–15.
(5) Ohto, N., Niki, E., and Kamiya, Y., *J. Chem. Soc.,* 1416 (1976).
(6) Sojka, S. A. and Monitz, W. B., *J. Appl. Polymer Sci., 20,* 1977 (1976).
(7) Private communication with Professor Peter Pappas of the North Dakota State University.
(8) Abdel-Fattah, S. H., Shalaby, S. E., Allam, E. A., and Habeish, A., *J. Appl. Polymer Sci., 21,* 3355 (1977).
(9) Misra, B. N. and Dogra, R., *J. Macromol. Sci. Chem.,* A14(5), 763 (1980).
(10) Allen, P. W., Ayrey, G., and Moore, C. G., *J. Polymer Sci., 36,* 55 (1959).
(11) Sundari, F., *J. Appl. Polymer Sci., 22,* 3163 (1978).
(12) Beddows, C. G., Gil, H., and Guthrie, J. T., *Polymer Bulletin, 3,* 645 (1980).

ORDER FORM

PICTORIAL STANDARDS OF COATINGS DEFECTS

Revised and updated edition of this manual (previously titled "Exposure Standards Manual") has been compiled in conjunction with the American Society for Testing and Materials, and includes definition, description, and photographic standards for each of the following defects: Blistering; Chalking; Checking; Cracking; Erosion; Filiform Corrosion; Flaking; Mildew; Print; Rust; Traffic Paint Abrasion and Chipping.

Also included is reference information on supplementary standards, along with sample record sheets for compiling exposure data.

Bound in handsome 10" x 11½" x 1½" three-ring, vinyl-covered binder which readily accommodates additional material as it is developed.

Complete manual . . . $75 (plus shipping charges)

Individual Standards . . . $2 each, plus $2 for each photograph.

Record Sheets (pad of 100 sheets) . . . $2.50

Name ______________________________

Company ______________________________

Address ______________________________

City ______________________ State ______________ Zip Code ____________

PLEASE MAKE ALL CHECKS PAYABLE IN U.S. FUNDS

MAIL TO:
Federation of Societies for Coatings Technology
1315 Walnut Street ■ Philadelphia, Pa. 19107

Pennsylvania residents please add 6% sales tax

Federation of Societies for Coatings Technology

Conductivity Control of Cathodic Electrocoating

W.S. Springer, G.G. Strosberg, and J.E. Anderson
Ford Motor Company*

The conductivity of an automotive cathodic electrocoat bath was controlled by purging concentrate from a reverse osmosis (RO) unit. The RO unit separated ultrafiltrate into concentrate, which was segregated for waste treatment, and permeate, which was returned to the electrocoat system. This process reduced the volume requiring waste treatment by approximately 60%. Procedures were developed to reduce membrane fouling with its consequent decrease in permeate output. These included periodic chemical cleaning of the RO membranes and continuous pH control of the ultrafiltrate feed. Through the use of these procedures, the RO unit provided satisfactory performance during a year of operation.

INTRODUCTION

The cathodic electrocoat process (electrodeposition of paint at cathode) is now widely used to apply primer to automotive bodies.[1] Ultrafiltration, a membrane separation process, plays a key role by providing good utilization of the paint materials and by removing contaminants from the electrocoat bath.[2] Ultrafiltrate (permeate) is extracted from the electrocoat bath by pumping the bath past semipermeable membranes which allow water and ionic species to pass while retaining the pigment and large molecular weight resin particles. The ultrafiltrate is essentially water which contains solubilizer, other ionic materials, solvents, and low molecular weight ($<$18,000 M.W.) resins. The ultrafiltrate is normally used in a counterflow spray rinse system after electrodeposition to rinse off and return paint solids to the electrocoat bath. A portion of the ultrafiltrate is discarded (purged) to control bath conductivity. However, this ultrafiltrate purge has a high biochemical oxygen demand (BOD) and in some localities, discharge to the sewer system is either severely limited, subjected to a surcharge, or prohibited. In these areas, the purged material is hauled away by a licensed waste treatment contractor for disposal at an approved site.

Preliminary work at the Ford Motor Company's Ohio Truck Plant in 1978 and 1979 indicated that the volume of ultrafiltrate requiring treatment could be reduced by using reverse osmosis (RO) to extract from the ultrafiltrate an RO permeate which is returned to the rinse system.[3]

Reverse osmosis, like ultrafiltration, is a membrane separation process. In reverse osmosis, the application of external hydrostatic pressure across a semipermeable membrane causes water to flow from a more concentrated to a more dilute solution.[4] In contrast to ultrafiltration membranes, which pass dissolved inorganic salts, RO membranes reject the passage of ionic species. In the present application, both ions and paint residues are rejected. Therefore, the solution passing through the membrane contains water and low molecular weight organic solvents. Since the ionic materials are rejected and retained in the RO concentrate, discharge of this material controls bath conductivity.

---

*Manufacturing Process Laboratory, 24500 Glendale Ave., Detroit, MI 48239.

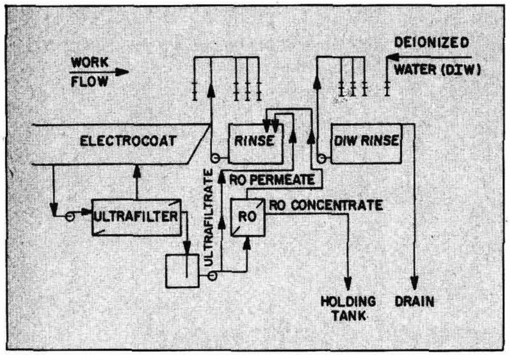


Figure 1—Reverse osmosis location within electrocoat system

Table 1—Purge Volumes With and Without Reverse Osmosis Treatment

PURGE MATERIAL	ULTRAFILTRATE	RO CONCENTRATE
TEST PERIOD (WEEKS)	5	5
FEED USED		
LITERS	144,981	172,895
(GALLONS)	38,304	45,679
CONDUCTIVITY (μmho)		
START OF PERIOD	1,370	1,340
END OF PERIOD	1,420	1,333
PURGE		
LITERS	162,755	116,192
(GALLONS)	43,000	30,698
RATIO (PURGE/FEED)	1.12	.67

EXPERIMENTAL

An Osmonics® RO unit (Model 880-43-SS97B) was placed in service at the Ford Motor Company's St. Thomas (Ontario, Canada) Assembly Plant on November 27, 1979. Its location within the electrocoat system is shown schematically in *Figure* 1. Ultrafiltrate, stored in a holding tank, is the inlet feedwater for the RO system. A portion of this feed stream passes through the semi-permeable RO membranes under the application of hydrostatic pressure. This stream, the RO permeate, contains substantially lower concentrations of paint residue and inorganic species than the ultrafiltrate feedstream. The remaining portion of the feedstream that *did not pass through the* RO *membrane* becomes RO concentrate. The present equipment uses cellulose acetate membranes that have a rated capability for 97% salt rejection for a 1000 mg/l saline solution. A 2758kPa (400 psi) hydrostatic pressure was used. The membranes are packed in spiral wound modules, each having a 102mm (4in.) diameter and a 991mm (39in.) length, and containing 5.1 m^2 (55ft^2) of membrane area. The four pressure vessels in the RO unit each hold four modules in series, providing 16 modules in the unit with 76.5 m^2 (880 ft^2) of membrane area. In these modules the permeate, after passing through the membranes, follows a spiral path to a perforated tube centered in the module. Since a single pass of ultrafiltrate through the unit would provide low recovery (permeate flow/feed flow) some of the RO concentrate is recycled. *Figure* 2 illustrates the arrangement of the pressure vessels within the unit, and also shows the auxiliary cleaning tank and pump which permit a "clean in place" (CIP) treatment of the membranes. An acid feed pump permits metering acid into the feedstream to maintain the feed pH at a preset value.

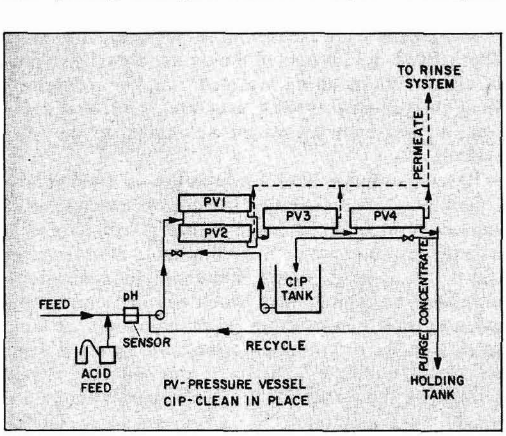


Figure 2—Arrangement of pressure vessels in reverse osmosis unit

During the one-year test period, St. Thomas Assembly Plant personnel daily recorded operating data, and these data were collected weekly, along with samples, during the periods set aside for investigation of various cleaning methods. The samples obtained were subsequently analyzed at the Ford Research Laboratories.

After start-up, the initial period of RO operation was used to evaluate its effect on the electrocoat process, and to investigate various cleaning methods. The most suitable were (1) a CIP procedure using a solution of 5% lactic acid and 5% detergent in deionized water and (2) injection of minute amounts of acetic acid into the feed stream during normal processing of ultrafiltrate to maintain the feed pH at 5.0 (± 0.2).

Once the preferred operating parameters were established, the unit was usually operated each production day, with the acid pump used to maintain the feed pH at 5.0. The daily operating time was adjusted to provide the

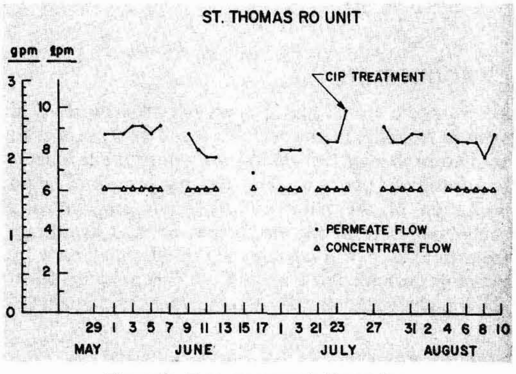


Figure 3—Reverse osmosis flow rates

Table 2—Analyses of RO Flow Streams

FLOW:	FEED	PERMEATE	CONCENTRATE	% RECOVERY
LITERS/MIN.	14.8	8.7	6.1	59
GALLONS/MIN.	3.9	2.3	1.6	59
ANALYSES:	FEED	PERMEATE	CONCENTRATE	% REJECTION
NON-VOLATILE (%)	.32	.09	.66	72
ACETIC ACID (%)	.097	.044	.113	55
pH	4.80	3.70	5.10	—
CONDUCTIVITY (μmho)	810	115	1500	86
CALCIUM (mg/l)	6.2	0.5	9.0	92
LEAD (mg/l)	240	8.3	432	97
SILICON (mg/l)	37	7	51	81

desired effect on the conductivity of the electrocoat bath. On some occasions the RO unit was idle due to production downtime, or to facilitate comparisons of the electrocoat process with and without RO use.

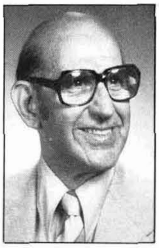
RESULTS AND DISCUSSION

Table 1 provides a comparison of purge volumes for electrocoat operation with and without reverse osmosis treatment. The first volume represents discharged ultrafiltrate; the second, RO concentrate. Both sets of data were collected over five-week intervals while bath conductivity was stable. A useful measure of the efficiency of the RO process is the ratio of purge volume to the volume of paint feed added to the electrocoat bath. The experimental ratios were (a) 1.12 without RO and (b) 0.67 with RO treatment. Ideally, this ratio should be as low as possible to minimize waste haulaway and treatment costs. It is limited by (a) mass balance constraints on water in the electrocoat process and (b) reversible fouling of the RO membrane under operation at fractional recovery $> 60\%$.

Control of the ultrafiltrate pH is instrumental in producing a stable permeate output. From May 30 to August 9, 1980, the RO unit was used on 30 days for an average of 12.3 hours daily. 58.7% of the feed processed during this period was returned to the rinse system as RO permeate. *Figure* 3 is a graph of the RO flow rates for this period when the feed pH was maintained at 5.0 (±0.2). This was accomplished automatically with controlled additions of acetic acid. The beneficial effect of the lower feed pH level is probably due to increased solubility of lead salts at the lower pH. Although other acids could be used for pH adjustment, acetic acid was selected because it also serves as the solubilizer in the electrocoat bath. Since excess solubilizer is continually removed from the bath through the anolyte system, the small amount of acid returned to the bath in the RO permeate does not adversely affect the solubilizer balance. In addition to maintaining the pH of the feed at 5.0 (±0.2), on one occasion during this period (July 24), a CIP treatment was carried out for one hour, using a solution of 5% lactic acid and 5% detergent in deionized water. This treatment improved the permeate output from 8.3 to 9.8 l/m (2.2 to 2.6 GPM).

Extensive analytical data indicate that the RO unit effectively removes ionic materials and paint resin constituents from the ultrafiltrate. *Table* 2 contains typical analyses of the three RO flow streams. The feed pH of 4.80 indicates that the acid feed system was in use when these samples were collected. The low levels of nonvolatiles (resin), conductivity, and cations in the RO permeate show that these materials were effectively rejected by the membranes and retained in the RO concentrate. During the one-year trial period, no adverse effects were noted from the return of RO permeate to the rinse system (and thence to the electrocoat bath). This returned permeate also decreased solvent and deionized water additions required for the electrocoat bath.

WILLIAM SPRINGER obtained a B.S. in Chemical Engineering in 1949, from Michigan State University. Following graduation, he was employed by the Michigan Water Resources Commission, and then as a plating chemist for Union Steel Products Co. Mr. Springer joined Ford Motor Co. in 1955 as a plating process engineer. His present assignment is the development of new electrocoat materials and processes with the Manufacturing Processes Laboratory of Ford's Engineering and Research Staff.



GORDON G. STROSBERG obtained a B.S. in Electrical Engineering from the University of Detroit in 1947. Following graduation he worked for Columbia Mills, Consolidated Trades, and Chevrolet Gear and Axle Division of General Motors before joining the Ford Motor Co. in 1951. Mr. Strosberg worked in Plant Engineering Department, Lincoln-Mercury Division, before moving to Manufacturing Staff where he worked in Plant Layout and Facilities Engineering. In 1959, he moved to the Manufacturing Development Office where he was responsible for design of facilities and development of process for electrocoating. His current assignment is with the Manufacturing Processes Laboratory, Engineering and Research Staff.

JAMES E. ANDERSON received a B.S. in Chemistry from Union College in 1960 and a Ph.D. in Physical Chemistry from Princeton University in 1963. He held a Post-Doctoral appointment at Bell Telephone Laboratories before joining the Ford Research in 1965. Dr. Anderson received a Humboldt Fellowship in 1975 and spent a year at the Max Planck Institut für Biophysik in Frankfurt, Germany. He has served on the Editorial Board of the *Journal of Membrane Science* since 1977. Dr. Anderson is presently in the Fuels and Lubricants Department of the Ford Engineering and Research Staff.

CONCLUSIONS

The conductivity of a cathodic electrocoat bath can be controlled by purging RO concentrate derived from the ultrafiltrate normally purged. The RO permeate can be returned to the electrocoat system, thereby, reducing the volume of waste requiring treatment. The use of acetic acid for pH control of the RO feed is effective in maintaining stable permeate output in such a system.

ACKNOWLEDGMENTS

The authors appreciate the assistance of many Ford colleagues during this study. Especially helpful were E. Bancroft, N. Buwalda, D. Farr, R. H. Hellner, T. M. Hunt, B. Joshi, L. Westwood, and C. W. Zawacki. We also benefited from conversations with L. F. Comb, of Osmonics, Inc.

References

(1) Wismer, M. and Bosso, J.R., "Make the Part the Cathode: Key to Resistant Coatings," *Chem. En.*, June 14, 1971, p. 114.
(2) Zahka, J. and Mir, L., "Ultrafiltration of Cathodic Electrodeposition Paints," *Plating and Surface Finishing*, November 1979, p. 34.
(3) Anderson, J.E., Springer, W.S., and Strosberg, G.G., "Application of Reverse Osmosis to Automotive Electrocoat Paint Wastewater Recycling," *Desalination*, 36, (1981) p. 179.
(4) Spatz, D.D., "Reclamation Via Reverse Osmosis," *Chem. Tech.*, Vol. 7, November 1977, p. 696.

Bis Cyclic Urea Compounds as Masked Aliphatic Isocyanate Curing Agents For Baking Enamels

Philip W. Sherwood
The Upjohn Company*

Bis cyclic urea compounds dissociate upon heating without the release of volatile by-products to produce aliphatic diisocyanates. The use of these compounds as curing agents for baking enamels formulated from hydroxy-functional coating resins is currently being evaluated. Sprayable solution coatings have been formulated using N,N′-azelaoyl bis(trimethylene urea) ["azelaoyl BCU"] in combination with commercially available acrylic and epoxy resins. The properties of coatings cured with azelaoyl BCU are presented. The effects of catalysts, cure time, cure temperature, and urea concentration on coating properties are presented and discussed.

INTRODUCTION

Blocked aliphatic diisocyanates are used in light stable one-component polyurethane coating systems. Examples of such systems are baking enamels and powder coatings. Blocked isocyanates are commonly produced by reacting the free isocyanate with active hydrogen-containing compounds, notably oximes, phenol, and ε-caprolactam. Heating of the blocked isocyanate regenerates the free isocyanate, but the blocking agent is released as an often undesirable volatile by-product (*Figure* I).

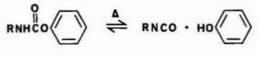
Bis cyclic urea compounds, with the general formula presented in *Figure* II, thermally dissociate to produce aliphatic diisocyanates without the formation of volatile by-products.[1] This process is illustrated in *Figure* III. The formation of isocyanate groups from these compounds has been confirmed by infrared spectroscopy and by trapping with alcohols to produce the biscarbamates.[2]

The use of bis cyclic ureas as thermally activated isocyanate curing agents for coating systems based on resins containing pendant hydroxyl groups is currently under study. N,N′-azelaoyl bis(trimethylene urea) ["azelaoyl BCU"] (*Figure* IV) has been selected to illustrate this application of bis cyclic urea compounds and is the subject of this paper. The pertinent chemical and physical properties of azelaoyl BCU are presented in *Table* 1. The coating resins used were commercially available hydroxy-functional acrylic and epoxy resins, and are summarized in *Table* 2.

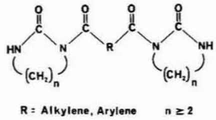
Although all of the coatings described in this paper were prepared as solution vehicles, powder coating formulations have also been prepared. The use of bis cyclic urea compounds in powder coatings will be the topic of a future report.

---

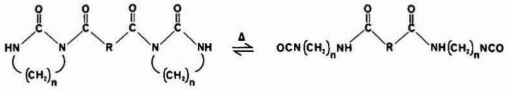
*Donald S. Gilmore Laboratories, North Haven, CT 06473.



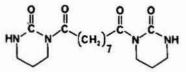
I



II



III



IV

EXPERIMENTAL

Coatings Preparation, Application, Curing, and Shelf Stability

The coatings described herein were prepared as solution vehicles. The azelaoyl BCU, exhibiting low solubility in the solvents used (*Table* 1), was incorporated by ball milling. Unless otherwise stated, all coatings were prepared using a stoichiometric quantity of azelaoyl BCU based on the hydroxyl content of the coating resin (i.e., 1:1 NCO/OH).

All formulations were pigmented white using an enamel grade of titanium dioxide at a level of 50% TiO_2 by weight of binder (i.e., coating resin + azelaoyl BCU).

Table 1—Chemical and Physical Properties of Azelaoyl BCU

Chemical formula	$C_{17}H_{28}N_4O_4$
Molecular weight	352
NCO Equivalent weight	176
Melting range	108 – 110°C
Approximate solubility at 25°C	
Solvent	g/100g Solvent
Methyl ethyl ketone	17
Methyl n-amyl ketone	3
Ethyl acetate	6
n-Butyl acetate	2
Ethylene glycol monoethyl ether acetate	14
Toluene, xylene	<1
Diethylene glycol dimethyl ether	33
Ethylene glycol monoethyl ether	80

Table 2—Commercially Available Hydroxy-Functional Acrylic and Epoxy Coating Resins

Trade Name	Resin Type	Physical Form	Hydroxyl Equivalent Weight (on solids)
G-Cure® 867	Acrylic	Solution—60% N.V.	600
Coroc® A2500M	Acrylic	Solution—60% N.V.	374
Polytex® 975	Acrylic	Solution—70% N.V.	365
Araldite® GT-7074	Epoxy	Solid	340
Epon® 1007F	Epoxy	Solid	314

A typical azelaoyl BCU-containing white acrylic coating formulation is presented in *Table* 3.

The coatings were applied using conventional air atomization spray equipment onto zinc phosphate (Bonderite® 880) treated cold-rolled steel test panels. After allowing 10 to 20 min for solvent evaporation, the coatings were cured in a circulating air oven that was temperature controlled to ±0.5° C.

The film thickness of the cured coatings averaged two mils (50 μm).

None of the azelaoyl BCU-containing solution vehicles showed any significant changes in viscosity after six months storage at room temperature. BCU settling upon storage did occur, but redispersion was readily accomplished via hand stirring or mechanical shaking.

Test Procedures

The cured coating films were evaluated using the following test methods:

Pencil Hardness: Pencil hardness was evaluated per ASTM D3363-74. Results are reported as gouge hardness/scratch hardness, where gouge hardness is the hardest lead that does not cut through the coating while scratch hardness is the hardest lead that will not mar the surface of the coating.

MEK Resistance: MEK resistance was determined by applying six to eight drops of methyl ethyl ketone onto the surface of the coating and covering with a one-inch watchglass. After a five-minute exposure period, the films were checked for solubility (manual rub). Insoluble

Table 3—Typical Azelaoyl BCU-Containing Solution Coating Formulation

	Parts by Wt.
Acrylic resin solution (60% Non-Volatile)[a]	100.0
Azelaoyl BCU	17.6
Enamel grade TiO_2	38.8
Solvents[b]	38.0
	194.4

	Percent by Wt.
Binder solids content	40%
Total nonvolatile content	60%

(a) G-Cure® 867.
(b) 2:1 (w:w) Methyl ethyl ketone/Ethylene glycol monoethyl ether acetate.

Table 4—Properties of Acrylic and Epoxy Based White Coatings Cured with Azelaoyl BCU[a]

Coating	Coating Type	Pencil Hardness	MEK Resistance	Conical Mandrel Flexibility inch (mm)	Impact Resistance in · lb (Joule)	
					Reverse	Direct
867/Azelaoyl BCU	Acrylic	4H/F	<6B	<1/8 (<3)	<1 (<0.1)	10 (1.1)
A2500M/Azelaoyl/BCU	Acrylic	4H/HB	<6B	<1/8 (<3)	60 (6.8)	120 (13.6)
975/Azelaoyl/BCU	Acrylic	3H/B	<6B	<1/8 (<3)	10 (1.1)	25 (2.8)
GT-7074/Azelaoyl BCU	Epoxy	6H/F	6H/F	<1/8 (<3)	40 (4.5)	100 (11.3)
1007F/Azelaoyl BCU	Epoxy	6H/F	6H/F	<1/8 (<3)	60 (6.8)	120 (13.6)

(a) All coatings contained 1% dibutyltin dilaurate catalyst by weight of resin solids and were cured for 30 min at 175°C.

Table 5—Adhesion of Acrylic and Epoxy Based White Coatings Cured with Azelaoyl BCU[a]

Coating	Coating Type	Adhesion		
		Untreated Cold-Rolled Steel	Zinc Phosphate Treated Cold-Rolled Steel	Alodine Treated Aluminum
867/Azelaoyl BCU	Acrylic	4B	4B	4B
A2500M/Azelaoyl BCU	Acrylic	5B	5B	4B
975/Azelaoyl BCU	Acrylic	5B	5B	4B
GT-7074/Azelaoyl BCU	Epoxy	5B	5B	5B
1007F/Azelaoyl BCU	Epoxy	5B	5B	5B

(a) All coatings contained 1% dibutyl tin dilaurate catalyst by weight of resin solids and were cured for 30 min at 175°C.

films were immediately tested for pencil hardness per ASTM D3363-74. Pencil hardness results are reported in gouge/scratch hardness values as indicated above, but films which were MEK insoluble yet soft enough to crumble under a 6B lead are rated "<6B."

FLEXIBILITY: Flexibility was determined using a conical mandrel per ASTM D522-60. Results are reported as the smallest mandrel diameter, to the nearest 1/8-inch (3mm), at which coating failures such as cracking or crazing are not observed. The minimum diameter of the mandrel used was 1/8-inch (3mm) and the maximum was one inch (25mm). Films which did not fail this test are rated <1/8″ (<3mm), and films which failed throughout the bend area are rated >1″ (>25mm). The thickness of the test panels used for flexibility determinations was 0.010″ (0.25mm).

IMPACT RESISTANCE: Impact resistance was determined per ASTM D2794-69 using a Gardner Heavy Duty Impact Tester, Model No. IG1120. Values for both direct and reverse impact are reported in inch·pounds (Joules). The thickness of the test panels used for impact measurements was 0.020″ (0.51mm).

ADHESION: Coating/substrate adhesion was determined using the cross-cut tape test (Method B) of ASTM D3359-78. Scotch® Brand Tape No. 810 was used, and results are reported on a scale of 5B (best adhesion) to 0B (worst adhesion) in accordance with the descriptions outlined in the ASTM procedure. In addition to assessing adhesion on zinc phosphate treated cold-rolled steel test panels, coating adhesion on untreated cold-rolled steel and alodine treated aluminum (3003 H14 alloy) test panels was also measured.

RESULTS AND DISCUSSION

The properties of various acrylic and epoxy based white coatings cured with azelaoyl BCU are listed in *Table* 4. These coatings are hard, flexible, and insoluble in methyl ethyl ketone. Impact resistance is varied. These films also exhibit good adhesion to both untreated and zinc phosphate treated cold-rolled steel and to alodine treated aluminum substrates, as shown by the data in *Table* 5.

Organometallic urethane catalysts reduce the time and temperature required for effective curing of coatings

Table 6—Pencil Hardness of Azelaoyl BCU Cured White Acrylic Coatings as a Function of Dibutyltin Dilaurate Catalyst Concentration[a,b]

A. Cure Temperature—175°C

Cure Time	No DBTDL	0.5% DBTDL	1.0% DBTDL
5 minutes	HB/B	F/HB	H/HB
15 minutes	H/HB	4H/HB	4H/F
30 minutes	2H/HB	4H/F	4H/F

B. Cure Time—30 Minutes

Cure Temp.	No DBTDL	0.5% DBTDL	1.0% DBTDL
160°C	H/HB	2H/HB	3H/HB
168°C	2H/HB	4H/HB	4H/F
175°C	2H/HB	4H/F	4H/F
185°C	2H/HB	4H/F	4H/F
195°C	4H/F	4H/F	4H/F

(a) Acrylic resin used was G-Cure® 867.
(b) DBTDL catalyst concentration is expressed as percent by weight of resin solids.

Table 7—Properties of a White Acrylic Coating Cured with Azelaoyl BCU as a Function of Cure Time and Cure Temperature[a,b]

	150°C		160°C		168°C		175°C		200°C	
Cure Time	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.
5 min	(Not Tested)		B/B	Soluble	HB/B	Soluble	F/HB	<6B	4H/F	<6B
15 min	HB/HB	Soluble	F/HB	<6B	2H/HB	<6B	4H/F	<6B	4H/F	<6B
30 min	F/HB	<6B	3H/HB	<6B	4H/F	<6B	4H/F	<6B	(Not Tested)	

(a) Acrylic resin used was G-Cure® 867.
(b) All coatings contained 1% dibutyltin dilaurate catalyst (by wt. R.S.).

Table 8—Properties of a White Epoxy Coating Cured with Azelaoyl BCU as a Function of Cure Time and Cure Temperature[a,b]

	150°C		160°C		168°C		175°C		200°C	
Cure Time	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.	Pencil Hardness	MEK Resist.
5 min	(Not Tested)		F/B	Soluble	F/HB	<6B	H/HB	<6B	6H/F	F/B
15 min	F/B	Soluble	5H/HB	<6B	6H/HB	6B/6B	6H/F	F/B	6H/F	6H/F
30 min	2H/F	<6B	6H/HB	3B/3B	6H/HB	2H/B	6H/F	4H/HB	(Not Tested)	

(a) Epoxy resin used was Araldite® GT-7074.
(b) All coatings contained 1% dibutyltin dilaurate catalyst (by wt. R.S.).

containing azelaoyl BCU. This is illustrated in *Table* 6 which lists the pencil hardness values of azelaoyl BCU-containing white acrylic coatings cured for different times and temperatures as a function of dibutyltin dilaurate (DBTDL) catalyst concentration. At a cure temperature of 175°C (*Table* 6,A), maximum film hardness (4H/F) is achieved within 15 min with 1% DBTDL versus 30 min with 0.5% DBTDL. Without catalyst, a cure time greater than 30 min is required to produce maximum film hardness at a cure temperature of 175°C.

Similarly, for a cure time of 30 min (*Table* 6,B), maximum film hardness (4H/F) is achieved at 168°C with 1% DBTDL versus 175°C for 0.5% DBTDL. Without catalyst, a minimum temperature of 195°C is required to produce maximum film hardness for a 30-minute cure time.

Other organometallic compounds such as dibutyltin bis(2-ethylhexanoate) and zinc octanoate have been shown to be effective catalysts for coatings cured with azelaoyl BCU.

Tertiary amine urethane catalysts, such as triethylenediamine (DABCO) and N,N'-dimethyl cyclohexyl amine do not significantly affect the cure rate of coatings cured with azelaoyl BCU.

The minimum conditions required for effective curing of azelaoyl BCU containing coatings with one percent dibutyltin dilaurate catalyst are approximately:

>30 min	@ 150°C
30 min	@ 160°C
15–30 min	@ 168°C
15 min	@ 175°C
5 min	@ 200°C

This can be seen from the data in *Tables* 7 and 8 which list pencil hardness and MEK resistance values for acrylic- and epoxy-based white coatings cured with azelaoyl BCU (1% DBTDL). Despite the differences in film properties arising from differences in the base resins, both coatings are effectively cured under the same time and temperature conditions.

While all of the property data reported thus far have been generated from coating systems in which a stoichiometric quantity of azelaoyl BCU based on resin hydroxyl content was used, acceptable film properties may be obtained with less-than-stoichiometric quantities of azelaoyl BCU. This is illustrated in *Table* 9, which lists the properties of a white acrylic coating as a function of azelaoyl BCU concentration. These data show that the properties of the film cured with 50% urea are identical to those of the film cured with the stoichiometric amount (100%) of urea.

Table 9—Properties of a White Acrylic Coating As a Function of Azelaoyl BCU Concentration[a,b]

Azelaoyl BCU Concentration (% of Stoichiometric)	Pencil Hardness	MEK Resistance	Conical Mandrel Flexibility Inch (mm)
0	F/HB	Soluble	>1 (25)
20	2H/HB	<6B	>1 (25)
30	3H/HB	<6B	3/4 (19)
40	4H/HB	<6B	<1/8 (<3)
50	4H/F	<6B	<1/8 (<3)
75	4H/F	<6B	<1/8 (<3)
100	4H/F	<6B	<1/8 (<3)

(a) Acrylic resin used was G-Cure® 867.
(b) All coatings contained 1% dibutyltin dilaurate catalyst by wt. R.S. and were cured for 30 min at 175°C.

PHILIP W. SHERWOOD received his B.S. Degree in Chemistry from Fairfield University and his M.S. Degree in Organic Chemistry from Worchester Polytechnic Institute. He has previous experience in the development of specialty polyurethane and fluoroelastomer coatings for the aerospace industry, and is presently with The Donald S. Gilmore Laboratories of The Upjohn Co., North Haven, CT, specializing in the development of coating systems.

SUMMARY

N,N′-azelaoyl bis(trimethylene urea) ["azelaoyl BCU"] thermally dissociates without the release of volatile by-products to produce an aliphatic diisocyanate which is capable of crosslinking hydroxy-functional acrylic and epoxy resins. Coatings cured with azelaoyl BCU are hard, flexible, MEK resistant, and exhibit good adhesion to metallic substrates. Effective cure schedules for catalyzed coating systems range from 30 min at 160°C to five min at 200°C. Coatings formulated using less-than-stoichiometric quantities of azelaoyl BCU based on the hydroxyl content of the base resin have demonstrated good retention of properties relative to the same coatings formulated using a stoichiometric quantity of azelaoyl BCU.

References

(1) Richter, R.H., Tucker, B.W., and Ulrich, H., (to The Upjohn Company), U.S. Patent 4,217,436 (1980).
(2) Ulrich, H., Tucker, B., and Richter, R., *J. Org. Chem.*, *43*, 1544 (1978).

Trademark References

Bonderite®	Oxy Metal Industries Corp.
G-Cure®	Henkel Corp.
Coroc®	Cook Paint and Varnish Co.
Polytex®	Celanese Corp.
Araldite®	CIBA-Geigy
Epon®	Shell Chemical Co.
Scotch®	3M Company

IF ENOUGH GOOD ENGINEERS AREN'T MADE IN AMERICA, WHAT WILL BE?

Remember when "Made in Japan" was a joke?

Now "Made in Japan" is a mark of excellence on cars, stereos, cameras, television sets and many other products. And "Made in America" is seen less and less.

MADE IN BELGIUM

Why are other countries, like Japan, producing better products? A big reason is their growing supply of quality engineers.

MADE IN ENGLAND

These countries are now producing more of the people who make the products—more good engineers, physical scientists and mathematicians.

So how can we continue to compete with countries like Japan and West Germany? One important way is by making sure our colleges and universities can keep producing enough good engineers and scientists.

MADE IN W. GERMANY

FRANCE

And that requires money—money to help American colleges fight skyrocketing costs.

Colleges need money to make professors' salaries competitive with industry, keeping them in the classroom. Right now, 10 percent of all full-time engineering faculty positions are unfilled, creating overcrowded classes. And threatening the quality of education.

Colleges need money to help students earn graduate degrees. And, just as important, to continue vital research.

So please make sure your company gives as much as it can to the colleges of its choice.

It's the only way your business will have all the new engineers—and new ideas—it will need to compete against the world.

MADE IN SWEDEN

And the best way to keep "Made in America" a sign of quality.

MADE IN JAPAN

MADE IN ITALY

Send for our free booklet, "Guidelines—How to Develop an Effective Program of Corporate Support for Higher Education." Write CFAE, 680 Fifth Ave., New York, NY 10019

Help preserve American know-how. Give to the college of your choice.

COUNCIL FOR FINANCIAL AID TO EDUCATION INC.
680 FIFTH AVENUE NEW YORK NY 10019
CFAE Ad Council
A PUBLIC SERVICE OF THIS MAGAZINE AND THE ADVERTISING COUNCIL

Society Meetings

Birmingham — Mar. 4

Honored guest was John Oates, Past-President of the Federation and member of the New York Society. Mr. Oates reflected on the special relationship between the Birmingham Society and the Federation.

Peter Quednau, of Byk-Mallinckrodt, discussed "WETTING AND DISPERSING AGENTS FOR NON-AQUEOUS SYSTEMS."

The incorporation of particles into a binder medium, said Mr. Quednau, is one of the most expensive processes of paint making. Wetting and dispersing agents alter the interfaces of media and particles in order to speed up or improve the quality of dispersion. They do this either by affecting the surface tensions within the system or by modifying the stereochemistry or charge repulsion properties of particles.

Mr. Quednau discussed the dispersion process which consists of three stages, all of which take place simultaneously: wetting, which is the removal of air from pigment surfaces and its replacement with medium; grinding, the mechanical reduction of pigment agglomerates; and stabilizing, the effective separation of particles, avoiding reflocculation of pigment. The rate of surface wetting varies directly with the interfacial tension between particles and medium and indirectly with the viscosity of the medium, said Mr. Quednau. Grinding is brought about by shear-forces in the medium and these increase with viscosity.

Mr. Quednau stressed the particular importance of good stabilization of dispersion. Certain additives, which were readily absorbed onto particles, reduced the attractive forces and steric hindrance so keeping particles separate.

Mr. Quednau raised the question of whether it was always best to have total freedom from flocculation. In Mr. Quednau's opinion, a certain amount of controlled flocculation could actually improve some properties. For example, the use of expensive pigments and the need for depth of color and high gloss made it essential that car finishes be finely dispersed. But primers and lower grade finishes could show improved settlement if controlled flocculation were carried out, said Mr. Quednau.

Mr. Quednau illustrated that changes in rheology (affecting film-build) and surface appearance (reducing Benard cell formation) could also be brought about by using the technique.

Q. It is generally felt that the use of such additives may affect some properties adversely. For example, the humidity resistance of primers may be lowered. Is this the case?

A. This is true, in general. To be more active, additives need to be polar and therefore moisture resistance will be affected. A compromise has to be reached on the level of additions and this level can best be determined by experiment.

Q. Many pigment manufacturers offer treated pigments. Are additives complementary?

A. Yes. Such pigments have good wetting properties, but there is an example of a company grinding treated pigments in acrylics. No agents were needed to achieve good grind, but eventually 70 tonnes of paint were scrapped because of hard settlement. The overall picture has to be considered.

Q. Would you recommend the use of both flocculants and deflocculants in a system?

A. Yes. High gloss top coats generally need deflocculants. Grinding can be increased with deflocculants/wetting agents and the system stabilized once ground.

D. H. CLEMENT, *Secretary*

Golden Gate — Mar. 15

A moment of silence was observed in remembrance of Roy G. Landis, formerly Plant Manager of the Sherwin-Williams Co., who died on March 5.

"HANDLING OF HAZARDOUS WASTES" was presented by Michael L. Markowitz, of Rollins Environmental Services, Inc.

Mr. Markowitz discussed the types of waste generated in our industry, and how they might be handled. He also described the various services available from an environmental site, such as Rollins. The potential disposal methods were explained, i.e., burning, which comprises about 10 to 20% of the national waste removal technique; chemical, physical, biological removal which encompass another 20 to 40%; and land disposal which completes the available technologies at about 60%.

The incineration facility available at Rollins was described. There are no such sites available in the state of California, or on the West Coast, stated Mr. Markowitz.

Q. How accurate does a company have to be in characterizing their waste?

A. As complete as possible, and consistant with the requirements of the state as far as characterization goes and class of materials that are in the waste.

Q. Are any companies doing anything to publicize the waste removal problem?

A. Yes, indeed! Rollins was involved in a presentation on National Television regarding this problem.

K. E. TRAUTWEIN, *Secretary*

Los Angeles — Mar. 10

Society Past-Presidents in attendance for Past-Presidents' Nite included: Carl Howson (1930–31), oldest surviving Society Past-President and one of the society's founding fathers; William Gerhart (1940–41); John Warner (1945–46); Alan Hershey (1961–62); Al Aronow (1964–65); Trev Whittington (1969–70); Duke Cromwell (1970–71); Ken O'Morrow (1975–76); Bob Koperek (1977–78); Fred Croad (1978–79); Al Seneker (1979–80); and Don Jordan (1980–81).

President Van Zelm presented Federation certificates to Lloyd Haanstra for the 1981 Trigg Award for LASCT Secretarial proficiency and to Robert Athey for the 1981 Program Award for second place for the LASCT Technical Paper presented at the 1981 Annual Meeting.

Lloyd Haanstra reported for Environmental Committee Chairman Jim Elliott on activities associated with CARB Architectural Rule 1113. It was reported that the San Diego AQMD may adopt a softer stand and yield to a less strict rule than required previously. Ken O'Morrow reported on the present waste disposal posture. He discussed the March deadline for all generators of hazardous waste to file a waste disposal report with the State Board of Equalizations. Also mentioned was the Hazardous Waste Super Fund which is intended to collect $10 million over a 10-year period. Mr. O'Morrow also stated that the State Department of Health has requested that generators must file a report in March to report all landfill waste disposal exceeding 1000Kg (approximately 200 gallons) per month. Also noted was that E.P.A. has advanced its deadline for liquid hazardous waste disposal in a landfill from November 1981 to April 1, 1983.

"HAZARDOUS WASTE MANAGEMENT" was presented by Michael Markowitz, of Rollins Environmental Services, Inc.

Mr. Markowitz presented a general discussion on the many aspects of waste disposal related to preserving a quality environment for our families and children.

In the past, manufacturers have been product oriented and waste has been ignored, said Mr. Markowitz. Dumping has been haphazard and at least cost. Slides illustrated several publicized dump sites.

Today, RCRA and other Federal regulations will be controlling manufacturers to exercise responsibilities, stated Mr. Markowitz. These include: (1) waste generation; (2) storage; (3) transportation; (4) treatment/disposal; and (5) recovery. Generators must look at the legal and liability aspects, stressed Mr. Markowitz.

Mr. Markowitz gave a visual plant tour by slides of the Rollins regional facilities and services. He described and exhibited the waste data sheet for evaluating waste and prescribing treatment methods. Rollins arranges for collection, transportation, evaluation, and storage of hazardous waste, said Mr. Markowitz.

The field services provided by Rollins offer a wide range of disposal methods arranged by contract. Discussed were: (1) recovery—5-20% of waste; (2) incineration—5-10%; (3) chemical/physical/biological—24-45%; and (4) land disposal—40-60%. An additional service of Rollins is deep well injection of aqueous waste. The field services also include evaluation of abandoned waste disposal sites and recommendations for clean-up, reclamation, and control, explained Mr. Markowitz.

The legal aspects of the regulatory requirements, liability, and contractual agreements were discussed. Good record keeping is essential, stressed Mr. Markowitz. Regulatory and legal issues were discussed as to ownership, responsibility, and liability.

Mr. Markowitz discussed personal protection, fire fighting, clean up and disposal equipment for employee protection. Labelling is extremely important for health and safety, stated Mr. Markowitz.

Mr. Markowitz concluded by stressing the importance of a healthy environment.

Q. After a customer has certified the content of the wastes, do you still go through the analysis to confirm it? Does this not make it exhorbitantly expensive?

A. We would check major parameters simply for confirmation of the certified analysis. This is to just avoid errors.

Q. With whom does responsibility lie if there is an accident during transportation of hazardous waste due to: (1) driver negligence; (2) faulty maintenance of equipment; and/or (3) an act of God (flood, earthquake, etc.)?

A. Our contracts provide that we accept total responsibility when the waste leaves your plant, provided the waste is defined. I do not know about an Act of God, except that title to the waste is mine and the consequences would lie there in.

Q. You talk quite a bit on the organic wastes. What about the solids we deal with—such as, silicas, antimony oxide, alumina and other inorganic pigments and fillers? Are these all land-filled? Can they be treated to assure they won't leach or blow around as dust?

A. These are perfect land-fill chemicals. Yes, they can be treated by the flue-dust process. Or, they can be treated in a separate cell in a landfill. Leachate control requires special control of water. Dust control simply requires ground cover.

Philadelphia Society Board Members for 1981-82 are (Seated from left to right): Treasurer—Frank Bartusevic; President—Willis Johnston; P.J. Sotorrio; and President-Elect—Ralph Myers. Standing left to right are: William Georgov; Technical Chairman—Robert Sonntag; Membership Chairman—Philip Reitano; Carl Fuller; Society Representative—John Stigile; J. Richard Kiefer, Jr., and Barry Oppenheim

Q. Have you successfully solidified paint sludge with flue dust?

A. Low flash-point ingredients such as solvents and resins must be incinerated but water-based products can be dried and packed with flue-dust and landfilled.

Q. Is incineration practical for latex paint waste water when the water content of the waste is 90% or more?

A. No. The waste must be burnable. Waste of this nature would be landfilled with chemical or biological pretreatment, if necessary for the solid portion.

Q. Do you plan to deal with nuclear waste in the future? If so, how would it be disposed of?

A. One of the conditions of our state operating permits at all of our plants was that we would not handle nuclear waste. Consideration has been given to incineration at low-level nuclear medicines from hospitals that contain trace amounts of radioactivity. No decision has been made yet.

Q. If laws become too restrictive in California, how many tons per day can you take from California?

A. We are now taking waste from California; such as, solvents, chlorinated materials, and PCB's. I anticipate that California will have a commercial incinerator here someday. Meantime, we can do so now, if you are willing to ship it over the Rockies!

EARL B. SMITH, *Secretary*

New England Mar. 18

Curtis Fricke, of Fricke Enterprises, discussed "PROPER SELECTION OF FILLING AND SEALING EQUIPMENT."

Mr. Fricke pointed out that in the manufacturing process packaging can be a very time-consuming operation and if it is efficiently handled there is potential for great savings.

Mr. Fricke stressed that it is very important to match the various components of the packaging operation to run at compatible speeds. Why have a very rapid canning process if the filtering step is abysmally slow, he asked?

Another important consideration, according to Mr. Fricke, is the cost of the material and the accuracy of the fill level. In a gallon can a 1/16 inch overfill represents approximately 1% overage. With a material cost of $2.00/gal for 1,000,000 gallons, this represents a $20,000 material loss. Mr. Fricke stated that automatic packaging is more efficient and more accurate than semiautomatic or manual packaging.

The filling equipment must be properly designed and selected for each individual operation. What may be an outstanding operation for one company may not transfer to your company, he said. Equipment must be matched to your operation, to your batch size, and to your container size.

Mr. Fricke pointed out the six basic points that comprise the concept for product unity in selecting filling and sealing equipment.

(1) Production requirements must be considered. For example, how many units per day, what package size, what product mix, and how many batches per day?

(2) Plant layout should be evaluated for current use and future requirements. One way flow should be considered and bottlenecks eliminated.

(3) Training of personnel for safe and proper handling is essential. Housekeeping is also extremely important. A major cause of malfunction is poor housekeeping.

(4) Versatility of equipment is an important consideration. If possible equipment should be chosen that can be used as often as possible for as many tasks as possible.

(5) The availability of parts and service is important to minimize potential downtime.

(6) Dependability of the equipment and reliability of the manufacturer should play an important part in the selection process.

Mark Dahlquist, of Elmar Industries, explained the "WORKINGS OF ROTARY PISTON FILLERS FOR PACKAGING PAINT PRODUCTS."

The concept, according to Mr. Dahlquist, was developed in Scotland and it has been found to be extremely accurate in all installations. Mr. Dahlquist claimed that the overage has been reduced 50% over other methods in all Elmar installations. With a series of slides showing filler schematics, he explained the filler design, and how the rotary piston unit works. Mr. Dahlquist claimed accuracy of ±¼ fl. oz. per gal, and ±0.1 fl. oz. per quart. Slides illustrated several installations.

N. BRADFORD BRAKKE, *Secretary*

New York Mar. 9

Honored guests included Federation President Howard Jerome, Executive Vice-President Frank Borrelle, and Thomas Kocis, Director of Field Services.

President Jerome discussed several of the Federation's current activities and programs. He urged members to be motivated in participating in the Federation, their Society, and in Technical Committee activities.

Education Committee Chairman Jeff Kaye introduced the Mini-Workshops program and the speakers. David Young, of Pfizer, Inc., discussed "SELECTION OF EXTENDER PIGMENTS FOR USE IN TRADE SALES AND INDUSTRIAL PAINT COATINGS." "POLYMER COMPATIBILITY" was presented by Dr. Eli Pearce, of Polytechnic Institute of New York. "COST SAVINGS IN THE PLANT AND LAB" was discussed by Fred Gartenlaub, of New York Bronze, and Tom Accomando, of Lehman Brothers.

HERBERT ELLIS, JR., *Secretary*

Northwestern Feb. 2

R.I. Ensminger, of NL Chemicals, presented "PIGMENT DISPERSION AND THE CRITICAL PIGMENT VOLUME CONCENTRATION."

Mr. Ensminger stated that he would explain the physical aspects of dispersion as he did not think the wetting of commercial pigments is very clearly defined.

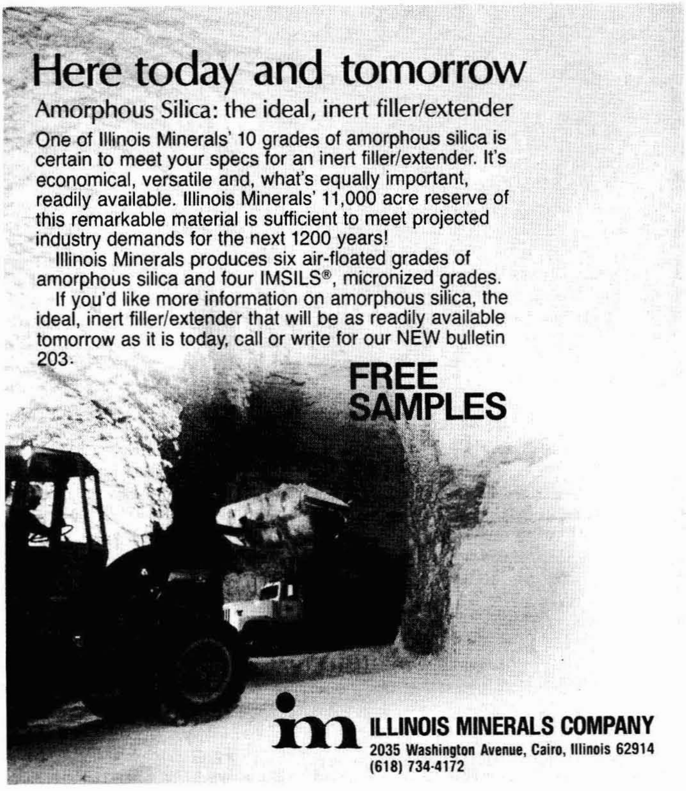
Mr. Ensminger defined a primary particle as a pigment particle which is properly sized for its intended use. The pigment you receive in a bag is composed of primary particles, pigment agglomerates which are primary particles loosely held together, and a few pigment aggregates which are clusters of primary particles tenaciously held together.

About the only type of problem encountered is with the pigment agglomerates, said Mr. Ensminger. This is what you are talking about when you talk about dispersion. It is the breaking down of these agglomerates so to achieve the right degree of sheen when you are talking about an extender—the right depth of blue in the case of a phthalo blue or the right level of hiding power in the case of TiO_2.

When you talk about pigment dispersion and wetting you are covering a huge area. The average surface area of titanium dioxide is 14 square meters per gram or in more visible terms, it would take the surface area of 25 grams of TiO_2 to cover a football field. So when you are making 2,000 gallons of paint, calculate back and figure out what you have to do to replace all the air that is entrapped in the pigment bag with the vehicle, explained Mr. Ensminger.

A small amount of aluminum trihydrate is used to alter the normal behavior of TiO_2 to improve wetting and dispersion. Dispersion is the intimate incorporation of pigment particles into a suspending media to produce a stable usable product, explained Mr. Ensminger.

The first step is to wet the pigment. The rate of wetting is dependent on the fourth power of the radius, the viscosity of the



The 1981–82 Officers for the Pittsburgh Society are from left to right: Treasurer—Clifford Schoff; President-Elect—William Cibulas; President—Richard Trudel; and Secretary—Michael Gillen

liquid, and the length of the capillary. The rate of wetting is more difficult with a high viscosity liquid than with a low viscosity liquid, said Mr. Ensminger. If the core radius is very small and it has to penetrate a long path, it is going to be difficult to wet the pigment. If you want fast wetting, use a lower viscosity liquid, suggested Mr. Ensminger.

There are two types of milling equipment: smashing operation or smearing operation, said Mr. Ensminger.

A dispersion is best measured by what you don't see rather than what you do see. Even a well-dispersed and deflocculated pigment will give you the optimum physical properties that the pigment is supposed to impart, but won't necessarily give you a practical saleable product because the well-dispersed pigment will settle to a hard layer in the bottom of the container, explained Mr. Ensminger. A flocculate pigment will not develop its optimum properties however the package stability will be good. Most paints will have some kind of a suspending agent to help prevent the settling.

Mr. Ensminger defined critical P.V.C. as oil absorption in volumetric terms. It is the weight of oil sufficient to cover the surface of the pigment and to fill the voids between the pigment. The oil absorption of the various pigments is not additive. The log of the relative viscosity is equal to 50% of the pigment volume divided by the difference between the critical PVA and the pigment volume, and will predict what the viscosity of any pigment system will be by knowing the critical PVC and the viscosity of the liquid that you are going to disperse it in. In water systems the TiO_2 will require a dispensing agent. The critical PVC is an important parameter to know with respect to hiding power and other properties of a dried film, however it can be also useful to you to get the proper viscosity thru the proper pigment loading in the dispersion operation, stressed Mr. Ensminger.

Never try to calculate what a critical PVC will be as you will be wrong. You will actually have to make up the physical mixes and determine the oil absorption and then plot a graph, said Mr. Ensminger.

Elio Cohen, of Daniel Products Co., presented a talk on "FACTORS GOVERNING TINTER PERFORMANCE."

Mr. Cohen defined the factors that govern tinter performance as the materials going into a pigment dispersion; the dispersing mediums which are designated as vehicle: additives, pigments, solvents; the dispersing equipment that does the work; and the interactions.

Some of the early methods used by the paint manufacturers to tint paint were reviewed. In Daniel Products Company's investigation on dispersing the pigment in a vehicle, they used a solvent thinnable acrylic resin, said Mr. Cohen. They used a TiO_2 in one base and nonflocculating noncrystalizing phthalo blue in another. Both looked good. They added this tint color to a tint base using a slow mixer. The result was that the tinting color did not want to disperse properly in the tint base, explained Mr. Cohen. Even by using a high sheer mixer, it still showed a dirty hue. The tinting color did not want to disperse properly in the tint base. It is possible that the acrylic resin vehicle was not the proper one for the phthalo blue pigment as the acrylics may not be good wetters, said Mr. Cohen. They also tried a long-oil alkyd and a medium-oil alkyd for the dispersion vehicle in place of the acrylic resin. The results were that the medium oil alkyd was good when freshly prepared, but was unacceptable when aged for a period of time. The long-oil alkyd didn't behave too badly.

Their next question was—could the long-oil alkyd be used as a broad tinting color? The result of course was that it could not be used in conjunction with all different types of vehicles such as short-oil alkyds, styrenated baking bases, etc., explained Mr. Cohen. This led them to prepare a special dispersing vehicle using phthalo blue which worked perfectly. Mr. Cohen cautioned that this type of an approach isn't universal as he did not think such a thing is possible yet. He said that they learned that the dispersing vehicle can contribute to the development of pigment contorial strength in the stability of the tinter. Normally vehicles designed to produce coatings with a high degree of exterior durability and chemical resistance lack pigment dispersing qualities. The trick is therefore to find vehicle additive combinations which, when used in normal tinting levels (meaning a maximum of 10% addition), work well in such high performance coatings without sacrificing exterior durability and chemical resistance.

The second factor is the pigments, said Mr. Cohen. They explored this by maintaining the vehicle constant and varying the pigment. Again, they used the standard dispersing vehicle and phthalo blue pigments from two different manufacturers. Slides indicated a difference in the appearance between the two pigments. It was apparent that you should be aware of the fact that pigments from different manufacturers can affect the film appearance, noted Mr. Cohen. Even the easy to disperse pigments are not interchangeable. He said that when formulating tinters one should be aware of pigment vehicle in tint base interaction, as it is necessary to evaluate the same type of pigment from several suppliers and check carefully how they behave in a variety of film formers in special dispersing vehicles. The best pigment is the one which gives uniform tinter performance in the greatest number of important tint bases, said Mr. Cohen. Never assume that pigments of the same hue from different suppliers are fully interchangeable, he said.

The third factor is solvents. Again, they used phthalo blue and their standard vehicle. One tinter was let down in mineral spirits, the other was in xylene. The one with xylene was harder to breakdown but not dramatically. It was shown that solvents greatly influence the rheology of tinters which in turn determine the ease of incorporation, said Mr. Cohen. The ecology permissible solvents should be evaluated as a single component and in combination to insure ease of tinter defusion into a tint base the thixatrophy factor should be low but not to the point pigment settling will occur. Thixatrophy can be controlled by manipulating the solvent and vehicle content in a tinter. The solvents are also a great controlling factor in minimizing the drying out of tinters in part full containers, explained Mr. Cohen.

The fourth factor is the type of milling equipment used in making the dispersions. The use of high energy milling may improve how well the pigments go into the dispersion. The hue of the pigment and the cleanliness will be more pronounced, which can give you more latitude in shading, said Mr. Cohen. Their work indicated that an attritor type was the better mill to use when they ran the test using phthalo blue. Better milling often produces tinters with greater tint strength, cleaner hue, and trouble-free incorporation into a base, he said. Finer grinds lead to less interference with loss of gloss and less tendency for pigment settling. Also, it does stabilize the tinter so that on aging you will have less problems in having that tinting color you made perform the same way as when it was made fresh.

Mr. Cohen also pointed out that tinter interaction is important. It is possible that when two separate tinter colors are mixed together you will not get a good color match even though each individual color looks good. The performance of a tinter should never be judged without also evaluating combinations with other tinters in a variety of tint bases, stressed Mr. Cohen.

HERB DAVIDSON, *Secretary*

Northwestern Mar. 9

The Society sponsored its annual seminar entitled, "PRESENT AND FUTURE EQUIPMENT FOR ECONOMICAL AND EFFICIENT APPLICATION OF COMPLIANCE COATINGS."

Robert Acker, of Ransbürg Co., discussed "NEW HIGH SPEED ELECTROSTATIC EQUIPMENT AND THE REA-3 HANDGUN."

Mr. Acker stressed that emissions from finishing processes are a function of film build, area coated, VOC, and transfer efficiency. The new REA-3 handgun has the capability of handling paints with as low as .05 megohms resistance. The REA-3 gun is designed to be used either with water-borne or solvent-borne paints, and handles the higher solids paints, stated Mr. Acker.

Rotational atomizers were discussed. With the old electrostatic disks which operated at 3600 rpm, it is not possible to handle all of the new higher solids coatings, explained Mr. Acker. This led Ransburg to develop a new Turbo-disk that is powered by an air turbine motor and rotates at 30,000 rpm as compared to the old electric powered disks that rotated at 3600 rpm.

"AUTO-STATIC 400 SPRAY GUN AND THE EFS AUTO ROLL SPRAY BOOTH" was presented by Arvid C. Walberg, of the Arvid C. Walberg Co.

The auto-static 400 spray gun utilizes a special method of atomization which Mr. Walberg called "Conical Film Atomization." This spray gun has been used to apply conventional, 3.5 VOC, and water-borne systems. Mr. Walberg explained the new automatic spray booth which provides much better filtering efficiency to prevent particulate emission and cuts labor costs and booth cleaning by at least 90–95%.

Ken Coeling, of the DeVilbiss Co., presented "ROTATIONAL ATOMIZERS AND ROBOTS."

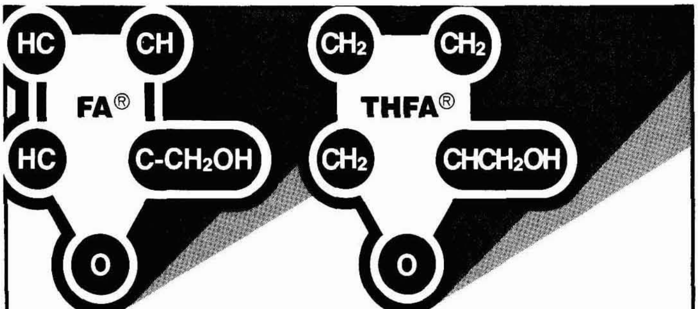
Mr. Coeling discussed the DeVilbiss turbo-bell. He listed limitations of low speed rotational atomizers: (1) There is a limit with electrostatics on the conductivity of the paint with the low speed rotational atomizers; (2) The viscosity of the paint is limited with the low speed rotational atomizers; (3) The flow rate is also limited; and (4) The surface tension of the paint is limited within a certain range for successful use on low speed rotational atomizers. High speed rotational atomizers operate upwards of 20,000–40,000 rpm as compared to 3600 rpm for the low speed, explained Mr. Coeling. Most of the atomization is done by mechanical means. High flow rates of 1500–1600 grams per minute are possible. Mr. Coeling claims that any material that can be pumped can be atomized with the high speed rotational atomizer.

Mr. Coeling also gave a brief description and overview of the DeVilbiss Trallfa Robot for automatic spray painting.

Gary Burls and Robert Keown, of the Nordson Corp., spoke on "AUTOMATIC AND MANUAL HIGH SPEED EQUIPMENT," and "THE AN-8 AND AN-9 SPRAY GUNS AND POWDER EQUIPMENT," respectively.

Mr. Burls discussed the effect of the E.P.A. regulations, the economics of changing to higher solids coatings advances to atomization, electrical charging methods, safety methods, and Nordson's new application equipment.

Mr. Keown discussed powder coatings which were in use about 1966 with the fluidized bed powder. Application techniques were soon developed by the Polymer Corp. Powder is projected to grow at the rate of 10–12% per year, according to Mr. Keown, with 85 million pounds to be sold in 1985. The escalated usage of powder coatings is due primarily to the E.P.A. Waste Control Standards, increasing energy costs, and the increasing cost of the paint carriers or solvents.



Norm Fender, of Grayco Robotics Group, discussed the new airless and air electrostatic guns that handle high solids and have transfer efficiencies of 60-70%. Both guns are fabricated from plastic and are therefore very light-weight and easy to handle, explained Mr. Fender. He also described the Grayco high speed rotary atomizer which operates at speeds up to 60,000 rpm.

Mr. Fender also discussed the Easy Robot from Grayco. The unique part about the Grayco robots, said Mr. Fender, is that the controls are software controlled, and there are only three printed circuit boards in the entire control system. Grayco also has a remote 15″ × 3″ × 4″ panel that is capable of being mounted right in the spray booth area to reprogram the robot directly from the booth area.

Mr. Fender stated that robots are providing sufficient paint savings, labor savings, savings on exhaust requirements, and savings due to automatic controlling to provide 1-1½ year paybacks on most purchases.

"AIR AND AIRLESS ELECTROSTATIC EQUIPMENT" was discussed by Pat Shaffer, of Binks Manufacturing Co.

Mr. Shaffer stated that all electrostatic equipment has problems with Faraday cages. One of the optimum combinations of spray guns was the Bink's air electrostatic spray gun with touch-up using a conventional spray gun. Binks also provides a turbo-bell, described as their electrostatic rotational atomizer or ERA, that utilizes a power system of 100 kilovolts.

HERB DAVIDSON, *Secretary*

Pacific Northwest Feb. 18

A panel discussion was presented by Bill Biddle, Consultant, Bill Almond, of NL Chemicals Canada, Inc., Stu Taylor, of Tioxide of Canada, Inc., and Dennis Songhurst, Reichhold Chemicals Ltd. The topic presented was "IS THE SUPPLY OF RAW MATERIALS IN SLURRY FORM ADVANTAGEOUS?"

The panel discussed the criteria used when supplying a paint company with needed materials. Most important are knowing what they are making and in what quantity. A company has to purchase at least 300 tons of an item to make the use of slurry economically feasible. It was stressed that there is no one TiO_2 that can be supplied in slurry that suits all formulas. TiO_2 in slurry form comprises about 5% of TiO_2 market. Presently, slurry products are available for latex systems only.

O. SCHMIDT, *Secretary*

Piedmont Mar. 19

"COMPLIANCE-SOLVENT OPTIONS" was presented by Raul M. Oteiza, of Dow Chemical Co.

The Federal Clean Air Act of 1970 has mandated many changes in paint regulations to meet emission standards, said Mr. Oteiza. Primary concern is the control of V.O.C.'s and ozone levels in the ambient air. One approach paint formulators may take, according to Mr. Oteiza, is the use of select solvents to achieve low V.O.C. coatings. Two solvents that are presently growing in use and consumer acceptance are methylene chloride and 1,1,1 trichloro ethane. These solvents have very favorable physical properties such as: no flash point (TCC); thermal stability to 500°F; worker exposure toxicity levels (TLV) of 500 ppm and 350 ppm respectively; high saturation ($\sim$8%) to achieve lower explosion level (LEL); and miscibility with other solvents. These chlorinated solvents are unreactive with metallic process equipment with the exception of aluminum systems where pressure, sheer, and temperatures could be high, explained Mr. Oteiza. The methylene chloride and 1,1,1 trichloro ethane have fast dry rates, and do not leave a residue after evaporation. Application of these solvents are currently found in traffic paint, aerosols, rapid dry lacquer, conventional air spray, electrostatic, and printing ink formulations, said Mr. Oteiza.

J.E. HUSTED, *Secretary*

Rocky Mountain Society Officers for 1981-82 are from left to right: Past-President—Bruce Regenthal; Society Representative—Jim Peterson; President—Steve Crouse; Treasurer—Louis Garcia; Vice-President—Don Bagge; and Secretary—Don Shillingburg

Pittsburgh Mar. 1

Honored guests in attendance included Federation President-Elect, Clarke A. Boyce, Executive Vice-President, Frank Borrelle, and JCT Editor, Robert Ziegler. Mr. Boyce discussed "Unity of Purpose" in reference to the Federation. A slide presentation illustrating current Federation activities was given by Mr. Borrelle.

Donald S. Onnen, of AMF Cuno Division, discussed "THE WHYS AND WHEREFORES OF CARTRIDGE FILTRATION IN THE COATINGS INDUSTRY."

Mr. Onnen discussed the difference between filtration and separation. The disposable or reusable cartridge is widely used for filtration, said Mr. Onnen.

There are many variables affecting filter selection. The type of media gives you surface (like a screen) or depth (particles trapped within). The nature and amount of contamination, such as dirt, grit, fibre, and formable gels require different types of filtration, explained Mr. Onnen.

The fluid characteristics to be considered, according to Mr. Onnen, include: liquid or gas, viscosity, temperature, and compatability. If you double the number of cartridges, you increase the life three times at equal total flow rate, stressed Mr. Onnen.

MICHAEL GILLEN, *Secretary*

Pittsburgh Apr. 5

Lee W. Campbell, of Campbell Chemical Co., and Kenneth E. Luyk, of Alcoa Research Labs, were presented with 25-year membership pins.

Ten past presidents were in attendance for Past-Presidents' Nite.

Dr. Hugh Smith, of Sun Chemical Co., presented "ENVIRONMENTAL UDATE."

Dr. Smith noted that in the 1970's government agencies attempted to control all areas of the paint industry. However, the 1980's has started with a willingness by the government to work with the industry to reconsider some regulations. One problem is that under President Reagan's "New Federalism", new regulations will be enacted on the state level which is greatly influenced by members of the past administration. Each state could have their own regulations which would put a terrible strain on the paint industry, stated Dr. Smith.

He also reported that toxicological testing of organic pigments for coatings was being done.

MICHAEL GILLEN, *Secretary*

Elections

BIRMINGHAM

Active

Mudge, Michael S.—International Paints Ind. Coatings, Birmingham, England.

CHICAGO

Active

Brower, Loyd R.—Barrett Varnish Co., Cicero, IL.
D'Errico, Michael J.—Sherwin-Williams Co., Chicago, IL.
Engelking, Gerald L.—Standard T Chemical Co., Inc., Chicago Heights, IL.
Erickson, Peggy L.—Sherwin-Williams Co., Chicago.
Gardner, Kenneth J.—The Enterprise Cos., Chicago, IL.
Hanacek, John J.—Standard T Chemical Co., Inc., Chicago Heights.
Harris, Bruce R.—Eschem, Chicago, IL.
Jezler, Roger S.—Standard T Chemical Co., Inc., Chicago Heights.
Johnson, Kenneth S.—Standard T Chemical Co., Inc., Chicago Heights.
Rettker, James—Standard T Chemical Co., Inc., Chicago Heights.
Skorupa, Milton J.—Sherwin-Williams Co., Chicago.

Associate

Hutchison, Dave—Engelhard Corp. Appleton, WI.
Koett, Albert—Safety Kleen, Elgin, IL.
Lee, James S.—Diamond Shamrock Corp. Oak Brook, IL.

CLEVELAND

Active

Blabolil, Wayne, A.,—Master Builders, Cleveland, OH.
Eley, Richard R.—Glidden Coatings and Resins Div., SCM Corp., Strongsville, OH.
Erickson, Leonard—Kalcor Coatings Co., Willoughby, OH.
Kummins, Charles A.—Gates Mills, OH.
Martinek, Hank J.—Mid America Chemical Corp., Cleveland, OH.
Nemeth, Ilona N.—Sherwin-Williams Co., Cleveland, OH.
Orch, William M.—Glidden Coatings and Resins Div., SCM Corp., Strongsville.
Schroyer, David O.—State Chemical Co., Cleveland, OH.
Szabo, Leslie, J.—Sherwin-Williams Co., Cleveland.

Associate

Bennett, Robert E.—Chem Materials Co., Inc., Cleveland, OH.
Dudas, Joseph F.—Davies Can Co., Solon, OH.

Educator and Student

Miller, James, D.—Case Western Reserve Univ., Cleveland, OH.
Yoshida, Shuuji—Case Western Reserve Univ., Cleveland.

NEW ENGLAND

Active

Fitzpatrick, William—A. W. Chesterton Co., Groveland, MA.
Lafontaine, Normand W.—Lovezzola-Ward Co., Inc., Shrewsbury, MA.

Associate

Esslinger, Pete—Hercules Inc., Bedford, NH.
Fish, Warren E.—Commonwealth Chemical, Tewksbury, MA.
Macy, Tom, Jr.—Buckman Labs., Memphis, TN.
Savory, Betsy—Columbian Chemical Co., S. Glastonbury, CT.
Taylor, Philips V.—Fish Chemical & Equip., Inc., Walpole, MA.

NEW YORK

Active

Amrich, George M., Jr.—Benjamin Moore & Co., Newark, NJ.
Bauman, Moe—Bauman & Co., Inc., Livingston, NY.
Burrows, James J.—Synkote Paint Co., Elmwood Park, NJ.
Cerqueira, Joe E. Jr.—Amsterdam Color Works, Bronx, NY.
Czitter, Dov—Nationwide Chemical Co., Brooklyn, NY.
Engel, Walter D.—Kirker Chemical Co., Paterson, NJ.
Friedman, Jack—Steven Paint Corp. Yonkers, NY.
Goldenhill, Robert—Multi Tech Corp. Manchester, CT.
Holt, John L. Sr.—Continental Technical Finishes Corp. Brooklyn, NY.
Kamen, Melvin—C & E Laboratories, Carlstadt, NJ.
Kassman, Irving—Technical Coatings Co. Nutley, NJ.
Liberti, Felix P.—Koppers Co., Newark, NJ.
Marinzulich, Gerald E.—Colloids, Inc., Newark, NJ.
Nowak, Edward—Allied Paint Co., Bronx, NY.
Pont, J.D.—International Paint Co., Inc., Union, NJ.
Rosenthal, James—Magnet Paint Co., Brooklyn, NY.
Tinello, Vincent J.—NL Industries Inc., Perth Amboy, NJ.
Ullah, Sadat M.—Pyramid Paint Prod., Inc., Brooklyn, NY.
Viso, Joseph—Daniel Products Co., Jersey City, NJ.
Werther, David—Mobil Chemical Co., Edison, NJ.

Associate

Barufaldi, Daniel J.—Ciba-Geigy Corp., Ardsley, NY.
Bogatin, Robert S., Jr.—Peltz Rowley Chemical Co., Philadelphia, PA.
Cuba, Rudy N.—Alcan Ingot & Powders, Elizabeth, NJ.
Evans, Mark D.—Charter Chemical Co., Wayne, PA.
Jackson, Suzanna—Spencer Kellogg Div., Textron, Inc., Rutherford, NJ.
Jordan James J.—Richardson Co., East Hanover, NJ.
Przybylowski, Robert—Whittaker, Clark, & Daniels, Inc., South Plainfield, NJ.
Smerak, Lance P.—Mobay Chemical Corp., Hawthorne, NJ.
Swenson, C. Richard—Bunge Corp. New York, NY.

FSCT Membership Anniversaries

25-Year Members

Kansas City

Earl Baumbart, of Cook Paint & Varnish Co.
Bill Fitzpatrick, of Cook Paint & Varnish Co.
William Kohen, of Osage Paint & Varnish Co.
Warren Manley, of Cook Paint & Varnish Co.
Robert Reed, of Pratt & Lambert
R.R. Robertson, of Valspar Corp.

Pacific Northwest

Frank Giltrow, of Flecto Ctg. Ltd.
Reginald Giltrow, of General Paint and Wallcoverings
Deryk Pawsey, of Rohm and Haas Canada Ltd.

Pittsburgh

Lee W. Campbell, of Campbell Chemical Co.
Kenneth E. Luyk, of Alcoa Research Labs.

Technical Articles in Other Publications

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

Farbe und Lack
(in German)

Published by Curt R. Vincentz Verlag, Schiffgraben 41-43,
3000 Hannover 1, Postfach 6247.

Vol. 87 No. 10 October 1981

"Thoughts prior to Formula 81 in Amsterdam"; 831-832.

Adrian, G., Bittner, A., and Gawol, M.—"New Phosphate-Based Anti-Corrosion Pigments"; 833-837.

Glaser, F.—"Investigations into the Angle Dependence of the Diffuse Reflectance of Lacquers and Related Products"; 837-845.

Hadjistamov, D.—"Critical Consideration of the Application of the Hysteresis Loop Method for Paste-Like Disperse Systems"; 845-849.

Gross, H.—"Surface Preparations Using Flame Descaling (3). Behaviour of Anti-Corrosion Coatings"; 849-853.

Brushwell, W.—"Main Research Topics in Development of Binders and Pigments"; 853-861.

Landwehr, E. and Diebener, H.—"New Edition of *Technical Conditions of Supply for Paints* (TL 918 300) of the Federal German Railways"; 861-863.

German Standard Draft DIN 55 943 A 1: Colouring Materials; Terms and Definitions; Amendment and Addendum 1; p. 868.

German Standard Draft DIN 55 956: Binders for Paints and Varnishes; Determination of Monomer Diisocyanates in Isocyanate Resins; p. 869.

Vol. 87 No. 11 November 1981

Dübbers, H.—"Selling in the Paint Industry"; 915-917.

Kuschel, J. and Sickfeld, J.—"Resistance of Coatings to Mineral Oils and Mineral Oil Products—Development of Test Liquids"; 917-924.

Wolski, W. and Wolniewicz, A.—"Processing of Iron Oxide Yellow for Manufacture of Magnetic Tape (2). Some of the Physicochemical Processes Accompanying Processing"; 925-930.

Berner, G. and Rembold, M.—"Aspects of New Developments in Light Stabilizers for Industrial Paints"; 930-935.

Gross, H.—"Surface Preparation by Flame Descaling (4). Behaviour of Primer Coatings During Burning Off"; 936-938.

Brushwell, W.—"Latest Developments and Applications of Polyurethane Lacquers"; 938-943.

German Standard Draft DIN 53 236: Testing of Colouring Materials; Conditions of Measurement and Evaluation for the Determination of Colour Differences for Paint Coatings, Similar Coatings and Plastics; p. 948

Vol. 87 No. 12 December 1981

"Blackening the Name of the Chemical Industry"; 997.

Mosle, H.G. and Wellenkotter, B.—"Sonic Emission Investigations of Coated Steel Plates Following Cathodic Polarisation in 1N NaCl Solution"; 998-1003.

Haagen, H.—"Investigation of Factors Influencing Mechanical Cleaning Processes for Automotive Finishes"; 1004-1010.

Kindervater, F. and Gegusch, W.—"Analytical Techniques for Colouring Agents and Paints. National and International Standardization Work"; 1011-1014.

Sniezko, A., Penczek, P., Ostrysz, R., and Swierz-Motysia, B.—"Use of Polyethylene Terephthalate in Manufacture of Alkyd Resins": 1014-1016.

Brushwell, W.—"Expanding the Range of Acrylic Resins for Paint Applications"; 1016-1021.

German Standard Draft DIN 55 945: Coating Materials (Paints, Varnishes and Similar Products); Terms and Definitions; p. 1026.

Jurging, K.—"International Industrial Colour Identification with Colour Samples"; p. 1046.

Vol. 88 No. 1 January 1982

Dorffel, J.—"Influence of Polyester Molecular Mass on the Properties of Polyester Melamine Resin Stoving Enamels"; 6-12.

Julich, G. and Thieme, Chr.—"Economics of Precipitated Calcium Carbonates in Dispersion Paints"; 13-19.

Penczek, P., Cynkowska, G., and Wardzinska, E.—"Polyesterimide Resins for Wire Lacquers. Influence of Chemical Composition of Polyesterimide Resins on Behaviour of Wire Lacquers at Elevated Temperatures"; 20-22.

Gross, H.—"Surface Preparation Using Flame Descaling (5). Evaluation of Surface Purity"; 22-27.

Brushwell, W.—"Principles of Formulation and Applications of Epoxy Resin Systems": 27-31.

Kent State Schedules Coatings Courses in June

The Rheology and Coatings Laboratory of the Chemistry Department of Kent State University, Kent, OH, will sponsor "Adhesion Principles and Practice for Coatings and Polymer Scientists," June 7-11 and "Applied Rheology for Industrial Chemists," June 21-25 on the university campus.

"Adhesion Principles and Practice for Coatings and Polymer Scientists" will offer adhesion principles and concepts and discuss applied problems that have been solved in industrial and academic settings. This short course is especially recommended for industrial scientists who earned degrees in a traditional science or engineering curriculum. The following topics will be featured:

Monday, June 7

"Principles of Bonding I"—Raymond R. Myers, Kent State University.

"General Rheology and Its Application to Adhesion"—Donald L. Hunston, National Bureau of Standards."

"Principles of Bonding II"—Raymond R. Myers.

I—"The Effect of Water on Adhesive Bonding" and II—"Testing Adhesive Bonds"—Robert L. Patrick, Trebor Assoc., Inc.

Tuesday, June 8

"Theory and Practice of Silane Adhesion Promoters"—Edwin P. Plueddemann, Dow Corning Corp.

"The Nanotensilometer—A Tensile Test Instrument with Applications to Adhesives and Interfaces"—Richard W. Hoffman, Case Western Reserve University.

"Structure and Properties of Silane Primers for Adhesive Bonding of Iron, Titanium, and Aluminum"—F. James Boerio, University of Cincinnati.

"Interfacial Energies and Their Role at the Interface"—Richard J. Ruch, Kent State University.

Wednesday, June 9

"Overview of Surface Chemical Analysis Techniques"—Thomas W. Rusch, Perkin-Elmer Physical Electronics Div.

"Etching of Polymer Surfaces for Adhesive Bonding"—James Koutsky, University of Wisconsin.

"Interfacial Chemistry of Corrosion Induced Adhesion Loss"—Ray A. Dickie, Ford Motor Co.

"Introduction to Stress and Fracture Analysis of Adhesive Bonded Joints"—William B. Jones, Air Force Materials Laboratory.

Thursday, June 10

"Deformation and Fracture of Adhesives"—Alan N. Gent, Institute of Polymer Science, The University of Akron.

"Principles of Adhesion Measurements"—Walter K. Asbeck, Consultant.

"Pressure Sensitive Adhesives"—Fred Hammond, Kendall Co.

"Long Range Effects of Polymer Sorption and Its Relation to Adhesion"—Charles A. Kumins, Consulting Services.

Friday, June 11

"Bonding of Plastics and Elastomers I"—Edward M. Petrie, Westinghouse Electric Corp.

"Bonding of Plastics and Elastomers II"—Edward M. Petrie.

• • •

"Applied Rheology for Industrial Chemists" will discuss problems faced by derivative industries which normally rely on basic industries to supply their raw materials. Practioners in the coatings, adhesives, elastomers, and plastics industries should gain insights which will enable them to improve quality, tailor materials for prescribed end uses, and learn research techniques. The first day is tutorial; thereafter, applications are interspersed among presentations. Lectures include:

Monday, June 21

"Basic Concepts of Rheology I"—Hershel Markovitz, Carnegie-Mellon University.

"Basic Concepts of Rheology II"—Hershel Markovitz.

"Measuring Techniques for Viscoelastic Properties of Liquids"—Raymond R. Myers.

"Applied Rheology of Elastomers"—Edward A. Collings, Diamond Shamrock Corp.

Tuesday, June 22

"Kinetic Rheology Applied to Liquid-to-Solid Conversion"—Raymond R. Myers.

"Application of Rheology to Process Problems"—Joseph M. Starita, Rheometrics, Inc.

"Application of Rheology to End Use Performance Problems"—Joseph M. Starita.

"Torsional Braid Analysis (TBA): Time-Temperature-Transformation (TTT) Pure Diagram of Epoxy/Amine System"—John K. Gilham, Princeton University.

"Characterization of Polymer Systems by Dynamic Mechanical Analysis"—Philip S. Gill, du Pont Co., Analytical Instruments Div.

Instrument Display.

Wednesday, June 23

"Brush Application of Coatings"—J. Edward Glass, North Dakota State University.

"Roll Application of Coatings"—J. Edward Glass.

"Application of Rheology in Petroleum Recovery Processes"—J. Edward Glass.

"Chemorheology of Thermosets"—Richard R. Eley, Glidden Coatings and Resins Div., SCM Corp.

Thursday, June 24

"Characterization of Non-Newtonian Fluids: An Industrial Viewpoint"—Mike Rosen, Union Carbide Corp.

"Rheology of Dispersions"—Irvin M. Krieger, Case Western Reserve University.

"Correlation of Film Morphology with Drying Behavior"—John W. Vanderhoff, Emulsion Polymers Institute, Lehigh University.

"Flow Fundamentals in Fluid Systems of High Molecular Weight Additives"—Donald L. Hunston, National Bureau of Standards.

Friday, June 25

"Fracture Behavior of Brittle Materials"—Donald L. Hunston.

"Application of Rheology to Industrial Problems"—Donald Bigg, Battelle Columbus Laboratories.

The cost per course is $385 which includes registration, instruction, reference material, lunches, mixers, and banquet.

For additional information and to register, contact College of Special Program, 327 Rockwell Hall, Kent State University, Kent, OH 44242.

Organic Coatings Science Conference To Be Held July 12–16, Athens

The State University of New York and the Greek Professional Societies will sponsor the Eighth International Conference in "Organic Coatings Science and Technology." July 12–16, at the Apollon Palace Hotel, Athens, Greece.

The conference will bring together leading scientists, engineers, industrialists, and educators in an international forum to discuss all aspects of organic coatings science and technology, including inks. This interchange of ideas and information will enable the industry to establish more productive programs of research, development and production, as well as to increase the rate of useful technological innovations.

Designed for chemists and other professionals who want to understand the principles involved in the science and technology of organic coatings, the conference will discuss the manufacture, applications to surfaces, and properties of organic coatings. In addition, the latest developments in the field of organic coatings will be featured in a manner that will permit the scientist or engineer to integrate fundamental scientific principles with processing and application technology.

The program will consist of invited lectures and contributed papers. Topics and invited speakers are as follows:

"Predicting Durability of Finishes for Wood from Basic Properties"—Dr. Harry E. Ashton, National Research Council, Canada.

"New U.V. Absorbers and Stabilizers for High Solid Coatings"—Dr. Godwin Berner, Ciba-Geigy, Switzerland.

"Critical Pigment Volume Concentration in Latex Paints"—Dr. B. Bierwagen, Sherwin-Williams, U.S.A.

"Aspects of Metal Pretreatment before Painting"—Dr. P.B.A. Cooke, ICI Ltd., U.S.

"New Epoxy Resin/Hardener System for Coatings"—Dr. S. Eldin, Ciba-Geigy, Switzerland.

"Chemistry of High Solids Aklyd/Reactive Diluent Coatings"—Dr. William D. Emmons, Rohm and Haas Co., U.S.A.

"Protection of Steel by Blastcoating and Painting Under Water"—Dr. R.C. Groot, AKZO, Netherlands.

"Solvents in Coatings"—Dr. Charles Hansen, Scandinavian Paint and Printing Ink Research Institute, Denmark.

"High Solids Alkyd Resins"—Dr. Krister Holmberg, EKA Kemi, Sweden.

"New Approaches to the Problem of Corrosion Protection by Means of Organic Coatings"—Dr. Takeo Imai, Kansai Co., Japan.

"Structure of Adsorbed Polymer Layers on Pigment Surfaces as Related to Dispersion Stability"—Dr. G. Joppien, Deutsches Kunststoff-Institut, Germany.

"New Techniques to Study Corrosion Mechanisms Under Organic Coatings"—Dr. Jerome Kruger, National Bureau of Standards, U.S.A.

"Formation and Properties of Colloidal Alkyds"—Dr. J. Kumanotani, University of Tokyo, Japan.

"Recent Advances in Coatings for Household Appliances"—Dr. Thomas Miranda, Whirlpool Corp., U.S.A.

"Interfacial Interactions between Coatings and Metals Related to Adhesion and Corrosion Protection"—Dr. W.J. van Ooij, AKZO, Netherlands.

"Effects of Surface Tension and Viscosity on Coatings Defects"—Dr. Percy Pierce, PPG Industries, Inc., U.S.A.

"Techniques for Characterization of Oligomers Used In Coatings"—Dr. Theodore Provder, Glidden Coatings and Resins Div., SCM Corp., U.S.A.

"Radiation Curing of Coatings for Leather"—Dr. Frank Scholnick, Eastern Regional Research Center, U.S.A.

"Contribution to Energetic Characterization of Pigment Dispersions: Pigments and Solvents"—Dr. J. Schroder, BASF AG, Germany.

"Thermal Analytical Investigation of Epoxy Resins at High Temperatures"—Dr. J. Sickfeld, Bundesanstalt fur Materialprufung, Germany.

"Abrasion Resistant Polyurethane Coatings"—Dr. A. Singh, Uniroyal Chemical Co., U.S.A.

"Use of Silicon Polymers and Additives in High Solids and Water Reducible Coatings"—Dr. Forest Stark, Dow Corning Co., U.S.A.

"Influence of the Polyester Melamine Resin Networks on Mechanical Properties and Corrosion Stability of High Solids Coatings"—Dr. D. Stoye and Dr. Dorffel, Huls Chemische Werke AG, Germany.

"Reaction of Polyisocyanate in Coatings"—Dr. Kunihiko Takeuchi, Nippon Paint Co., Japan.

"Utility of Surface Analytical Instrumentation to Coatings Problem Solving and Product Development"—Dr. S. Valenty, General Electric Co., U.S.A.

"Steel Surface Cleanliness: Preparation, Characterization and Paint Performance"—Dr. R.P. Wenz, 3M Co., U.S.A.

The registration fee for the conference is $300 which includes participation in the scientific sessions and the book of the published proceedings of the conference.

For further information, contact Conference Director Angelos V. Patsis, School of Chemistry, State University of New York, New Paltz, NY 12561.

DCMA Annual Meeting To Be Held June 13–16

The Dry Color Manufacturer's Association will sponsor its 1982 Annual Meeting, June 13–16 at The Greenbrier, White Sulphur Springs, WV.

This year's meeting will feature the most extensive educational and business sessions ever presented at a DCMA annual meeting and will be highlighted by four informative General Sessions.

Opening the program on Monday morning will be Robert Metz, *New York Times* financial columnist, who will present "The Economy: Can We Save It?" at the President's Breakfast.

The annual business meeting will follow and will be chaired by DCMA President Paul Papillo. Featured will be the election of new officers and board members, the President's report, the June 1982 Legislative Update, approval of the budget, and a review of other association business.

"The Pigments Industry in Western Europe" will be reviewed by Dr. Robert Pascoe of ICI, England, at Tuesday's General Session. A "Pigments Users Forum" will follow which will feature speakers from the ink, paint, and plastics industries. Discussed will be the trends and developments in those industries and their effects and impact on pigments manufacturers. Ronald Lang, Executive Director of the Synthetic Organic Chemical Manufacturers Association, will moderate this panel which features Roland Gravenkemper, Senior Vice-President of Inmont Corp.; William Kinsell, Jr., President of Glidden Coatings and Resins Div., SCM Corp.; and William Bradbury, Jr., Vice-President of PMS Consolidated.

The final session, scheduled for Wednesday morning, is an update of last year's highly successful Special Board of Governors Meeting with Ecology Committee Chairmen. The chairmen will present individual reports on the work of their committees during the past year, outline special areas of concern, and discuss future areas of endeavor.

For additional information, contact DCMA, Suite 100, 1117 N. 19th St., Arlington, VA 22209.

People

Joseph E. Gaske, Senior Research Associate with DeSoto, Inc., was presented with the firm's 1981 Researcher of the Year Award in recognition of his development of a primer whose qualities could withstand the chemical assault of acid rain. He is a member of the Chicago Society.

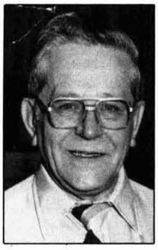
DeSoto, Inc. has announced the promotion of **Robert E. Ansel** to the position of Research Associate in the New Venture Research Department. Mr. Ansel is a Chicago Society member.

Meanwhile, **Rudolph Maul** was named Product Manager for the Argo Automative Division of DeSoto, Inc., Westland, MI. He will be responsible for the commercial development of new and existing products as well as augmenting customer/supplier relations.

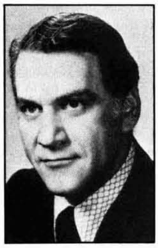
Samuel E. Firestone, former Chairman of the Board and Chief Executive Officer of McCloskey Varnish Co., has announced the formation of S.E. Firestone Associates, Inc., a manufacturer's representative organization for the paint, printing, and plastics industries. The firm will operate in the Eastern Pennsylvania, New Jersey, Delaware, and Maryland areas, representing manufacturers of resins, pigments, chemicals, and additives. Mr. Firestone has over 30 years experience in paint, printing ink, plastics, rubber, adhesive, paper, and allied industries in sales, sales and marketing management, and general management. He is 1981–82 President of the Philadelphia Association of the National Paint and Coatings Association and has been President of the Printing Ink Makers Production Club, Philadelphia Chapter. He is also Director of the Manufacturers Association of Delaware Valley.

Michael J. Dunn, Marketing Manager for Industrial Colorants for H. Kohnstamm & Co., Inc., New York, NY, has retired. He will continue as a consultant for the firm based in San Diego, CA. Mr. Dunn is a member of the New York Society.

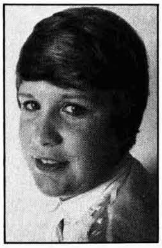
Two marketing appointments were announced by the Chemicals Field Marketing Division of Eastman Chemical Products, Inc. **Stephen P. Rounds** was appointed Senior Marketing Representative, responsible for marketing chemicals in the New Jersey and New York areas. **Lee H. Davis** was also appointed a Senior Marketing Representative, based in the Kansas City area.



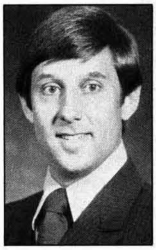
J.E. Gaske



S.E. Firestone



P.A. Verlodt



R.L. Vaughan

Color Communications, Inc., Chicago, IL, has appointed **Patricia A. Verlodt** as Director of Color Design and Technology. In this capacity, Mrs. Verlodt will continue to manage the computerized Color Laboratory and will assume responsibility for a broad range of activities involved in the development of color systems, color cards, and color merchandising programs. Mrs. Verlodt is a member of the Chicago Society, the Inter-Society Color Council, and the Color Marketing Group for which she serves as co-chairman of the Technical Directions Committee.

Maurice Samson, President of Samson Chemical Co., was honored by the Paints, Plastics, Petroleum and Chemical Division (PPPC) at the annual paints industry luncheon at the Los Angeles Music Center held on behalf of the United Jewish Welfare Fund. Mr. Samson was presented with the division's 1982 Ike Sinaiko Achievement Award for his lifelong dedication and service to humanity through the United Jewish Welfare Fund. Mr. Samson is a member of the Los Angeles Society.

Lloyd R. Brower was appointed Technical Director of Barrett Varnish Co., Cicero, IL. Mr. Brower has been involved in R&D for industrial finishes for more than 41 years, and was most recently associated with Standard T. Chemical Co. He has published various papers in the field of electrodeposition and is co-holder of two patents in the field.

Borden Chemical has announced the appointments of **George T. Sickinger** as General Manager of its Printing Ink Group and **Peter B. Semadeni** as General Manager of its Specialty Products Group. Both operations, headquartered in Cincinnati, OH, have become units of the firm's newly organized Graphics Division.

American Cyanamid Co. has appointed **Richard L. Vaughan** to the position of Marketing Manager, Resins and Adhesives, Resins Products Department, based in Wayne, NJ. Prior to this appointment, Mr. Vaughan served as Western Regional Manager, Resins and Adhesives, for the firm's Industrial Products Division, Chicago, IL. Mr. Vaughan is a member of the Chicago Society.

Also announced by the company was the appointment of **A. Blair Battistini** as National Sales Manager for Color Pigments in the Color Products and Intermediate Chemical Department.

The appointment of **Donald R. Marsh** as the Baltimore District Sales Manager was announced by the Spencer-Kellogg Division of Textron, Inc. Prior to his appointment, Mr. Marsh had been a manufacturer's representative with Stern & Marsh Co. He is a member of the Baltimore Society.

Dennis L. Dalton, Technical Service Manager for Buckman Laboratories, Inc., has also assumed responsibilities as Industry Specialist-Paint Industry. Before relocating to the firm's international headquarters in Memphis, TN, Mr. Dalton was associated with Buckman-Ghent in Belgium, as Assistant Marketing Manager for paint and plastics, and most recently served as Development Specialist-Europe.

The Resins Department of Ciba-Geigy Corp., Hawthorne, NY, has formed a new strategic business group. This specialty coatings group is headed by Market Center Manager **Edward Bozzi**. Working with him are **Marcel Gaschke**, Market Manager for Maintenance and Marine Coatings; **Camilla Zendig**, Market Manager for Powder Coatings; and **William Collings**, Sales Manager. Mr. Bozzi and Mr. Gaschke are members of the New York Society.

John Gleason, Color Director of the Ameritone Paint Corp., member of Grow Group, Inc., has been named the Chairholder of the Color Marketing Group. This honorary title is awarded to members of the Color Marketing Group who have made vital contributions to the organization, which is an international association of designers, marketers, and technical specialists.

Sylacauga Calcium Products has named **Mack L. Williams,** Technical Director responsible for the direction of the firm's research, product development, and quality control groups. Mr. Williams is a member of the Southern Society.

Also announced by the company was the promotion of **W.N. Laughridge** to Marketing Director responsible for regional, national, and international sales and market development.

Robert A. Katherine has been elected President and Chief Executive Officer of McCloskey Varnish Co., Philadelphia, PA. Mr. Katherine joins the firm with over 20 years of experience in marketing, manufacturing, and strategic planning in the domestic and international plastics, chemical, and petrochemical industries. He assumes overall responsibility for management and profitability of the entire McCloskey operations, including the Philadelphia headquarters and subsidiaries.

Also announced by the firm was the appointment of **David Setzer** to the position of Materials Control Manager of the Philadelphia plant.

PPG Industries, Inc. has appointed **Dr. Leland H. Carlblom** and **Charles Friedlander** to the positions of Senior Research Associate in their Coatings and Resins Division, Research and Development Laboratory, Allison Park, PA. **Dr. Suryya K. Das** was named Scientist for the division.

Also announced by the firm was the appointment of **Thomas A. Leathers** to the position of Senior Engineering Associate, Coatings and Resins Division, Research and Development Laboratory, Springdale, PA. **Rodger G. Temple** was promoted to Development Associate for the division.

Burks, Inc., Atlanta, GA, has announced the promotions of **W. Vonn Sieber** to Vice-President and **Roselle E. Henschen** to Assistant Secretary-Treasurer Corporate. Mr. Vonn Sieber is a Southern Society member.

Carboline Co., St. Louis, MO, has appointed **David P. Nick** to the position of International Division General Manager.

Louis A. Graham, Manager of Corporate Research and Development of Burlington Industries, Inc., was elected President of the Inter-Society Color Council, 1982–84. Mr. Graham, a cofounder of the Color Marketing Group, has been a member of ISCC since 1958. **Joyce A. Davenport,** a member of the Federation, was elected President-Elect. She is Supervisor of Color Development, Color Research, for DeSoto, Inc., Des Plaines, IL. The Secretary is **Therese R. Commerford,** of the U.S. Army Natick Research and Development Labs. **Edward T. Connor,** of Pacific Scientific Co., was named Treasurer.

Irvin S. Hull, a Sales Representative for the Bareco Division of Petrolite Corp., has been promoted to Supervisor, Special Projects, in the division's domestic sales organization. He will be based at the firm's Tulsa, OK headquarters.

Joyce McFadden has joined the Dexter Corp., Midland Division, as a Senior Analytical Chemist. **Gilbert J. Anderson** has been promoted to the position of Senior Coatings Chemist, Packaging Laboratory. Mr. Anderson is a member of the Chicago Society.

Gilbert J. Anderson was promoted to Senior Coatings Chemist, Packaging Laboratory, for the Midland Division, The Dexter Corp., Waukegan, IL. Mr. Anderson is a member of the Chicago Society.

Joining the firm were **John P. Knudtson** as Manager, Packaging Laboratory, and **Christianah O. Oladeinde** as a Coatings Chemist.

William A. Adams was appointed General Sales Manager of Morehouse Industries, Inc., Fullerton, CA.

Thomas F. Plummer was named Vice-President of Freeport Kaolin Co., New York, NY. He will be responsible for financial and other business aspects of the company.

Mautz Paint Co. has announced the promotion of **William T. Johnson** to the position of Production Manager based in Madison, WI. Mr. Johnson is responsible for scheduling and processing paint manufacturing for trade sales as well as industrial and maintenance products. He succeeds **Alford Markham** who recently retired.

Diamonite Products Manufacturing, Inc., Shreve, OH, has announced the appointment of **Donald C. Wiles** to Custom Products Sales Manager. In his new position, Mr. Wiles will direct all domestic and off-shore sales and related activities for custom alumina ceramics.

Glidden Coatings & Resins, SCM Corp., has announced two managerial appointments. At the Western Region headquarters, **William B. Anthony** was named Technical Manager. In Atlanta, at the company's Southeastern Region headquarters, **David Lawrence** was promoted to Plant Superintendent. Mr. Lawrence was previously Quality Control Technician and Manufacturing Foreman.

Henkel Corp., Minneapolis, MN, has restructured its businesses in the U.S., resulting in several new appointments. **Eugene A. Snyder** was named President of Amchem Products, Inc., Ambler, PA, and was also appointed an Executive Vice-President of Henkel Corp. **Dr. David D. Taft** was named President of Chemical Products Division, Minneapolis. Dr. Taft is also an Executive Vice-President, Henkel Corp. **Johan B. Swildens**, Executive Vice-President, Henkel Corp., was appointed President of Functional Products Division, Minneapolis. A Technology Group, a major support organization within Henkel Corp., was formed. Under the direction of **Dr. F. William Tuominen**, Vice-President, the group will be responsible for corporate research and development, process and project engineering, and will generally support the divisions in technology areas.

John N. Lauer has been appointed Vice-President-Marketing by Celanese Chemical Co., Dallas, TX. He replaces **Dr. H. David Medley**, who was named President of Celanese International Marketing Co.

Obituary

Roy G. Landis, 70, retired plant engineer with The Sherwin-Williams Co., died March 5. An employee with Sherwin-Williams for 35 years, Mr. Landis was also a member of the Golden Gate Society and the Golden Gate Paint & Coatings Association.

Herman J. Fritz, 67, retired Vice-President and Technical Director of Mobile Paint Co. and a Past-President of the Southern Society for Coatings Technology, died March 19. Mr. Fritz joined Mobile in 1952 after being employed as a chemist and plant manager in other industries and for government departments. He served the Southern Society as its President in 1961–62.

Literature

Product Digest

A new product digest describing process analytical and control instrumentation, air and water quality products, exhaust analysis instruments and systems, and automative test instruments is now available from Beckman Instruments, Inc. The 16-page digest, Bulletin 4210A, highlights product features and references available literature describing in detail each product model. Photographs illustrate these systems and a listing of domestic and international sales and service offices are provided. For your free bulletin, contact Beckman Instruments, Inc., Process Instruments & Controls Group, Literature Distribution, MS: L-19, 2500 Harbor Blvd., Fullerton, CA 92634.

LC Pump

A six-page brochure has been published that describes the first high-performance preparative liquid chromatograph (HPPLC) with single-pump, multisolvent gradient capability. Text and chromatograms illustrate how the Series 8800 HPPLC and "Zorbax" columns help users master difficult separations of complex mixtures, achieve high sample throughput, and simplify transfer of analytical separations to preparative scale. The literature also explains how to convert the Series 8800 analytical system to preparative operation. For a copy of "Liquid Chromatography Technical Notes," write DuPont Co., Analytical Instruments Div., Concord Plaza, McKean Bldg., Wilmington, DE 19898.

Computer Lab Program Package

Literature is available describing a computer-assisted lab program package, designed to include both hard and software elements. Information features a program which enables small to medium chemical and coating manufacturers to efficiently coordinate a whole range of laboratory procedures including: integral formulation revisions; multi-vendor access; inventory maintenance and adjustments; formula files; batch-ticket print-outs; instant calculations of RMC; and finished product cost. The system also performs all related accounting functions. The package operates on eight bit microprocessor in COBOL. For information, write Universal Micro Systems, 123 Jordan St., San Rafael, CA 94901.

Slide Rule Guide

An easy-to-use, slide rule for matching NL Chemicals rheological additives and pigments with their correct applications is available. The first side of the compact reference, the rheological additives selector, presents a simple method to match the primary solvent used with the appropriate NL Chemicals rheological additive product. In addition, activation temperature, polar activator indications, product density, N.V. percentages, and usage percentages are provided for each NL product. By sliding the indicating arrow to the primary solvent being used, users can determine the specific NL products that are indicated for use. The second side of the slide rule, the pigment selector, lists NL Chemicals pigment products for a wide variety of applications. By moving the indicating arrow to one of 23 applications listed, users discover the NL pigments that are specifically recommended for use. The applications are divided into three areas: product finishes, architectural coatings, and miscellaneous coatings and finishes. In addition, data on specific gravity, percentage composition of titanium dioxide, chalk resistance levels, and conformance to applicable ASTM standards are indicated. Order the free selector guide by contacting NL Chemicals/NL Industries, Inc., P.O. Box 700, Hightstown, NJ 08520.

2-Nitro-*p*-toluidine

A newly issued technical bulletin providing information on uses and properties of 2-Nitro-*p*-toluidine is available. Applications featured are as intermediates for dyes, pharmaceuticals, and azo pigments. To obtain a copy of Technical Bulletin 150, write, Sherwin-Williams Co., Publications Dept., 11541 S. Champlain Ave., Chicago, IL 60628.

Colorimeter

Literature is available which announces a new extender memory storage for standards on Hunterlab's D25-9 series of microprocessor colorimeters. Based on need, the expanded memory can now store 100, 200, or up to 300 different product standards which can be instantly recalled for comparison with specimens being tested. Highlighted are the advantages of using this extender memory storage option. For additional information, contact Hunter Associates Laboratory, Inc. 11495 Sunset Hills Rd., Reston, VA 22090.

Organic Intermediates

A new 20-page booklet on specialty organic intermediates has been published. The literature features the uses of these intermediates in the manufacture of disperse dyestuffs and in the production of industrial cleaners, emulsion polymers, light sensitive diazos, plasticizers, polyester resins, and pharmaceuticals. A copy of the booklet may be obtained from Emery Industries, Inc., Dept. P, 1300 Carew Tower, Cincinnati, OH 45202.

Calculation Techniques In Formulating Resins

Information is available which highlights calculation techniques in the formulation of alkyd and related resins. Various calculation techniques are demonstrated by specific examples; comments are featured on the related general principles; and practice examples are given so that the reader can gain confidence in handling the calculations. Included are some general case solutions and some special cases are considered such as castor oil-based alkyds, "Cadura" alkyds, and water-soluble resins. Publication 19 can be obtained from the Paint Research Association, Waldegrave Rd., Teddington, Middlesex TWII 8ID, England.

"Adhesives IV"

"Adhesives IV", a multi-client, techno-economic marketing study, has recently been completed by Skeist Laboratories, Inc., consultants to the polymer industries. The study provides a comprehensive analysis of markets, raw materials, technological trends, marketing shifts, prices, major suppliers, leading end users, and volumes for the year 1980 with projections for 1985. Separate sections feature: hot metals; pressure sensitives; engineering/structural adhesives; and radiation curable adhesives. The Industry; Review gives a complete assessment of the structure of the adhesive business, including detailed profiles of the leading 22 merchant adhesive formulators and their adhesive sales by market segment. The data contained within 811 pages and 880 tables and an index of 5700 entries are invaluable to raw material suppliers, formulators and end users, and newcomers. The subscription fee is $11,000. A free brochure, with Table of Contents, is available from Skeist Laboratories, Inc., 112 Naylon Ave., Livingston, NJ 07039.

Black Dispersion

A new high tint strength black aqueous dispersion, designed for use in a variety of applications for coloring and tinting purposes, is the subject of recently published literature. Information is provided on rheology, compatibility, and stability characteristics and the fields of applications which include: aqueous coatings, paper coloring and coatings; aqueous printing inks; textile applications; cement compositions; and leather finishes. For more information, write CDI Dispersions, 27 Haynes Ave., Newark, NJ 07114.

Additives

A new line of additives for solvent-based coatings, inks, and sealants is featured in recent literature. Information is provided on anti-settling and -sagging agents; wetting and dispersing agents; anti-flood, -float, and -silking additives; and defoamers and leveling agents. Featured uses include: high film build epoxy coatings; architectural coatings; marine paints; air dry and baking enamels; automative coatings; and powder coatings. Literature is available from King Industries, Inc., Science Rd., Norwalk, CT 06852.

UV Cure Coatings

A four-page brochure is available which describes the physical properties and cure conditions of Photoglaze® UV cure coatings. According to the brochure they provide resistance to abrasion, scuffing, stains, and UV yellowing in both high and low gloss finishes. The brochure detailing these solventless coatings may be obtained from the Chemical Products Group, Lord Corp., P.O. Box 10038, Erie, PA 16514.

Polyvinyl Alcohol Bulk Handling Systems

A new brochure describing selection and design guidelines for Vinol® polyvinyl alcohol (PVOH) bulk handling equipment is now available. The literature is designed for anyone engaged in the design, construction, or use of PVOH bulk handling systems. Provided are recommended guidelines on silo construction and discharge equipment, airlocks, blowers, airveying lines, and miscellaneous equipment used in bulk handling systems. Also included is material safety data. For a free copy of the brochure, contact Air Products and Chemicals, Inc., Public Affairs Dept. #82N30, P.O. Box 538, Allentown, PA 18105.

ASTM Publications

ASTM, developers of over 6,000 active voluntary consensus standards used worldwide, have announced the availability of Parts 27-29 of the *Annual Book of ASTM Standards*. Part 27, "Tests for Formulated Products and Applied Coatings," provides information on paints, varnishes, and lacquers and their related physical and chemical tests, panel specifications and preparation, drying rates and anomalies, and film preparation. Also featured are data on dry paint film properties, thickness, porosity and permeability, appearance properties, nonchemical physical strengths and resistances, resistances to chemicals and environment, exterior testing, durability tests, and schedules of examination for testing paint products. It is available for $50. Part 28, "Pigments, Resins, and Polymers," provides information on paint and related coatings and materials including pigments, resins, and polymers. Cost is $34. Part 29, "Fatty Oils and Acids, Solvents, Miscellaneous; Aromatic Hydrocarbons; Naval Stores," features paint and related coatings and materials including drying and nondrying fatty oils and acids; fatty nitrogen products; solvent specifications; solvent tests; miscellaneous paint materials; industrial aromatic hydrocarbons; naval stores—rosin, liquid naval stores. Fee for the publication is $49. For information, contact ASTM, 1916 Race St., Philadelphia, PA 19103.

Fungicides

Application information for a series of metallic carboxylates for use as fungicide agents in various formulations is discussed in a new technical bulletin. Property and application data are provided on Witco® 8% Copper Naphthenate, 8% Zinc Naphthenate, and 6% Copper Oleate. Copies of "Witco Metallic Carboxylates as Fungicides," No. 414, may be obtained from Witco Chemical Corp., Organics Div., 6200 W. 51st St., Chicago, IL 60638.

Vinyl Resin

A new vinyl resin, UCAR Solution Vinyl VYES, developed primarily for high solids maintenance coatings, is the subject of recent literature. Information is provided on the resin's solubility and low molecular weight which facilitate high solids formulation and the use of low-cost solvent blends. Uses of the resin are highlighted along with its advantages. For information, write Union Carbide Corp., Coatings Materials Div., Dept. K3442, Danbury, CT 06817.

Literature Index

Technology Marketing Corp. has announced the availability of a complete literature index featuring all articles which appeared during the last decade on the subjects of UV curing, high solids, water-borne and powder coatings. Articles described in this index aid in the understanding and help to promote involvement in: high productivity, energy efficiency, and nonpolluting technologies. The index covers all issues and back volumes of publications issued by Technology Marketing Corp. For a free index, contact Technology Marketing Corp., 17 Park St., Norwalk, CT 06851.

Interior Coating

An advanced water-borne compliance internal spray coating for two-piece beer and soft drink containers is highlighted in recently published literature. Data is provided on the coating, System Aquarius, which has extremely good economics, based on actual production usage, and will apply at consistently lower film weights than other materials currently in use. For information, contact the Midland Div., The Dexter Corp., E. Water St., Waukegan, IL 60085.

Respirator Fit Manual

A Respirator Fit Test Manual and audio-visual program which describe "qualitative" test procedures for fitting industrial respirators on workers is available from the National Paint and Coatings Association. The manual and audio-visual program can be used by employers in a wide range of industries as they assist compliance with the Occupational Safety and Health Administration's (OSHA) Respiratory Protection Standard. Additionally, the procedures described are currently under consideration for adoption under the OSHA Standard on Occupational Exposure to Lead. The manual details instructions for: fitting a respirator properly; training employees to wear, adjust, and determine if respirators fit properly; conducting an odor test for assessing the fit of vapor respirators; and conducting a taste test for assessing the fit of particulate respirators. The audio-visual program is a slide/sound training program designed for employees which includes separate programs for each procedure, explaining the tests to employees in an attempt to gain their cooperation. The price per set for the manual and the audio-visual program is $50 for NPCA members and $100 for nonmembers. For further information, contact Sherry Mahoney, Regulatory Assistant, Technical Div., NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005.

Newsletter

Climax Molybdenum Co., a division of AMAX, Inc., has introduced its "Moly Corrosion Inhibitor Newsletter," a periodical describing uses of molybdenum compounds in water treatment, pigments, engine coolants, oil field fluids, solar energy fluids, metalworking fluids, and metal phosphating. To receive a free copy of the first issue as well as subsequent issues, please write to Climax Molybdenum Co., Reader Service Dept., P.O. Box 594, Canal St. Station, New York, NY 10013.

Abstract Newsletter

A weekly abstract newsletter is available which covers such areas as adhesives and sealants; coatings, colorants, and finishes; corrosion and corrosion inhibition; elastomers; materials degradation and fouling; and plastics. An annual subscription to this newsletter is available for $75 from the U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161.

Epoxy-Dimerates

A guide to preparation, pigmentation, and application of low-bake, high solids epoxy-dimerates for coatings is now available. This 16-page brochure describes EPON® resin-dimer acid adducts and details their end use in coatings with conventional bake schedules, and energy-saving and low-temperature cure schedules. For a copy, contact Shell Chemical Co., Manager of Chemical Advertising, One Shell Plaza, Houston, TX 77002.

Lead-Free Primer Coat

A new lead and chromate free rust inhibitive primer coat which also exhibits excellent corrosion resistant properties has been introduced in recent literature. Information is provided on this new primer coating which is designed primarily for applications over metal, allowing industrial users to apply the coating without requiring worker protection measures necessary when using a lead-based paint. For more information, contact Charles Dauderman, the DeGraco Div., The Valspar Corp., 200 Sayre St., Rockford, IL.

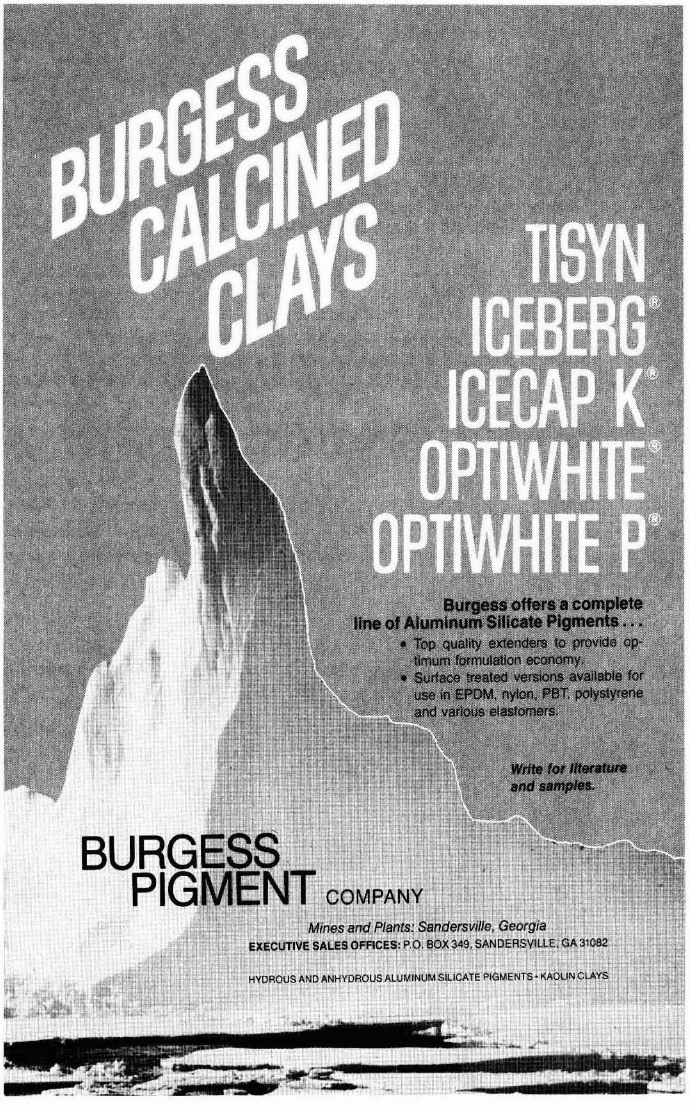
CLASSIFIED ADVERTISING

PAINT TECHNICIAN

Chemist with experience in screen process ink formulation or related fields. Nationally known company producing quality decal transfers. Durochrome Products, Inc., 2475 W. La Palma, Anaheim, Calif. 92801 (714) 527-1213 Mr. John Morris.

PAINT LINE SUPERVISOR

Mid-Atlantic Corporation has an opening for a qualified Paint Line Supervisor to coordinate painting of aluminum extrusions. Must have experience using waterborne and high solids environmental coatings, as well as conventional solvent base paint. Previous supervisory experience desirable, but will consider candidates with a high degree of technical knowledge and experience with paint equipment. Send resume with previous salary history in confidence in c/o JCT, Box 329, 1315 Walnut St., Suite 832, Philadelphia, PA 19107.



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

(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

(June 14)—Golden Gate Society for Coatings Technology Computer Seminar. A. Sabella's Restaurant, San Francisco, CA. (E. Bud Harmon, Borden Chemical Co., 41100 Boyce Rd., Freemont, CA 94538).

(Oct. 5)—Cleveland Society for Coatings Technology Manufacturing Committee Symposium on "The Use of Computers in the Manufacture of Coatings." Cleveland Engineering and Scientific Societies Bldg., Cleveland, OH. (Chairman Charles K Beck, Premier Industrial Corp., 4415 Evelid Ave., Cleveland, OH 44103).

1983

(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. 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).

OTHER ORGANIZATIONS

(June 13–16)—Dry Color Manufacturers' Association Annual Meeting. The Greenbrier, White Sulphur Springs, WV. (P.J. Lehr, DCMA, Suite 100, 1117 N. 19th St., Arlington, VA 22209).

(June 14–18)—"Principles of Color Technology" Short Course. Rensselaer Polytechnic Institute, Troy, NY. (Office of Continuing Studies, Rensselaer Polytechnic Institute, Troy, NY 12181).

(June 20–23)—American Society for Testing and Matrerials Committee D-1 Meeting on Paint and Related Coatings and Materials. Sheraton Center, Toronto, Canada. (Jane M. Turner, ASTM, 1916 Race St., Philadelphia, PA 19103).

(June 20–25)—75th Air Pollution Control Association's Annual Meeting and Exhibition. The Rivergate Convention Center, New Orleans, LA. (APCA, P.O. Box 2861, Pittsburgh, PA 15230).

(June 21–25)—"Advances in Color Technology" Short Course. Rensselaer Polytechnic Institute, Troy, NY. (Office of Continuing Studies, Rensselaer Polytechnic Institute, Troy, NY 12181).

(June 21–25)—"Applied Rheology for Industrial Chemists" Short Course. Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, OH 44242).

(June 21–25)—"High Solids Coatings" Short Course. North Dakota State University, Fargo, ND. (Dr. Zeno Wicks, Jr., NDSU, Polymers & Coatings, Fargo, ND 58105).

(June 23)—"Powder Coatings: How It will Work for You" Workshop. Birmingham, AL. (Susan Buhr, Technical Activities Dept., Society of Manufacturing Engineers, One SME Dr., P.O. Box 930, Dearborn, MI 48128).

(June 28–30)—"Organic Coatings Technology" Short Course. Center for Professional Advancement's Academic Center, East Brunswick, NJ. (Center for Professional Advancement, Dept. NR., P.O. Box H, East Brunswick, NJ 08816).

(June 28–July 8)—"Polymer Colloids" Short Course sponsored by NATO Advanced Study Institute. University of Bristol, United Kingdom. (Dr. Gary W. Poehlein, School of Chemical Engineering, Georgia Institute of Technology, Atlanta, GA 30332).

(June 29–July 7)—20th Session of the International Commission on Illumination. National Philharmony Bldg., Warsaw, Poland. (U.S. National Committee, CIE, c/o National Bureau of Standards, Washington, D.C. 20034).

(June 30)—Western Finishing Association's Seminar on "Finishing Strategies for the 1980's" Luminaria's Restaurant, Monterey Park, CA. (Jack Doran, Cal-Star Chemicals, 4625 Fir Ave., Seal Beach, CA 90740).

(July 12–16)—8th International Conference on Organic Coatings, Science and Technology. Athens, Greece. (Angelos V. Patsis, Coykeydall Science Bldg., State University of New York, New Platz, NY 12561).

(July 12–16)—International Union of Pure and Applied Chemists' 28th Macromolecular Symposium. University of Massachusetts, Amherst, MA. (James C.W. Chien, Dept. of Polymer Science & Engineering, University of Massachusetts, Amherst, MA 01003).

(Aug. 2–20)—Battelle's International Program in Productive R&D Management. Columbus, OH. (Dr. William D. Hitt, Battalle's Columbus Laboratories, 505 King Ave., Columbus, OH 43201).

(Aug. 9–13)—"Introductory Short Course on Composition of Coatings." University of Missouri-Rolla, Rolla, MO. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, UMR, Rolla, MO 65401).

(Aug. 16–20)—Fifth Annual Short Course on "Advances in Emulsion Polymerization and Latex Technology." Schatzalp Berghotel, Davos, Switzerland. (Dr. Gary W. Poehlein, School of Chemical Engineering, Georgia Institute of Technology, Atlanta, GA 30332).

(Aug. 16–20)—"Physical Testing of Paints and Coatings" Short Course. University of Missouri-Rolla, Rolla, MO. (Norma R. Fleming, UMR, Rolla, MO 65401).

(Aug. 30–Sept. 3)—"Films and Coatings for Technology" Short Course. Davos Congress Center, Davos, Switzerland. (Course Registration Office, Anita Hall, Gustav Adolfsgatan 9, S-582 20 Linkoping, Sweden).

(Sept. 12–17)—American Chemical Society's 184th National Meeting. Kansas City, MO. (A.T. Winstead, ACS, 1155 Sixteenth St., N.W. Washington, D.C. 20036).

(Sept. 13–17)—"Introduction to Paint Formulation" Short Course. University of Missouri–Rolla, Rolla, MO. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, UMR, Rolla, MO 65401).

(Sept. 18–21)—Canadian Paint and Coatings Association. 70th Annual Convention. Four Seasons Hotel, Toronto, Ont. (R. Murry, CPCA, 515 St. Catherine St. W., Montreal, Que., Canada H3B 1B4).

(Sept. 20–24)—"Advanced Paint Formulation—Industrial" Short Course. University of Missouri–Rolla, Rolla, MO. (Norma Fleming, Senior Coordinator, Arts & Sciences Continuing Education, UMR, Rolla, MO 65401).

(Sept. 21–23)—"Radiation Curing VI" Conference and Exhibition sponsored by the Association for Finishing Processes of the Society of Manufacturing Engineers. Ramada O'Hare Inn, Des Plaines, IL. (Susan Buhr, Technical Activities Dept., SME, One SME Dr., P.O. Box 930, Dearborn, MI 48128).

(Sept. 29–Oct. 1)—"Surfair '82"—Conference on surfaces' treatments in aeronautical and aerospace industries sponsored by *Surfaces* magazine. Cannes (French Riviera), France. (Thierry Delmotte, *Surfaces*, 46, Rue Ampere, 75017 Paris).

(Oct. 5–7)—9th International Naval Stores Conference. Mayflower Hotel, Washington, D.C. (Pulp Chemicals Assoc., 60 East 42nd St., New York, NY 10165).

(Oct. 6–8)—"Production Planning and Inventory Management" Seminar. Colony Square Hotel, Atlanta, GA. (National Paint & Coatings Association's Meetings & Conventions Div., 1500 Rhode Island Ave., N.W., Washington, D.C. 20005).

(Oct. 11–13)—10th Congress of the Federation of Scandinavian Paint and Varnish Technologists. Copenhagen, Denmark. (G. Christensen, Sadolin & Holmblad Ltd., Holmbladsgade 70, DK-2300, Copenhagen S, Denmark).

(Oct. 13-15)—"Fundamentals of Adhesion: Theory, Practice and Applications" Course. State University of New York, New Paltz, NY. (Dr. Angelos V. Patsis, SUNY-New Paltz, Chemistry Dept., New Paltz, NY 12561).

(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. 26–27)—"New Coatings Systems for Bridges" World Congress. Holiday Inn LaGuardia, New York, NY. (Norma

Fleming, Senior Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(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 Bradley-Welch, NPCA, 1500 Rhode Island Ave. N.W., Washington, D.C. 20005).

(Nov. 9-10)—Electrocoat/82". Westin Hotel, 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. 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. 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. 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).

(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. 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. 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, Lake Buena Vista, FL. (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. Lake Buena Vista, FL. (Cochairman R.F. Wint, Hercules Incorporated, 910 Market St., Wilmington, DE 19899).

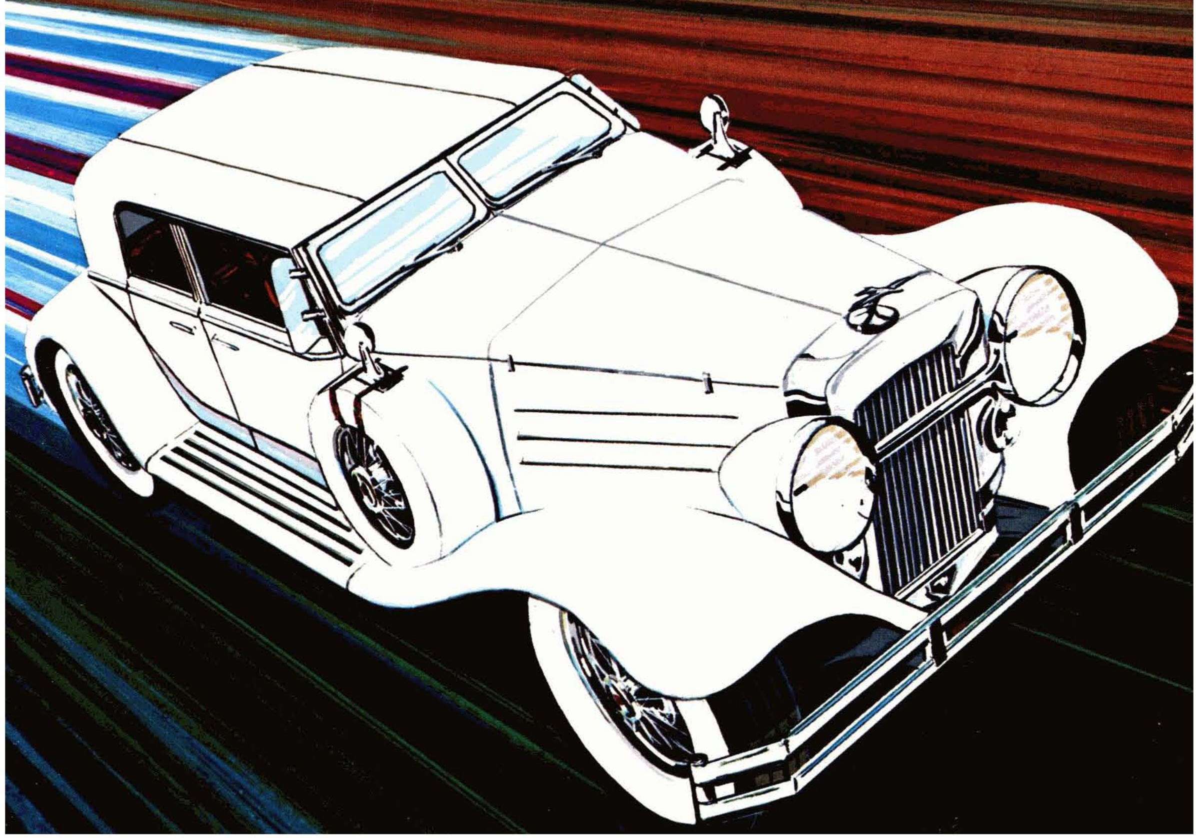
(June 15-18)—Oil & Colour Chemists' Association Biennial Conference on "The Efficient Use of Surface Coatings." Viking Hotel, York, England. (R.H. Hamblin, Director and Secretary, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, HAO 2SF, England).

(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).

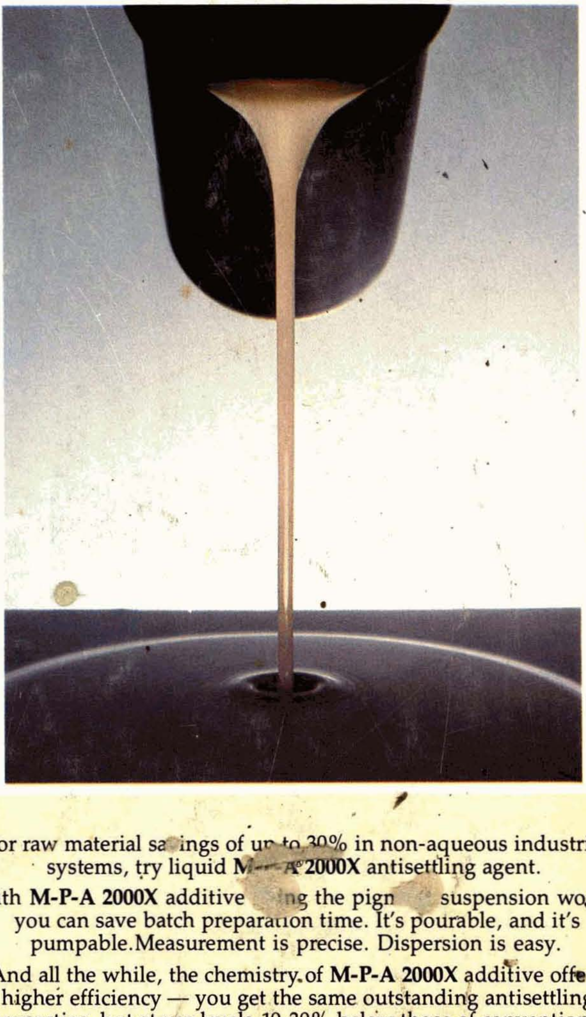
(Oct. 11-13)—"Finishing '83" sponsored by the Association for Finishing Processes of the Society of Manufacturing Engineers. Cincinnati Convention Center, Cincinnati, OH. (Susan Buhr, AFP/SME Administrator, One SME Dr., P.O. Box 930, Dearborn, MI 48128).

Advertisers Index

ALCOLAC, INC.	**10**
AMERICAN CYANAMID CO.	**Cover 3**
ASARCO, INC.	**27**
ATLAS ELECTRIC DEVICES CO.	**40**
BURGESS PIGMENT CO.	**81**
DATAK CORP.	**83**
DOW CORNING CORP.	**25**
DU PONT CO., DBE SOLVENTS	**15**
ECLIPSE SYSTEMS, INC.	**74**
HENKEL CORP.	**11**
ICI AMERICAS INC.	**18-19**
ILLINOIS MINERALS	**69**
MONSANTO INDUSTRIAL CHEMICALS	**1**
NL CHEMICALS/NL INDUSTRIES, INC.	**Cover 4**
PFIZER, INC., MPM DIV.	**13**
PURITY ZINC METALS	**Cover 2**
QUAKER OATS CO., CHEMICAL DIV.	**71**
ROHM AND HAAS CO.	**8-9**
TENNECO CHEMICALS, INC.	**28**
UNION CARBIDE CORP.	**4-5**
WORLD SURFACE COATINGS ABSTRACTS	**39**
R.T. VANDERBILT CO.	**2**



From NL, the antisettling agent that pours.



For raw material savings of up to 30% in non-aqueous industrial systems, try liquid **M-P-A® 2000X** antisettling agent.

With **M-P-A 2000X** additive doing the pigment suspension work, you can save batch preparation time. It's pourable, and it's pumpable. Measurement is precise. Dispersion is easy.

And all the while, the chemistry of **M-P-A 2000X** additive offers higher efficiency — you get the same outstanding antisettling properties, but at use levels 10-30% below those of conventional paste antisettling agents.

For samples and literature, just fill out the coupon and send to:
NL Chemicals/NL Industries, Inc., Box 700, Hightstown, N J 08520.
Or telephone 609/443-2230.

NL Chemicals

☐ Please send a sample and literature on **M-P-A 2000X**, the antisettling agent that pours.
☐ Please have your representative contact me.
Name
Title
Company
Address
City
State
Zip

M-P-A is a registered trademark of NL Industries, Inc.