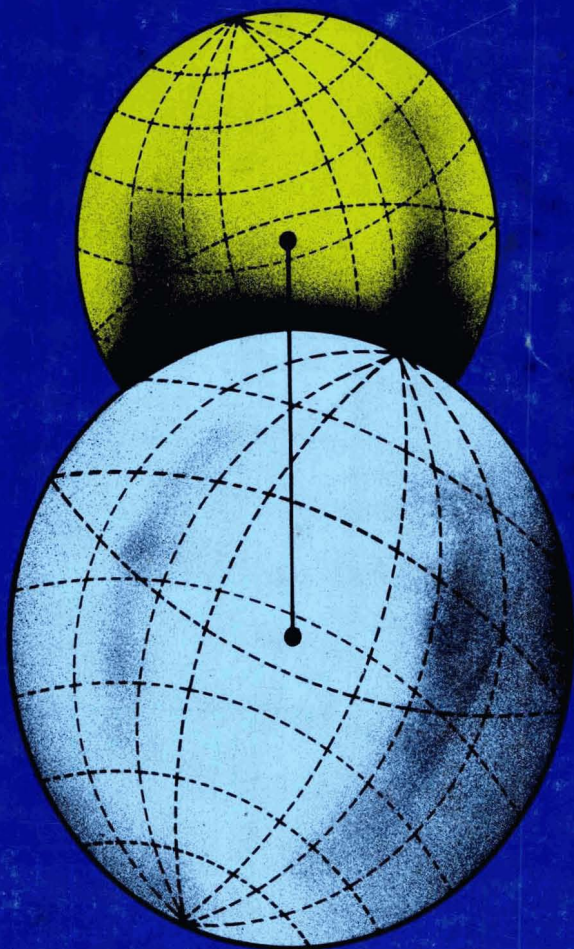


jct

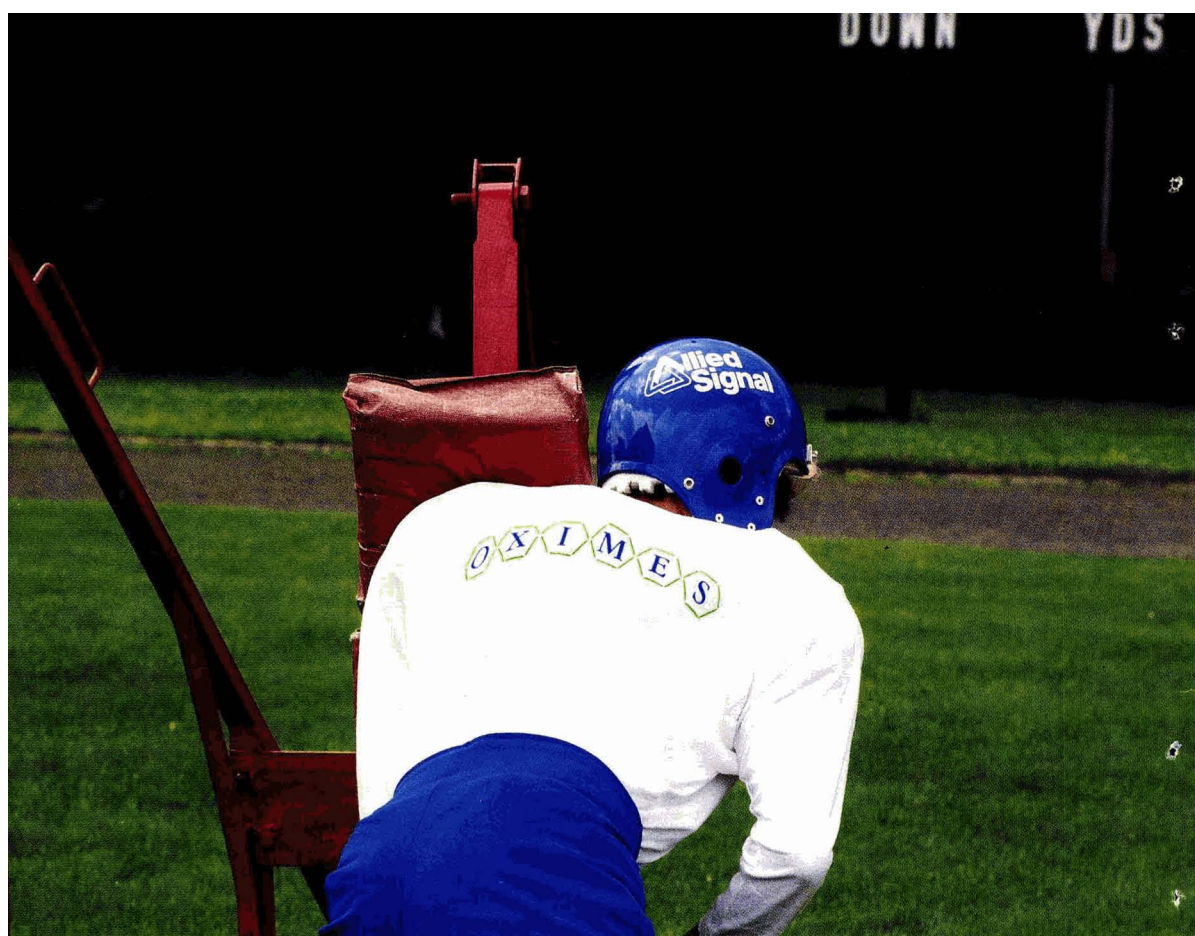
JOURNAL OF
COATINGS
TECHNOLOGY

April 1991

JCTAX 63 (795) 1-78 (1991)



*“Thermodynamic Analysis
of Phase Separation in
Selfstratifying Coatings —
Solubility Parameters Approach”*



The most effective urethane blocking agents for low temperature cure are on our team.

Whether in powder coatings or liquid urethane systems, oximes allow you to develop coating technology for lower temperature cure. This improves your customers' manufacturing efficiency and also enhances the ability to coat temperature sensitive materials as diverse as plastics, specialty metals, wood and textiles. Oxime blocked urethane coatings also offer the unique opportunity to coat fully assembled parts where cure temperature is of concern.

Oximes let you develop urethane crosslinkers which can be formulated into polyester and acrylic powder coatings that can be cured as low as 260 °F. In liquid systems, oximes enable you to develop blocked urethane prepolymers which can be formulated into higher solids, one-package latent heat curable coatings.

At Allied-Signal we not only manufacture oxime blocking agents, we also have an experienced project team to offer you effective technical service and new product development to help you develop solutions to many of your coating technology challenges. Call us for more information. Contact Frank Briden (201) 455-5191 or write Allied-Signal Inc., P.O. Box 1053, Morristown, NJ 07962.

Oximes. The Simple Solution.

OXIMES

 **Allied
Signal**

Rebirth of a New Company



Dry Branch Kaolin Company

Continuing a 90 Year Tradition of Excellence.

- 90 years in the clay business, now under a new name.
- A strong commitment to our customers and their future.
- The most experienced and knowledgeable management team in the clay industry.
- Extensive clay reserves to support long term growth.
- Highest production standards including statistical process and quality controls.
- A complete line of Hegman, fine particle, and calcined clays, including Glomax™ LL and Altowhite™ TE extender pigments.
- Over \$50 million invested in expansion and modernization since 1985.

- Plant expansion underway to significantly increase current capacity.

Dry Branch Kaolin Company A Tradition of Excellence

Dry Branch Kaolin Company
R.R.1, P.O. Box 468-D
Dry Branch, Georgia 31020
Tel: 912 743-7474 Fax: 912 746-0217



NEW



NATROSOL[®] PLUS, GRADE 430. ONE HEC OF A SAVINGS.

NATROSOL[®] Plus, Grade 430, modified hydroxyethylcellulose for flat and semigloss latex paints. It gives you even greater thickening efficiency than our Grade 330, so you use up to 30% less.

Grades 430 and 330 offer exceptional spatter resistance, improved film build for superior hiding, and the ease of formulation you've come to expect from the NATROSOL[®] family of HEC products. Both are far more stable and easier to process than many synthetic associative thickeners.

Ask about both grades of NATROSOL[®] Plus: Track-tested Grade 330 and super-efficient Grade 430. For rich paints...*and* rich profits.

AQUALON COMPANY,
Little Falls Centre One,
2711 Centerville Road,
Wilmington, DE 19850-5417,
or call 800-345-8104.



NATROSOL[®]
HYDROXYETHYLCELLULOSE

AQUALON COMPANY: a HERCULES INCORPORATED Company



Technical Articles	23	Thermodynamic Analysis of Phase Separation in Selfstratifying Coatings—T.A. Misev
	29	Kinetics of Crosslinking of Poly(Hydroxyethyl Acrylate) with Isocyanates—J. Lavrič, A. Šebenik, and U. Osredkar
Back to Basics	35	Effects of Immersion on the Electrochemical Properties and Water Uptake of an Epoxy/Mild Steel System—G.S. Shaw et al.
	43	Substrate of Factors Affecting the Performance of Organic Coatings on Steel Sheet Surfaces—B.M. Perfetti
Federation News	12	FSCT Paint Show Exhibit Space Nears "Sell-Out"; Preparation Underway for Annual Meeting Program
	14	Current List of 1991 Paint Show Exhibitors
	16	Paint Show Floor Plan
Departments		
JCT Guide for Authors	4	
Comment	7	Let's Exploit Our Resources
Abstracts	8	
Spanish Abstracts	10	
Government & Industry	20	NPCA to Recognize Industry Achievement with Paint Pollution Prevention Award Program
Regulatory UPDATE	33	
Society Meetings	53	
Elections	60	
CrossLinks	62	Solve the April Puzzle
People	63	Allen W. Grobin, Jr. Elected Three-Year Term on ASTM's Board of Directors
Obituary	65	Robert M. Noble, Chairman and Managing Director of SCM Chemicals Ltd., Bunbury, Western Australia
Meetings/Education	67	Highlights from the Western Coatings Societies' 20th Biennial Symposium & Show
Literature	71	
Book Review	74	"Alkylene Oxides and Their Polymers"
Coming Events	75	
Humbug from Hillman	78	"Scientific Principles Revealed in Feeding a Nine Month-Old-Baby"

ห้องสมุดเคมีวิทยาอุตสาหกรรม
17 ๑๓ ๒๕๓๔

GENERAL

The JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology for its membership of approximately 7,300 in 26 Constituent Societies in the United States, Canada, Great Britain, and Mexico. The JOURNAL is devoted to the advancement of knowledge in the science and technology of surface coatings, the materials comprising such coatings, and their use and performance.

The Editors invite submission of original research papers, review papers, and papers under the special headings *Open Forum* and *Back to Basics*, as well as *Letters to the Editor*. All manuscripts will be assumed to be previously unpublished writing of the authors, not under consideration for publication elsewhere. When review papers contain tables or graphs from copyrighted articles, the authors will be required to obtain permission for use from the copyright holders. When the organization with which the authors are affiliated requires clearance of publications, authors are expected to obtain such clearance before submission of the manuscript. Papers presented to associations other than the Federation must be released by written communication before they can be considered for publication in the JOURNAL OF COATINGS TECHNOLOGY. Authors are obligated to reveal any exceptions to these conditions at the time a manuscript is submitted.

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

Papers in which proprietary products or processes are promoted for commercial purposes are specifically nonacceptable for publication.

SUBMISSION OF MANUSCRIPTS...

...for the Journal

Four complete copies should be sent to the Editor, JOURNAL OF COATINGS TECHNOLOGY, 492 Norristown Rd., Blue Bell, PA 19422-2350. The cover letter should address copyright, clearance, and release issues discussed above and should specify paper category: *Original Research*, *Reviews*, *Open Forum*, or *Back to Basics*.

Letters to the Editor: The JOURNAL will consider for publication all correspondence relevant to the coatings industry and to the contents of the JOURNAL. When a letter concerns an article appearing in the JOURNAL, the original author is usually given an opportunity to reply.

... by Constituent Societies For Annual Meeting Presentation

Ten complete copies of the manuscript are required for committee review. The set of copies should be addressed to the Editor at the address listed previously.

... for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to the Chairman of the 1991 Roon Awards Committee, George R. Pilcher, Akzo Coatings, Inc., P.O. Box 147, Columbus, OH 43216. (For complete details, see "Roon Awards" section of the JOURNAL in January 1991 issue.)

MANUSCRIPT PREPARATION

In general, authors are advised to use the "Handbook for Authors" published by the American Chemical Society as a guide to the preparation of manuscripts (ACS, 1155 Sixteenth St., Washington, D.C. 20036). Another excellent reference work is "How to Write and Publish a Scientific Paper," by Robert A. Day (ISI Press, 3501 Market St., University City Science Center, Philadelphia, PA 19104).

Authors are encouraged to consider submissions in several categories and to prepare their manuscripts accordingly. The categories are:

Original Research Papers: The main technical content of the JOURNAL OF COATINGS TECHNOLOGY will continue to be original research papers. Editors support the trend in scientific writing to a direct, less formal style that permits limited use of personal pronouns to avoid repetitious or awkward use of passive voice.

Review Papers: Papers that organize and compare data from numerous sources to provide new insights and unified concepts are solicited. Reviews that show how advances from other fields can beneficially be applied to coatings are also desired. Reviews that consist mainly of computer searches with little attempt to integrate or critically evaluate are not solicited.

Open Forum: Topics for this category may be nontechnical in nature, dealing with any aspect of the coatings industry. The subject may be approached informally. Editors encourage submission of manuscripts that constructively address industry problems and their solutions.

Back to Basics: Papers that provide useful guides to Federation members in carrying out their work are solicited. Topics in this category are technical but focus on the "how to" of coatings technology. Useful calculations for coatings formulation and procedures that make a paint test more reproducible are examples of suitable topics. Process and production topics, i.e., paint manufacture, will also be reviewed in the *Back to Basics* category.

If a submitted paper consists of the text of a presentation made previously to a monthly or special meeting of a Society for Coatings Technology, or to another technical group, the name of the organization and the date of the presentation should be given. If someone other than the author of the paper made the presentation, this information, too, should be noted. Papers originally composed for oral presentation will have to be revised or rewritten by the author to conform to the style described in this guide.

Manuscripts should be typed with double spacing on one side of 8 1/2 x 11 inch (22 x 28 cm) paper, with at least one-inch (2.5 cm) margins on all four sides. All paragraphs should be indented five spaces, and all pages should be numbered at the top center, or upper right corner.

Title

The title should be as brief and informative as possible. Selection of titles that are key word-indexable is a helpful and recommended practice.

Authors' Biographies and Photographs

Give complete names, company or institutional affiliations, and brief biographical sketches of all authors. If available, submit a 5 x 7 inch (13 x 18 cm) black-and-white photograph with glossy or smooth high sheen surface, for each author. See later section on photographs for further details.

Abstracts

A 75-100 word abstract must be part of the manuscript, and should be a concise description of the key findings or teachings of the work described in the paper. The abstract should not repeat the title or include reference numbers, nor should it duplicate the Conclusion or Summary.

Text

Main headings and sub-headings should be used to improve readability, and to break up typographical monotony. The text should *not* be presented as an alphanumeric outline.

The main headings usually should be INTRODUCTION, EXPERIMENTAL, RESULTS AND DISCUSSION, and SUMMARY or CONCLUSIONS. Sub-headings will be specific to the subject.

Only as much review as is necessary should be given to provide an introduction to the subject; the main burden for extensive background should be placed on the list of references.

Standard scientific and technical terminology should be used to convey clear and unambiguous meaning, but the use of technical jargon or slang should be avoided. Authors should bear in mind that the JOURNAL has an international audience, for many of whom English is a second, not native, language. Use of regional idioms or colloquialisms should be avoided. The use of obscure abbreviations is also discouraged. When appropriate, abbreviations should be made in parenthesis immediately following first mention of the term in the text, and then used alone whenever necessary.

Recent issues of the JOURNAL should be consulted for desired style and technical level.

Metric System

Metric system units should be used wherever applicable with the equivalent English units shown afterwards in parentheses. The ASTM Metric Practice Guide, E 380-72 (American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103) is a convenient reference.

Tables, Graphs, and Drawings

Tables, rather than descriptive text, should be used only when they are genuinely helpful. They should be proportioned in accordance with the height and width limitations of the JOURNAL's pages. Each table should be typed on a separate sheet, rather than included in the text, and appended to the manuscript. Each table should be numbered and have a descriptive caption. Tables should be referenced in the text (e.g., "See Table 1").

In numerical data in tables, numbers less than one should have a zero before the decimal point.

Graphs should be on good quality white or nonphotographic blue-lined 8 1/2 x 11 inch paper. Each graph should be drawn on a separate sheet, numbered, and the captions listed on a copy of the original graph. Graph captions and legends should also be typed on a separate sheet from original for typesetting.

Drawings should conform to the guidelines given for Graphs and should be proportioned to fit the height-to-width ratio of the JOURNAL's pages and columns.

Photographs

All photographs should be sharp, clear, black-and-white prints no larger than 8 x 10 inches in size. Photos should be clearly labeled on the reverse side, taking care not to mar the image.

Color prints and slides are unacceptable.

When illustrations are secured from an outside source, the source must be identified and the Editor assured that permission to reprint has been granted.

Nomenclature

Whenever possible, generic names should be used in preference to trade names. When trade names must be used to avoid ambiguity, and the name is a registered trademark, the symbol R, in a circle or parentheses, should be given immediately following, and the manufacturer listed as a footnote. In general, trade names should be used only in footnotes or in an appendix, rather than in the text.

If special nomenclature is used, include a nomenclature table giving definitions and dimensions for all terms.

Nomenclature of chemical compounds should conform to the style of *Chemical Abstracts* and the IUPAC rules. For oligomeric or polymeric materials, characteristics such as molecular weight, polydispersity, functional group content, etc. should be provided.

Equations

Equations must be typed, or written clearly, with equations numbered sequentially in parentheses to the right. If Greek letters are used, write out their names in the manuscript margin at the first point of use. Place superscripts^a and subscripts_b accurately. Avoid the use of superscripts in a manner that can lead to their interpretation as exponents.

Summary

The paper should be concluded with a summary which is intelligible without reference to the main text. The summary may be more complete than the abstract, listing conclusions drawn from the text. A well written summary can serve to inspire the busy reader to turn back to the paper, to read it thoroughly.

Acknowledgment

If used, it should follow the summary.

References

These should be listed in the numerical order in which they are cited in the text, and should be placed at the end of the manuscript. Names of authors may or may not be shown in the text with reference numbers. If possible, include titles of articles referenced in the literature. The following are examples of acceptable reference citations for periodicals,^{1,2,3} books,⁴ and patents.⁵

- (1) Pascal, R.H. and Reig, F.L., "Pigment Colors and Surfactant Selection," *Official Digest*, 36, No. 475 (Part 1), 839 (1964).
- (2) Davidson, H.R., "Use and Misuse of Computers in Color Control," *JOURNAL OF COATINGS TECHNOLOGY*, 54, No. 691, 55 (1982).
- (3) Stephen, H.G., "Hydrogen Bonding—Key to Dispersion?," *J. Oil & Colour Chemists' Assoc.*, 65, No. 5, 191 (1982).
- (4) Patton, T. (Ed.), "Pigment Handbook," Vol. 1, John Wiley & Sons, Inc., New York, 1973.
- (5) Henderson, W.A. Jr. and Singh, B. (to American Cyanamid Co.), U.S. Patent 4,361,518 (Nov. 30, 1982).

OTHER INFORMATION

Galley proofs will be sent to the author for checking about six weeks prior to publication.

Offprints may be purchased in quantities of 100 or more. Authors will receive price quotations. Each author will receive a complimentary copy of the JOURNAL issue in which his or her paper was published.

* * * *

The JOURNAL OF COATINGS TECHNOLOGY is copyrighted by the Federation of Societies for Coatings Technology. The editorial contents of the JOURNAL may not be reprinted in whole or in part without written permission of the publisher.

jct JOURNAL OF COATINGS TECHNOLOGY

492 Norristown Rd., Blue Bell, PA 19422

The JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology at 492 Norristown Rd., Blue Bell, PA 19422-2350. Phone: (215) 940-0777. FAX: (215) 940-0292.

Annual dues for Active and Associate Members of the Federation of Societies for Coatings Technology is \$20.00. Of this amount, \$13.50 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	\$30.00	\$ 60.00	\$ 45.00
2 Years	\$57.00	\$117.00	\$ 87.00
3 Years	\$82.00	\$172.00	\$127.00

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

ROBERT F. ZIEGLER	PUBLISHER
PATRICIA D. VIOLA	EDITOR
THOMAS J. MIRANDA	TECHNICAL EDITOR
THOMAS A. KOCIS	CONTRIBUTING EDITOR
SAMUEL M. AMICONE	ASSOCIATE EDITOR
KATHLEEN M. WIKIERA	ASSISTANT EDITOR
LORRAINE LEDFORD	ADVERTISING SERVICES MANAGER
AURDEY E. BOOZER	SUBSCRIPTION FULFILLMENT MANAGER

Publications Committee

THOMAS J. MIRANDA, Chairman	
TAKI ANAGNOSTOU	THOMAS A. KOCIS
DARLENE BREZINSKI	PERCY E. PIERCE
PAUL R. GUEVIN, JR.	PATRICIA D. VIOLA
LOREN W. HILL	ROBERT F. ZIEGLER

Editorial Review Board

THOMAS J. MIRANDA, Chairman		
T. ANAGNOSTOU	R.A. DICKIE	T. HOCKSWENDER
J. ANTONELLI	G.D. EDWARDS	J. V. KOLESKE
R.D. BAKULE	F.L. FLOYD	H. LOWREY
R.F. BRADY, JR.	P.R. GUEVIN, JR.	P.E. PIERCE
A.H. BRANDAU	C. HEGEDUS	T. PROVIDER
D. BREZINSKI	H.E. HILL	R. RYNTZ
G.D. CHEEVER	L.W. HILL	R. STANZIOLA

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.

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

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

Copyright 1991 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. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients is granted by the Federation of Societies for Coatings Technology for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$1.00 per copy, plus .25 per page is paid directly to CCC, 27 Congress St., Salem, MA 01970. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transaction Reporting Service is: 0032-3352/86 \$1.00 + .25.



FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY BOARD OF DIRECTORS 1990-91

PRESIDENT

*KURT F. WEITZ
30 Rogers Rd.
Toronto, Ont., M6E 1N7
Canada

PRESIDENT-ELECT

*WILLIAM F. HOLMES
National Pigments & Chemicals, Inc.
2913 Ridgedale
Garland, TX 75041

TREASURER

*COLIN D. PENNY
Hampton Paint Mfg. Co.
P.O. Drawer E
Hampton, VA 23669

*JOHN C. BALLARD
Kurpees Coatings, Inc.
Louisville, KY

LARRY BRANDENBURGER
Valspar Corp.
Minneapolis, MN

THAD T. BROOME
J.M. Huber Co.
Macon, GA

JOHN DELMONICO
Old Western Paint Co., Inc.
Denver, CO

DAN DIXON
Engelhard Corp.
Gordon, GA

TIMOTHY DONLIN
Pacific Coast Chemical Co.
Berkeley, CA

CARLOS DORRIS
Jones-Blair Co.
Dallas, TX

JOHN FOLKERTS
Futura Coatings, Inc.
Hazelwood, MO

*JOSEPH D. GIUSTO
Lenmar, Inc.
Baltimore, MD

GERRY J. GOUGH
Holden Surface Coatings Ltd.
Birmingham, England

ARTHUR K. HAGOPIAN
ICI Paints, Inc.
Concord, Ont., Canada

NOEL L. HARRISON
Western Automotive Finishes
Grand Prairie, TX

*RICHARD M. HILLE
General Paint & Chemical Co.
Cary, IL

RICHARD J. HIMICS
Daniel Products Co.
Jersey City, NJ

JAMES A. HOECK
Akzo Coatings, Inc.
Louisville, KY

LOUIS F. HOLZKNECHT
Devco Coatings Co.
Louisville, KY

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

JAMES E. HUSTED
Husted & Associates, Inc.
High Point, NC

ARTURO ITA
Pinturas Aurolin S.A. de C.V.
Mexico, D.F., Mexico

GERALD IVANCIE
Pratt & Lambert, Inc.
Buffalo, NY

JAMES W. JUDLIN
Devco & Reynolds Co., Inc.
Houston, TX

BERGER JUSTEN
Ribelin Sales, Inc.
Tampa, FL

WAYNE KRAUS
Aqualon Co.
Wilmington, DE

JOHN LANNING
Courtaulds Coatings, Inc.
Louisville, KY

MAUREEN M. LEIN
Davidson Rubber Co.
Dover, NH

WILLIAM W. PASSENO
Red Spot Westland, Inc.
Westland, MI

*DERYK R. PAWSEY
Rohm & Haas Canada, Inc.
Vancouver, B.C., Canada

HORACE S. PHILIPP
Ottawa, Ont., Canada

LLOYD J. REINDL
Engelwood, OH

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

WILLIAM SHACKELFORD
Gaco-Western, Inc.
Tukwila, WA

RAYMOND C. UHLIG
Pittsburgh, PA

*JAN P. VAN ZELM
Byk-Chemie USA
Castaic, CA

*Executive Committee Members

EXECUTIVE VICE PRESIDENT
ROBERT F. ZIEGLER
FSCT Headquarters
492 Norristown Rd.
Blue Bell, PA 19422

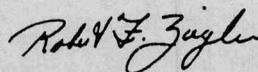
Let's Exploit Our Resources

Yearly, the Federation urges its membership and the industry to take advantage of its nationally-sponsored events, such as the Annual Meeting and Paint Show, Spring Seminar, and Statistical Process Control Seminars, among others. These are all worthy of attention and offer the latest information. The FSCT is pleased that these events have been well-supported by industry over the years, and we will continue to develop them in the future.

There is much more available, however, to local coatings personnel. The Constituent Societies of the Federation host annual regional meetings that offer topics which may address local concerns. These meetings, held in almost every section of the country, give the local industry an opportunity to participate and to learn of solutions to local problems.

The list is formidable: Chicago Society's SYMCO; Cleveland and Northwestern Societies' Technical Conferences; the Pacific Northwest Annual Symposium; Southern Society's Annual Meeting; Southwestern Paint Convention sponsored by the Dallas and Houston Societies; the Joint St. Louis/Kansas City Societies' Seminars; New York Society's Legislative Update; and the Biennial Western Coatings Societies' Symposium and Show. In addition, almost every one of the Federation's 26 Societies host special technical meetings annually.

These local efforts are your regional resources. Use them wisely.



Robert F. Ziegler
Executive Vice President

Abstracts of Papers in This Issue

THERMODYNAMIC ANALYSIS OF PHASE SEPARATION IN SELFSTRATIFYING COATINGS—SOLUBILITY PARAMETERS APPROACH—T.A. Misev

Journal of Coatings Technology, 63, No. 795, 23 (April 1991)

The three dimensional solubility parameter system has been applied in the analysis of the behavior of selfstratifying coatings. For a system consisting of two phases in equilibrium, the Gibbs free energy of mixing must be at the minimum value at constant temperature and pressure, or the chemical potential of each component must be equal in both phases. These conditions have been used to generate binodals and spinodals of the binary system in question, representing the boundaries between the stable, metastable, and unstable state. The phase separation phenomenon is analyzed as a function of the solubility parameters space distance (SPDS) and molecular weight changes during the curing and stratification process. The results indicate the importance of choosing the right curing pattern to obtain high stratification efficiency. A model for predicting the phase separation in a binary system in the presence of a mutual solvent for both polymers also has been proposed.

KINETICS OF CROSSLINKING OF POLY(HYDROXYETHYL ACRYLATE) WITH ISOCYANATES—J. Lavrič, A. Šebenik, and U. Osredkar

Journal of Coatings Technology, 63, No. 795, 29 (April 1991)

Using absorption and ATR IR, NMR, DSC, and the König pendulum, it was possible to follow the crosslinking of poly(hydroxyethyl acrylate) with isocyanate. It was found that in humidity chambers, urethanes are formed on the surface and throughout the film, while substituted urea are formed dominantly on the surface of the film. In a dry box, only urethanes are formed. The heat of the reaction was 45.0 J/g, and the activation energy was 57.7 for catalyzed and 65.0 J/mol of $-NCO$ groups for uncatalyzed systems. The reaction order was two.

EFFECTS OF IMMERSION ON THE ELECTROCHEMICAL PROPERTIES AND WATER UPTAKE OF AN EPOXY/MILD STEEL SYSTEM—G.S. Shaw et al.

Journal of Coatings Technology, 63, No. 795, 35 (April 1991)

This paper presents the changes in the properties of a polymer system and its ability to protect steel from corrosion as a function of exposure time and pH. The polymer system was based on Epon® 828 epoxide resin and Versamid® 140 polyamide hardener. These changes are related to the effect of water and the effect of the calcium carbonate filler. Electrochemical impedance spectroscopy, nuclear magnetic resonance, weight gain tests, and x-ray photoelectron spectroscopy were used to evaluate the electrochemical behavior of the system, the absorption of water by the system, and the effect of the calcium carbonate filler on the corrosion protection of the system.

SUBSTRATE FACTORS AFFECTING THE PERFORMANCE OF ORGANIC COATINGS ON STEEL SHEET SURFACES—B.M. Perfetti.

Journal of Coatings Technology, 63, No. 795, 43 (April 1991)

The typical responses of carbon steel and coated steel sheets to coating processes are discussed in terms of the characteristic surface variables which apply to each of these materials. Steel sheet products are normally coated or painted for purposes of protection or decoration. The coatings used for a particular application are selected on the premise that the sheet surfaces will be receptive to the coating and, otherwise, compatible with it to assure the suitable performance of the resulting coated system. When the coated or painted surfaces fail to meet the durability and protective qualities expected of them, it is usually because the surfaces were not in a suitable condition for coating. This report reviews the various substrate factors which affect the adherence and corrosion properties of the painted sheet system. The discussions include comments on the effects of surface composition, preparation, and pretreatments, and the responses of the organic-coated sheets to various conditions of exposure and service.

Before Joncryl 537, Full Gloss Latex Paint Never Got Such High Marks.

Report Card:
ARCHITECTURAL GLOSS ENAMELS

	Conventional Gloss Latex	Joncryl 537	Gloss Alkyd
Gloss (60°)	75	88	95
VOC Content (Lbs./Gal.)	1.9	1.7	4.5
Flow and Leveling	Fair	Excellent	Excellent
Inherent Film Build	Fair	Excellent	Excellent

Gloss white formula in supplier's product literature.

▼ If tougher environmental laws mean you'll be adding a high gloss, latex coating to your architectural line, consider the benefit of formulating with Joncryl 537, the polymer that's closing the gap between latex and alkyd.

Our report card stands for itself. In the critical areas of gloss, flow, leveling and film build, water-based Joncryl 537 formulations closely match the

performance of solvent-based alkyds, and far surpass conventional gloss latex.

Take a close look at the VOC figures and you'll see how Joncryl 537 can help you meet even the toughest environmental regulations.

Joncryl Rheology-Controlled Emulsions are unique; a non-conventional polymerization process gives Joncryl 537 the application and appearance

properties of alkyds with the low VOC of acrylic emulsions.

So look over our report card. The move to latex high gloss can be much easier than you thought possible. For more information about Joncryl 537, call **1-414-631-3920**, or write to SC Johnson Wax, Specialty Chemicals, Racine, WI 53403.

SC Johnson
wax
Specialty
Chemicals

Abstracts of Papers in This Issue

ANÁLISIS TERMODINAMICO DE LA SEPARACION DE FASES EN RECUBRIMIENTOS AUTOESTRATIFICABLES— APROXIMACION DE LOS PARAMETROS DE SOLUBILIDAD—T.A. Misev

Journal of Coatings Technology, 63, No. 795, 23 (April 1991)

El sistema tridimensional de parametros de solubilidad ha sido aplicado en el analisis del comportamiento de recubrimientos autoestratificables.

Para un sistema consistente en dos fases en equilibrio, la energia libre de Gibbs de mezclado debe tener un valor minimo a presion y temperatura constantes, o el potencial quimico de cada componente debe ser igual en ambas fases. Estas condiciones han sido usadas para generar binodals y spinodals del sistema binario en cuestion, representando los limites entre los estados estable, metaestable e inestable. El fenomeno de separacion de fase es analizado como una funcion de los parametros de solubilidad-distancia de espacio (SPDS) y cambios de peso molecular durante el proceso de curado y estratificacion. El resultado indica la importancia de escoger el patron adecuado de curado para obtener alta eficiencia de estratificacion. Tambien ha sido propuesto un modelo para predecir la separacion de fases en un sistema binario en presencia de un solvente comun para ambos polimeros.

LA CINETICA DE LA RETICULACION DEL POLI (HIDROXIETIL ACRILATO) CON ISOCIANATOS—J. Lavric, A. Sebenik, and U. Osredkar

Journal of Coatings Technology, 63, No. 795, 29 (April 1991)

Usando absorcion y ATR, IR, RMN, DSC y el pendulo Kőning, fue posible la reticulacion del poli(hidroxietil acrilato) con isocianato. Se encontro que en camaras humedas, son formados uretanos en la superficie y a traves de la pelicula, mientras que urea sustituida es formada predominantemente en la superficie de la pelicula. En una camara seca, solamente son formados uretanos. El calor de reaccion fue de 45.0 J/g, la energia de activacion 57.7 para el catalizado y 65.0 J/mol de grupos -NCO para sistemas sin catalizar. El orden de la reaccion fue el 2.

EFFECTOS DE LA INMERSION EN LAS PROPIEDADES ELECTROQUIMICAS Y ABSORCION DEL AGUA EN UN SISTEMA EXPOXI/ACERO AL CARBON—G.W. Shaw et al.

Journal of Coatings Technology, 63, No. 795, 35 (April 1991)

Este articulo presenta los cambios de las propiedades de un sistema polimerico y su habilidad para proteger al acero de la corrosion, como una funcion del tiempo de exposicion y ph. El sistema polimerico estuvo basado en la resina epoxica Epon[®] 828 y en el endurecedor de poliamida Versamid[®] 140.

Estos cambios se relacionan con el efecto del agua y con el efecto de la carga de carbonato de calcio. La espectroscopia de impedancia electroquimica, resonancia magnetica nuclear, pruebas de ganancia de peso y espectroscopia de fotoelectron de rayos x, fueron usados para evaluar el comportamiento electroquimico del sistema, la absorcion de agua por el sistema, y el efecto de la carga de carbonato de calcio en el sistema de proteccion de la corrosion.

FACTORES DEL SUSTRATO QUE AFECTAN EL COMPORTAMIENTO DE RECUBRIMIENTOS ORGANICOS EN SUPERFICIES DE LAMINAS DE ACERO—B.M. Perfetti

Journal of Coatings Technology, 63, No. 795, 43 (April 1991)

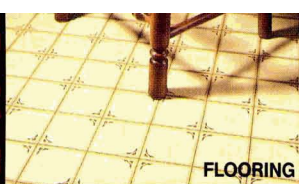
Las respuestas tipicas del acero al carbon y laminas de acero a los procesos de recubrimiento, son discutidas en terminos de las variables de las caracteristicas de superficie, las cuales se aplican a cada uno de estos materiales.

Los productos de laminas de acero son normalmente recubiertos o pintados para propositos de proteccion o decoracion. Los recubrimientos usados para una aplicacion particular son seleccionados bajo la premisa de que las superficies de las laminas sean receptivas al recubrimiento y dicho de otro modo, compatibles con el para asegurar el buen comportamiento del sistema protector resultante. Cuando las superficies recubiertas o pintadas fallan en reunir las cualidades de proteccion y durabilidad esperadas de ellos, es usualmente debido a que las superficies no estan en las condiciones apropiadas para ser recubiertas.

Este articulo revisa los diversos factores del sustrato que afectan la adherencia y propiedades de corrosion del sistema de la lamina pintada.

Las discusiones incluyen comentarios sobre los efectos de composicion de superficie, preparacion y pretratamiento y las respuestas de las laminas recubiertas con organicos para varias condiciones de exposicion y servicio.

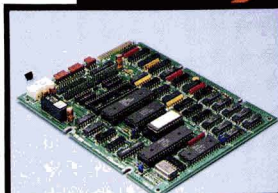
Spanish translation of abstracts was provided by Mexico Society Member, Ing. Gustavo Sanchez, Technical Chief, Instituto Mexicano de Técnicos en Pinturas y Tintas, Mexico



FLOORING



FURNITURE
WOODWORKING



ELECTRONICS



CONSUMER
PACKAGING

world of opportunities...

PHOTOMER[®]

Radiation Curing Chemicals

Explore the PHOTOMER world of opportunities...Radiation curing chemicals can help you achieve new heights in product quality, discover new products and explore innovative solutions to coating challenges. Let PHOTOMER's expert technical team and its outstanding support system help you navigate new worlds of opportunity.

Manufacturers of Furniture...Flooring...Electronic Components...Paper/Plastic Containers...the Printing Industry...whatever your world, PHOTOMER expands your horizons.

Discover a world of opportunities — the PHOTOMER world



Henkel Corporation
Coatings & Inks Division

300 Brookside Avenue, Ambler, Pennsylvania 19002-3498

SALES OFFICE 1-800-445-2207 • IN CHICAGO 708-579-6198 • TECHNICAL SERVICE 1-800-848-2502 • BUSINESS OFFICE 1-800-624-2339

FSCT Paint Show Exhibit Space Nears "Sell-Out"; Preparations Underway for Annual Meeting Program

The 1991 Annual Meeting and Paint Industries' Show of the Federation of Societies for Coatings Technology will be held on November 4-6, at the Metro Convention Centre, in Toronto, Ontario, Canada. The Paint Show will feature the products and services of the suppliers to the international coatings industry. To date, nearly 97% of the booth space available has been contracted—236 companies have reserved over 80,000 net square feet of exhibit space (*See list of exhibitors accompanying story. — Ed.*)

Exhibit hours will be 10:00 a.m. to 5:30 p.m. on Monday, November 4; 8:00 a.m. to 5:30 p.m. on Tuesday, November 5; and 8:00 a.m. to 12:00 noon on Wednesday, November 6.

Annual Meeting Program

To be held in conjunction with the 56th Paint Industries' Show, the 69th Annual Meeting will be keyed to the theme, "The International Coatings Environment: Today's Opportunity, Tomorrow's Challenge."

Highlights of the technical program will include the Mattiello Memorial Lecture by one of the technical leaders in coatings re-

search, Roon Awards Competition Papers, presentations from Federation Constituent Societies, and Seminars on new manufacturing technology, anti-corrosion coatings, and advanced topics in coatings research.

Program Chairman Gerry Parsons, of DeSoto Coatings Ltd., Mississauga, Ont., and his committee are developing a schedule of presentations. Serving on his committee are: John Lanning (Vice-Chairman), Courtaulds Coatings, Inc., Porter Paint Div., Louisville, KY; Mary G. Brodie, Strongsville, OH; Bob Deruiter, Reichhold Ltd., Toronto, Ont.; John Hall, Tioxide, Inc., St. Laurent, Que.; Peter Hiscocks, Ashland Chemicals, Mississauga, Ont.; George R. Pilcher, Akzo Coatings, Inc., Columbus, OH; and Roger Woodhull, California Products Corp., Cambridge, MA.

Hotels and Reservations

Nine hotels have reserved blocks of rooms for the Federation event. The Sheraton Centre Hotel and Royal York Hotel will serve as co-headquarters for the Annual Meeting and Paint Show. Other hotels include Bond Place, Holiday Inn-Downtown, Hilton International Toronto, King Edward, L'Hotel, Marriott Eaton Centre, and the Westin Harbour Castle. All housing will be processed through the Toronto Convention and Visitors Association. Housing information will be available to all members in April.

Special Airline Fares

American Airlines and Air Canada, in cooperation with the Federation, are offering special discount airline fares which af-

ford passengers a 25-40% savings off their round trip and undiscounted day coach fares for travel to the FSCT Annual Meeting and Paint Industries' Show on the airlines' transborder system.

To take advantage of these discounts, you must purchase tickets at least seven days in advance and travel between October 28 and November 12, 1991. For American Airlines, telephone 1-800-433-1790 and ask for *STAR File #S-0201CN*; for Air Canada, telephone 1-800-361-7585 and ask for *File #917086*. The special fares are available only through these numbers.

Discounts are good for both direct and connecting flights to Toronto. If you use a travel agent, have your reservations placed through the toll-free numbers to obtain the same fare advantages. Both American and Air Canada have a variety of other promotional fares, some of which may represent even greater savings. When phoning for reservations, ask for the best discount applicable to your itinerary.

Registration Fees

Advance registration forms and information will be sent to all members in April. Advance fees are \$65 for members and \$80 for non-members. The fee for spouses' activities is \$60 in advance. Retired members and their spouses may register for the special advance only fee of \$25 each.

On-site registration will be \$75 for full-time and \$55 for one-day for members. Non-members fees will be \$95 for full-time and \$65 for one-day. Spouses' activities will be \$60 on-site.

1991 Membership Directory Available from Federation

The 1991 Annual Membership Directory (Year Book) of the Federation of Societies for Coatings Technology has been published.

Listed in the 332-page directory are the names, companies, addresses, and telephone numbers of the 7300 Federation members by Society affiliation. The publication also provides an alphabetical index of members and includes informative details on FSCT Officers, the Board of Directors, Committee Members, and By-Laws.

The Year Book, included with membership in the Federation, is available to non-members for \$20 per copy. To place an order, contact Meryl Cohen, Federation of Societies for Coatings Technology, 492 Norristown Road, Blue Bell, PA 19422-2350, or call (215) 940-0777.

Birmingham Paint, Varnish & Lacquer Club Prepares History of Paint Manufacture in Midlands

The Birmingham Paint, Varnish, and Lacquer Club has announced the publication of "The History of Paint Manufacture in the Midlands of the United Kingdom."

Over two and one-half centuries are covered in this account of the origins of the U.K. Midland paint industry.

From the furnaces of the Industrial Revolution, there grew a need for more than medieval varnishes and the men of the Midlands answered the call. The resultant paint

industry's first faltering steps are recorded in this book.

Dating from 1773, companies, products, raw materials, sales records, prices and personal recollections are documented, along with photographs.

Copies of the book are available from the Federation for \$10. To order, contact Meryl Cohen, Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422-2350.



JACK SWEET
MANAGER,
TECHNICAL SERVICE

Ashland Chemical. Because there's more to paint than solvents.

When it comes to coatings ingredients, across North America, Ashland Chemical is "The Source."

Our systems approach means a complete range of performance chemicals and ingredients, from resins and primary pigments to specialty additives. Solvents, too. And you can call on industry experts like Jack Sweet and our staff of technical specialists when you need

assistance with reformulation, health and safety information, or environmental regulations.

We can probably simplify your buying, lower your inventory costs, and deliver whenever and wherever you need. With more service, and support, than anyone. Call your local representative, or write: Industrial Chemicals & Solvents Division, Dept. 468, P.O. Box 2219, Columbus OH 43216.

Ashland Chemical

Ashland Chemical, Inc.
Subsidiary of Ashland Oil, Inc.

The Source

1991 PAINT INDUSTRIES' SHOW

Current List of Exhibitors

ACS-Datcolor
 Aceo Corp.
 Advanced Coating Technologies
 Advanced Software Designs
 Air Products & Chemicals, Inc.
 Akzo Chemicals Inc.
 Allied Signal, Inc.
 American Cyanamid Co.
 Amoco Chemical Co.
 Anachemia Solvents Ltd.
 ANGUS Chemical Co.
 Anker Labelers USA, Inc.
 Aqualon Co.
 Arco Chemical Co.
 Aries Software Corp.
 Ashland Chemical Co., IC&S
 Atlas Electric Devices Co.
 Automated Filling Specialists Corp.

B&P Environmental Resources
 BASF Corp.
 Blackmer Pump Div., Dover Resources Co.
 Bohlin Reologi, Inc.
 Brookfield Engineering Labs., Inc.
 Brookhaven Instruments Corp.
 Buckman Laboratories, Inc.
 Buhler, Inc.
 Bulk Lift International, Inc.
 Burgess Pigment Co.
 Byk-Chemie USA
 Byk-Gardner, Inc.

C B Mills, Inc.
 CPI Purchasing Magazine
 Cabot Corp., Cab-O-Sil & Special Blacks Div.
 Calgon Corp., Div. of Merck & Co., Inc.
 Canada Colors & Chemicals Ltd.
 The Carborundum Co.
 Cardolite Corp.
 Cargill, Inc.
 Carroll Scientific, Inc.
 Caschem, Inc.
 Catalyst Resources, Inc.
 Chemical & Engineering News
 Chemical Marketing Reporter
 Chemical Week
 Coatings Magazine
 Color Corp. of America
 Colores Hispania, S.A.
 Colorgen, Inc.
 Consolidated Research, Inc.
 Coulter Electronics, Inc.
 Cray Valley Products International
 Crosfield Chemicals, Inc.
 Custom Recovery Services, Inc.
 Cyprus Industrial Minerals Co.

D/L Laboratories
 DSA Consulting, Inc.
 DSET Laboratories, Inc.
 Daniel Products Co.
 Day-Glo Color Corp.
 DeFelsko Corp.
 Degussa Corp.
 University of Detroit
 Dominion Colour Corp.
 Dow Chemical USA
 Dow Corning Corp.
 Draiswerke, Inc.
 Drew Chemical Corp.
 Dry Branch Kaolin Co.
 Du Pont Co.

E.C.C. America
 Eagle Picher Minerals, Inc.
 Eagle Zinc Co.
 Eastern Michigan University
 Eastman Chemical Products, Inc.
 Elger Machinery, Inc.
 Elders Resources Chemicals Inc.
 Elektro-Physik USA, Inc.
 Elmar Industries, Inc.
 Engelhard Corp., Spec. Min. & Colors Group
 Epworth Manufacturing Co., Inc.
 Etna Products Inc., Specialty Chemical Div.
 Exxon Chemical Co.

FMC Corp., Food & Pharmaceutical Div.
 FMJ International
 Fawcett Co., Inc.
 FCF-Bowers, Inc.
 Federation of Societies for Coatings Technology
 Freeman Polymers Div./Cook Composites & Polymers
 H.B. Fuller Co.

Paul N. Gardner Co., Inc.
 B.F. Goodrich Co., Spec. Polym. & Chem. Div.
 Goodyear Chemical Division
 Guer-Tin Brothers Polymers

Halox Pigments, Div. of Hammond Lead Products
 Harcross Pigments, Inc.
 Henkel Corp., Process Chemicals
 Hitox Corp. of America
 Hockmeyer Equipment Corp.
 Hoechst Celanese Corp.
 Horiba Instruments, Inc.
 Hüls America, Inc.
 Hungarian Aluminium Corp.
 Hunterlab

ICI Americas, Inc.
 ICI Resins U.S.
 Ideal Mfg. & Sales Corp.

S.C. Johnson Wax
 K-T Feldspar Corp.
 Kenrich Petrochemicals, Inc.
 King Industries, Inc.
 Kronos, Inc.

Labsphere
 Laporte Absorbents, Inc.
 Leeds & Northrup, A Unit of General Signal
 Liquid Controls Corp.
 The Lubrizol Corp., Coatings Technologies

3M, Industrial Chemicals Div.
 MTS Colormetrie (France), Klieve
 Macbeth Div., Kollmorgen Corp.

Malvern Minerals Co.
 McWhorter, Inc.
 The Mearl Corp.
 Michelman, Inc.
 Micro Powders, Inc.
 Micromeritics Instrument Corp.
 Mid-States Eng. & Mfg. Co.
 Miller Manufacturing Co., Inc.
 Millipore, Inc.
 Milton Roy Co.
 MiniFibers, Inc.
 Minolta Corp.
 Mississippi Lime Co.
 University of Missouri-Rolla
 Mixmor
 Modern Paint & Coatings
 Monsanto Co.
 Morton International
 Moulders Supply Ltd.
 Mountain Minerals Co., Ltd.

NYCO
 Nacan Products Ltd.
 Netzsch Incorporated
 Neupak, Inc.
 New Way Packaging Machinery, Inc.
 Nicolet Instrument Corp.
 Nippon Shokubai America, Inc.

Obron Atlantic Corp.
 Ortech International
 Otsuka Electronics (U.S.A.) Inc.

P Q Corporation
 PRA Laboratories
 Pacific Micro Software Engineering
 Paint & Coatings Industry Magazine
 Pen Kem, Inc.
 Peninsula Polymers
 Phillips Container Co.
 Phillips 66 Co., Specialty Chemicals
 Pierce & Stevens Corp.

Plastican, Inc.
 Poly-Resyn, Inc.
 Premier Mill Corp.
 Pyosa S.A. De C.V.
 The Q-Panel Co.
 Quantachrome Corp.

Raabe Corp.
 Red Devil, Inc.
 Reichhold Chemicals, Inc.
 Rheox, Inc.
 Rhone-Poulenc Inc.
 Rohm and Haas Co.
 Rosedale Products, Inc.
 Roto-King, Inc., Unit of IDEX Corp.

SCM Chemicals
 Sandoz Chemicals Corp.
 Sannacor Industries, Inc.
 Semi-Bulk Systems, Inc.
 Shamrock Technologies, Inc.
 Shell Chemical Co.
 Sherwin-Williams Chemicals Co.
 Shimadzu Scientific Instrument
 Silberline Manufacturing Co.
 Sino-American Metals & Minerals
 South Florida Test Service/Atlas Electric Devices
 University of Southern Mississippi
 Sub-Tropical Testing Service
 Sun Chemical Corp.

Texaco Chemical Co.
 Thiele Engineering Co.
 Tioxide America, Inc.
 Troy Chemical Corp.

U.S. Borax & Chemical Corp.
 U.S. Silica Co.
 Unimin Specialty Minerals Inc.
 Union Carbide Chemicals & Plastics
 Union Process, Inc.
 United Catalysts, Inc.
 United States Testing Co., Inc.
 Unocal Chemicals Div., Unocal Corp.

Van Waters & Rogers
 R.T. Vanderbilt Co., Inc.
 Velsicol Chemical Corp.

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

X-Rite, Incorporated
 York Fluid Controls Ltd.
 Zeelan Industries, Inc.



Guess which surfactant line reflects everything you want in your water-based inks and coatings. Surfynol® surfactants.

What do you want from your surfactant? Coverage over difficult to wet surfaces? Rapid wetting and color development? Defoaming? Low water sensitivity and viscosity? All of the above?

Then all you really want is one of our Surfynol surfactants. Surfynol is the most broad-based surfactant line for high performance water-based inks and coatings. Each of the more than two dozen Surfynol surfactants is *multi-functional*, so you're never forced to choose one desired property at the expense of another.

Somewhere in the Surfynol line you'll find a surfactant that provides precisely the combination of benefits

you're looking for, including superb dynamic wetting, excellent coverage on contaminated surfaces, stable pigment dispersions, reduced risk of water sensitivity problems—and, of course, foam control.

Just as importantly, Air Products can offer you the technical expertise to make our quality surfactants work for you. Take the guesswork out. Use a Surfynol surfactant. For a free sample, call (800) 345-3148 or (215) 481-6799. In Europe, call 31-30-511828. Or for more information, send in this coupon to Air Products and Chemicals, Inc., Chemicals Customer Service, 7201 Hamilton Boulevard, Allentown, PA 18195-1501.



Air Products and Chemicals, Inc.,
 Chemicals Customer Service,
 7201 Hamilton Boulevard,
 Allentown, PA 18195-1501.
 Yes, I'd like more information
 on Surfynol surfactants.
 Please send to:

Name _____

Company _____

Address _____

City _____ State _____ Zip _____

Telephone _____

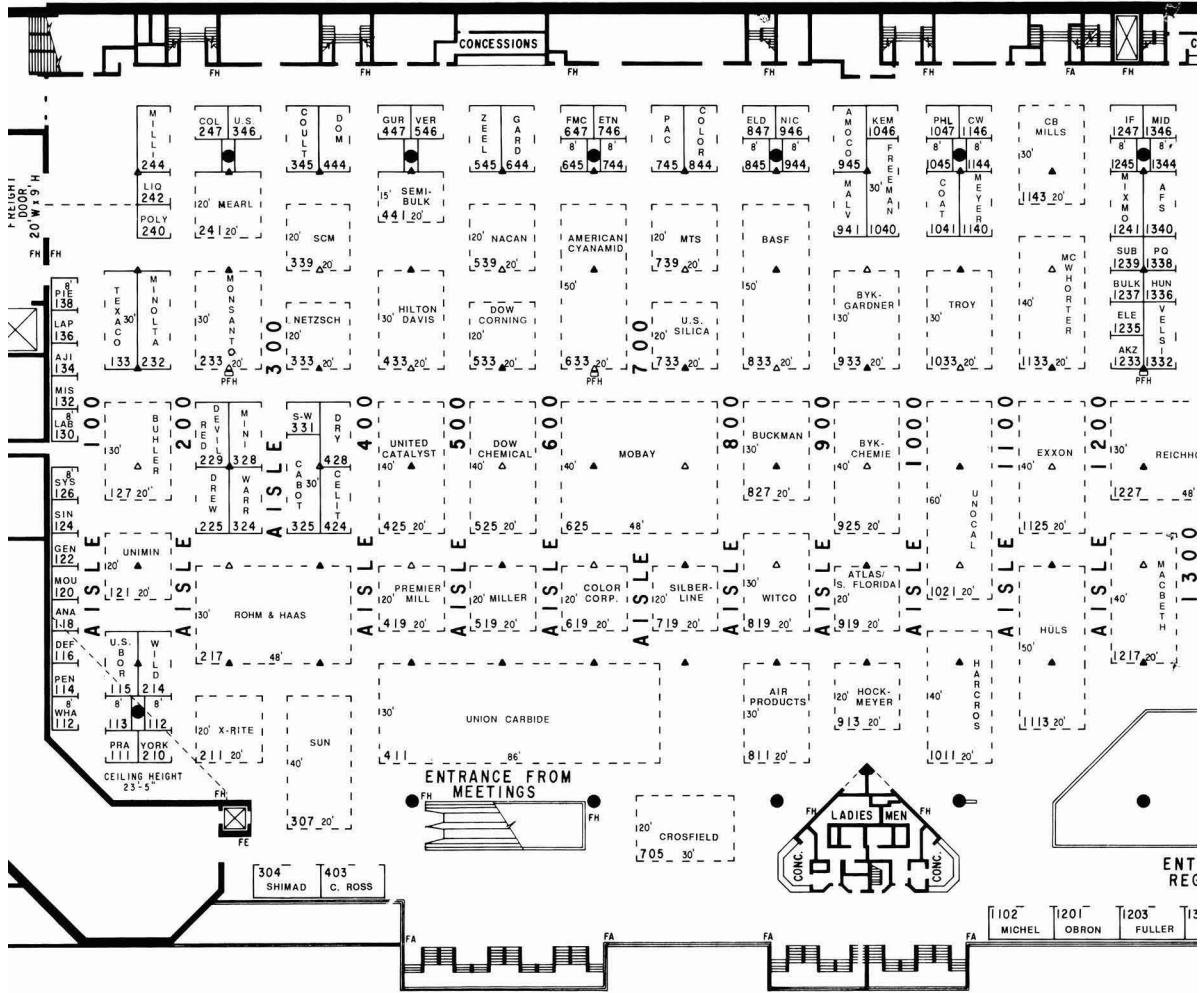
Desired Application _____

JCT

©Air Products and Chemicals, Inc., 1989

More than chemicals. Chemistry.

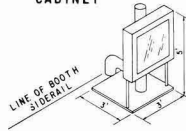
AIR PRODUCTS 



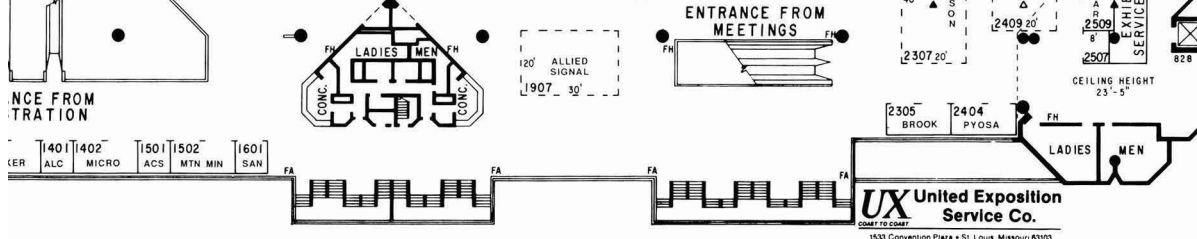
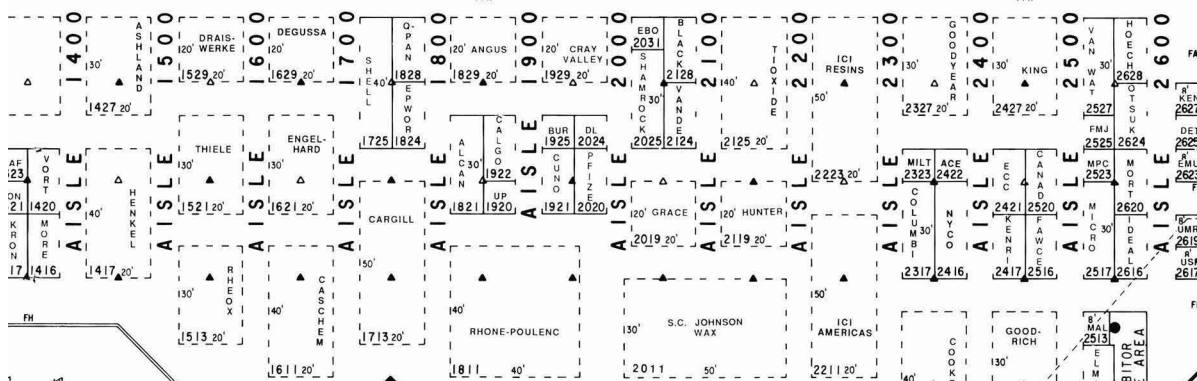
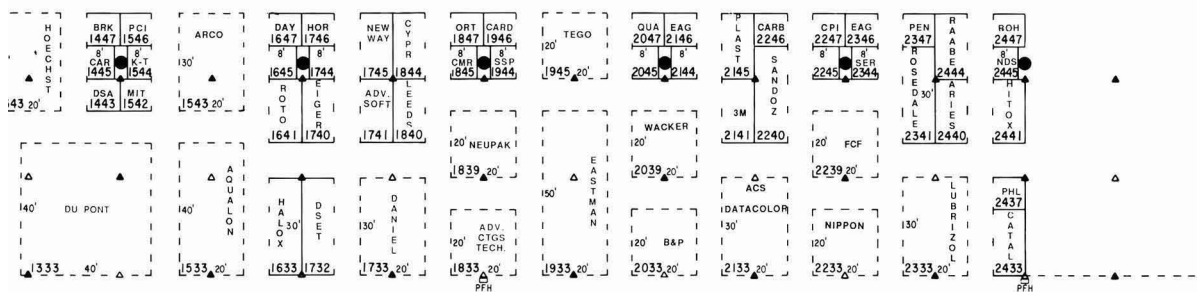
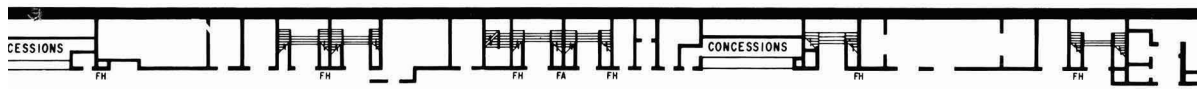
GENERAL INFORMATION

- ▲ - SERVICE MODULE CONTAINING 120/208 AND 600 VOLT ELECTRIC IN FLOOR
- ▲ - SERVICE MODULE CONTAINING ABOVE ELECTRIC PLUS GAS, COMPRESSED AIR, COLD WATER AND DRAIN IN FLOOR
- FA - FIRE ALARM BOX
- FH - FIRE HOSE CABINET
- PFH - PORTABLE FIRE HOSE CABINET
- CEILING HEIGHT: 35' CLEAR EXCEPT WHERE NOTED

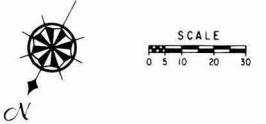
PFH PORTABLE FIRE HOSE CABINET



FEDERATION OF SO
56th ANNUAL
 NOVEMBER
 METRO TORONTO
 TORONTO



BOOTHS ARE 10' x 10' UNLESS OTHERWISE INDICATED



TECHNOLOGIES FOR COATINGS TECHNOLOGY
 PAINT INDUSTRIES SHOW
 FEBRUARY 4-6, 1991
 AT CONVENTION CENTRE
 ST. LOUIS, MISSOURI, ONTARIO, CANADA

UX United Exposition Service Co.
 1533 Convention Plaza • St. Louis, Missouri 63103
 314-421-1700

**"FORMULATING FOR THE FUTURE" SEMINAR
REGISTRATION FORM**

May 13-14, 1991

• Sheraton Society Hill, Philadelphia, PA

Registration fees: \$160 (FSCT members); \$190 (non-members)

Check must accompany registration form. Make checks payable to Federation of Societies for Coatings Technology. (Payment must be made in U.S. funds payable on U.S. banks.)

NICKNAME (For Registration Badge) _____

FULL NAME _____

JOB TITLE _____

COMPANY _____ PHONE _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Name of Federation Society
Of Which You Are a Member _____

I will will not use the Federation bus to the Philadelphia Airport at conclusion of seminar.

Return form and check to: FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
492 Norristown Road
Blue Bell, PA 19422-2350

**IF YOU REQUIRE HOUSING AT SHERATON SOCIETY HILL HOTEL
COMPLETE FORM BELOW**

**HOUSING FORM
Sheraton Society Hill Hotel**

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Arrival Date _____ Before 6 pm
 Late* Departure Date _____

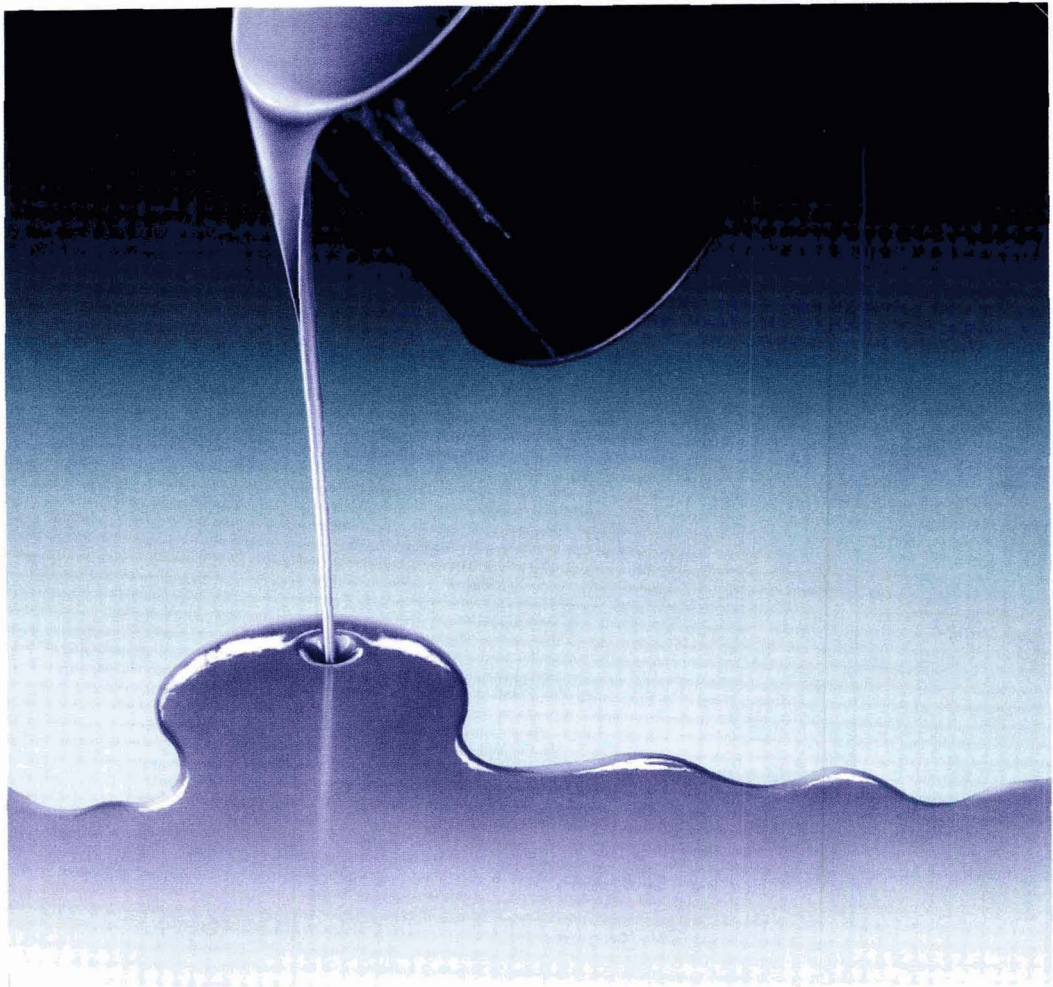
Please reserve: Single _____ \$118.00 (per night)

Double/Twin _____ \$138.00 (per night)

*Reservations will be held until 6:00 pm. If arrival is after 6:00 pm, hotel requires deposit for one night's lodging to guarantee availability. Make check payable to "Sheraton Society Hill Hotel."

Note: Reservations must be made no later than April 12 to guarantee availability and rates.

Return this form to: FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
492 Norristown Road, Blue Bell, PA 19422-2350



4/7903E

Solventless.

Advanced epoxy hardeners for superior flooring systems

For formulating self-leveling epoxy flooring systems that can perform in a wide range of tough applications, get to know our versatile amine hardeners.

We provide cycloaliphatic/aliphatic diamines **IPD, TMD** and

V214 that let you create easy-handling, highly durable flooring systems. With our full range of hardeners, you can customize formulations to emphasize specific properties, such as low viscosity, low vapor pressure, high filler content or chemical resistance.

Get to know Hüls. We are a vast, \$5+ billion worldwide corporation, strategically integrated to assure you of continuity of supply.

Our advanced manufacturing facilities are designed for responsive service.

For more information contact:

HÜLS AMERICA INC.
P.O. Box 456
80 Centennial Avenue
Piscataway,
New Jersey 08855-0456
Telephone: (201) 980-6929

hüls

In Canada:
Hüls Canada INC.
235 Orenda Road, Brampton,
Ontario L6T1E6, (416) 451-3810

NPCA to Recognize Industry Achievement With Paint Pollution Prevention Award Program

Entries are now being accepted for the new National Paint and Coatings Association (NPCA) Paint Pollution Prevention Award Program. The first award or awards will be presented at the NPCA 1991 Annual Meeting in San Francisco, CA, on October 21-23.

The award will recognize outstanding achievement by members of the paint and coatings industry, in protection of the environment through waste minimization and/or toxic reduction technologies or practices.

All types of pollution prevention or reduction programs will be considered, for example: waste minimization, air emissions reduction, water pollution reduction, source reduction or substitution, recycling, etc. Special consideration will be given to pro-

grams that can demonstrate financial savings to the company in addition to the benefit of reduced environmental pollution.

Programs will be evaluated on the basis of effectiveness, replicability (i.e., feasibility of adoption by other similar manufacturing operations), financial feasibility, sustainability, and benefit to the paint and coatings industry.

To evaluate a program in light of the previously mentioned criteria, programs must have been in place for at least six months at the time of submittal.

Entries will be publicized by NPCA, and winning programs will be summarized in announcements of the award(s). Award recipients may also be asked to participate in seminars or forums to discuss their pollution prevention strategies and the results achieved.

For further information, contact Barbara A. Walz, Manager, Environmental Affairs or Marilyn Ludwig, Director of Communications, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005-5503.

Manville Filtration and Minerals Renamed Celite Corporation

Manville Corporation, Denver, CO, recently announced that the company's U.S. and European Filtration and Minerals Groups have been combined and renamed Celite Corporation. Celite will continue to serve the worldwide fluid conditioning and functional filler markets, primarily with diatomite, perlite, silicates, and specialty industrial minerals.

It was also reported that the company's businesses in Europe, Africa, and The Middle East will now be known as Celite International. V. Thanh Nguyen, based in Paris, France, will serve as Vice President and General Manager for these operations.

The North and Central American operations will be known as Celite Americas and Harry R. Keefe, based in Lompoc, CA, will serve as Vice President and General Manager.

Celite Corporation manufactures filtration and functional filler products for the brewing, winemaking, foods, chemical, paints, plastic film, rubber, agricultural, and biochemical industries.

Manville Corporation is an international manufacturing and natural resources company. In addition to filtration and minerals, the company's primary businesses include building and engineered products, fiber glass and industrial insulation products, paper and wood products, packaging, and roofing systems.

Akzo Consolidates North American Operations

Akzo Coatings Inc., Louisville, KY, has announced the consolidation of several of its North American coatings operations. These actions are the result of a comprehensive study conducted by the company to utilize its existing manufacturing capabilities. Factors such as market location, customer service, product quality and capital outlay were all considered in the determination of the consolidation.

The four locations that will be affected include:

NORCROSS, GA—Manufacturing responsibilities will be shifted from this operation to the company's newly-opened Pontiac, MI plant. The Car Refinish Administration Center, Regional Distribution Center, and Car Refinish Information Center will remain in the Atlanta, GA area.

LOUISVILLE, KY—As a result of the restructuring and consolidation plans, Akzo's Louisville operation will become one of the company's resin producing facilities. Manufacturing of coatings produced here will be transferred to the firm's other exist-

ing locations. Coatings sales and service personnel will remain in the Louisville area. Akzo's corporate headquarters and Robertson Research and Development Center will remain at their current locations.

BREA, CA—Plans called for the integration of Akzo's two Southern California operations at Brea and Orange early this year. The Orange operation, purchased by Akzo in 1988, will assume manufacturing responsibility for the Brea facility.

REXDALE, ONT., CANADA—Manufacturing responsibilities will be transferred from this facility to the company's Pontiac and Quebec manufacturing plants. All administration, sales, and customer service personnel will remain in place throughout several Canadian locations.

Approximately 175 employees will be affected at these locations.

Akzo operates in a number of markets, including fibers, coatings, chemicals, salt, and health care products.

Crosfield Chemicals to Build Detergent Zeolite Plant

Crosfield Chemicals, a member of the Unilever Specialty Chemicals Group, has announced plans to build a multi-million dollar facility to produce detergent zeolites at its Joliet, IL, site. Construction of the plant is already underway with completion scheduled for the first quarter of 1992.

The facility will have a capacity of 55,000 anhydrous tons per year of 4A detergent zeolite. The new plant will result in

the addition of 40 new jobs to the local community.

Crosfield has experience in producing specialty zeolites for fluid cracking catalyst applications, which has been utilized in the design of modern, efficient detergent zeolite facilities. Crosfield commissioned its first major detergent zeolite operation in Eijsden, the Netherlands, in 1990.

CABOT SPECIAL BLACKS

The Perfect Start For Every Finish



Whether you are formulating an inexpensive drum enamel, a high-gloss, high-color top coat for auto bodies, or a tough, protective marine paint for battle-ships, Cabot has a carbon black grade that will meet your total coatings needs.

In fact, Cabot offers one of the broadest selections of coating-grade blacks available. If you are working on a new formulation or upgrading or optimizing an existing one, call our technical service specialists for recommendations and assistance... and for the black that will meet your requirements best.

Cabot Special Blacks for your fine finishes.

FLUFFY

MONARCH® 1400
MONARCH 1300
MONARCH 1100
MONARCH 1000
MONARCH 900
MONARCH 880
MONARCH 700
VULCAN® XC72R
MOGUL® L
REGAL® 660R
REGAL 400R
REGAL 330R
REGAL 300R
ELFTEX 8

ELFTEX 5
ELFTEX 12

MONARCH 130
MONARCH 120

PELLETS

BLACK PEARLS® 1400
BLACK PEARLS 1300
BLACK PEARLS 1100
BLACK PEARLS 1000
BLACK PEARLS 900
BLACK PEARLS 880
BLACK PEARLS 700
VULCAN XC72
BLACK PEARLS L
REGAL 660
BLACK PEARLS 570
REGAL 400
REGAL 330

BLACK PEARLS 460
BLACK PEARLS 450
BLACK PEARLS 440
BLACK PEARLS 430
BLACK PEARLS 410

BLACK PEARLS 280
BLACK PEARLS 130
BLACK PEARLS 120



CABOT

*A world of experience...
in Carbon Blacks*

Cabot Corporation
Billerica Technical Center
Concord Road
Billerica, MA 01821
(508) 670-7012

Judge a look by its cover

The look that lasts.

Cookson's new magenta, violet, maroon and red pigments make enduring first impressions.

Introducing a new era of high performance, enhanced rheology organic pigments.



ENDUROQUIN™
Quinacridone Magentas and Violets



ENDUROLENE™
Perylene Maroons



ENDURONONE™
Anthraquinone Red

Building on several decades of experience in organic pigment production, Cookson Pigments recently completed a \$20 million high performance pigments production facility — computer controlled throughout for quality and process reliability.

THE BONUS — BETTER PERFORMANCE

Fully integrated production technology yields improved rheology, reduced viscosity, and enhanced dispersion, flow and leveling characteristics. You'll have greater formulation latitude in conventional and high solids systems.

Cookson's new quinacridones and perylenes offer a unique alternative for metallic paint stylings with excellent rheology. Our anthraquinone red is the formulating tool for richer solid shades. All backed by Cookson's Quality Assurance program.

Call Cookson today to request your evaluation samples.

New High Performance Reds from Cookson



COOKSON
PIGMENTS

COOKSON PIGMENTS, INC.

256 Vanderpool Street
Newark, NJ 07114

Tel: (201) 596-6168
Fax: (201) 242-7274

Thermodynamic Analysis of Phase Separation in Selfstratifying Coatings—Solubility Parameters Approach

Tosko A. Misev
DSM Resins BV*

The three dimensional solubility parameter system has been applied in the analysis of the behavior of selfstratifying coatings. For a system consisting of two phases in equilibrium, the Gibbs free energy of mixing must be at the minimum value at constant temperature and pressure, or the chemical potential of each component must be equal in both phases. These conditions have been used to generate binodals and spinodals of the binary system in question, representing the boundaries between the stable, metastable, and unstable state. The phase separation phenomenon is analyzed as a function of the solubility parameters space distance (SPDS) and molecular weight changes during the curing and stratification process. The results indicate the importance of choosing the right curing pattern to obtain high stratification efficiency. A model for predicting the phase separation in a binary system in the presence of a mutual solvent for both polymers also has been proposed.

INTRODUCTION

The concept of selfstratifying coatings which will separate during the film forming process into two layers, each exhibiting different and desired properties, was introduced by Funke in the 1970s.¹ This rather shrewd way of applying two layers at one time not only saves labor, but also overcomes many of the problems associated with the present multilayer application techniques. The lack of intercoat adhesion is one example of a problem which can be solved by the selfstratifying coating concept as an

alternative to the existing conventional techniques, such as "wet-on-wet" spraying, "not-fully-cured" primer coating, use of "active solvents," etc.^{2,3}

There is not much evidence of the practical use of the selfstratifying coatings concept. However, reports on selfstratifying powder coatings,^{4,5} epoxy-rubber systems,⁶ and vinyl acetate/ethylene/vinyl chloride copolymer latexes⁷ can be traced in literature.

Stratification of the coating into two layers can be achieved by starting from a multiphase system, or from a monophase system which undergoes phase separation during the film forming process. The latter will be considered in this paper.

The separation of a homogeneous one-phase coating into two layers can result from the evaporation of the solvent, which keeps the system of otherwise noncompatible binders in thermodynamical equilibrium. A solventless monophase system can undergo phase separation as a result of an increase of molecular weight during film formation. The permanent reduction of the combinatorial entropy of mixing during the molecular weight growth shifts the system from the thermodynamical equilibrium, resulting in phase separation.

The factors influencing the stratification process of a ternary system, polymer/polymer/solvent, in terms of stratification kinetics, direction of the stratification, influence of the gravitational forces, interfacial tension between the different phases and the substrate, the layer thickness, and the evaporation of the solvent are discussed in detail by Vercholansev.²

Polymer-polymer phase separation is one of the driving forces for selfstratification. This paper will analyze the influence of molecular weight change of the polymers present in the paint systems on the stratification efficiency, assuming that the other necessary conditions for selfstratification are provided. Also, a simplified model

Presented at the XXth FATIPEC Congress, in Nice, France, in September 1990.
Reprinted with permission of *Double Liaison*.
*Ceintuurbaan 5, P.O. Box 615, 8000 AP Zwolle, The Netherlands.

for choosing the right polymer pair and solvent blend in a ternary system, polymer/polymer/solvent, will be proposed.

ANALYSIS IN THE ABSENCE OF A SOLVENT

Let us assume a monophasic system is composed of two polymers which are on the border of compatibility so that any increase in molecular weight will result in phase separation. Also, let us choose a curing agent (or curing agents) which does not react with both polymers equally, thus leading to mutual crosslinking and preventing phase separation. In other words, during the curing process, both polymers increase in molecular weight independently of each other. Another assumption is that the curing process does not change the chemical structure to such an extent that this, as such, can be a reason for phase separation. This is easily accepted, since the number of functional groups present in the system compared to the whole composition is rather low.

For the analysis of the phase behavior of the system, equations (1) and (2) for generating binodals (criteria for full compatibility) or equation (3) for generating spinodals (criteria for metastable state) originally developed by Scott⁸ can be used. However, since the stratification anticipates phase separation as complete as possible, the spinodal decomposition should be preferred and consequently, the application of equation (3) in this analysis certainly has justification.

$$\ln\Phi_{1a} + (1-r)\Phi_{2a} + V_1(\delta_1 - \delta_2)^2\Phi_{2a}^2/kT = \ln\Phi_{1b} + (1-r)\Phi_{2b} + V_1(\delta_1 - \delta_2)^2\Phi_{2b}^2/kT \tag{1}$$

$$\ln\Phi_{2a} + (1-r)\Phi_{1a} + V_2(\delta_1 - \delta_2)^2\Phi_{1a}^2/kT = \ln\Phi_{2b} + (1-r)\Phi_{1b} + V_2(\delta_1 - \delta_2)^2\Phi_{1b}^2/kT \tag{2}$$

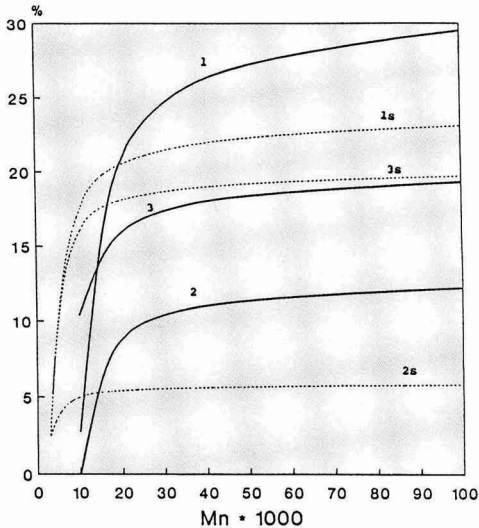


Figure 1—Volume fraction of the stratifying layer as a function of the curing pattern. Case a: stratifier undergoes curing (line 1 solventless, line 1s solvent-based coating). Case b: carrier undergoes curing (line 2 solventless, line 2s solvent-based coating). Case c: both polymers undergo curing (line 3 solventless, line 3s solvent-based coating)

$$(1-r)\Phi_1 + 2\Phi_1\Phi_2V_1(\delta_1 - \delta_2)^2/kT - 1 = 0 \tag{3}$$

where:

- Φ_{1a}, Φ_{1b} = volume fractions of polymer 1 in phase a and phase b
- Φ_{2a}, Φ_{2b} = volume fractions of polymer 2 in phase a and phase b
- δ_1, δ_2 = solubility parameters of polymer 1 and 2
- V_1, V_2 = molar volumes of polymer 1 and 2
- k = Boltzman constant
- T = temperature (K)
- r = V_2/V_1

The full derivation of equations (1)–(3) is given in the Appendix.

Substituting $\Phi_1 = 1 - \Phi_2$ and supplying the values for $r, V_1,$ and $T,$ the solution of equation (3) for Φ_2 gives the points for the construction of the diagram for the metastable state (spinodal curves).

For the purpose of the analysis, a system of two polymers is blended in a ratio of 80/20 (by volume) with an equal (relatively low) molecular weight of 3000. The system in question is monophasic at room temperature and undergoes curing at an elevated temperature of 140°C. In the absence of proper terminology and for the purpose of convenience, the component which is in lower concentration will be named a stratifier and the component in excess will be known as a carrier.

It has already been assumed that the polymers in question are borderline compatible. For a molar volume of 3000 cm³/mol in both cases (which means a density of both polymers 1 g/cm³), and a temperature of 20°C, the difference in solubility parameters at which the polymers border compatibility in all ratios should be 1.27 J^{1/2}

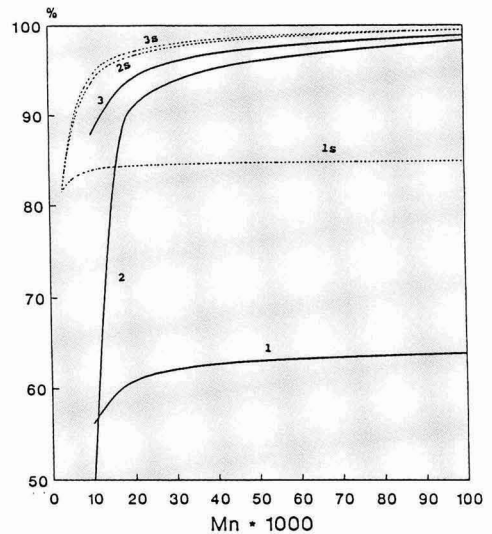


Figure 2—Purity of the stratifying layer as a function of the curing pattern. Case a: stratifier undergoes curing (line 1 solventless, line 1s solvent-based coating). Case b: carrier undergoes curing (line 2 solventless, line 2s solvent-based coating). Case c: both polymers undergo curing (line 3 solventless, line 3s solvent-based coating)

$\text{cm}^{-3/2}$. This value can be obtained by equalizing the first derivation of equation (3) to zero, thus obtaining the maximum of the spinodal curve in the δ/T diagram.

The following three different curing patterns will be analyzed:

(a) The stratifier undergoes crosslinking or chain extension much quicker than the carrier. At first approximation, it will be assumed that the molecular weight of the carrier does not change until the stratifier reaches a molecular weight of 100,000.

(b) The carrier undergoes crosslinking or chain extension much quicker than the stratifier. At first approximation, let us assume that the molecular weight of the stratifier does not change until the carrier reaches a molecular weight of 100,000.

(c) Both polymers undergo crosslinking or chain extension at the same rate, building up the same molecular weights with time.

A system of two equations, equation (3) and the equation which represents simple material balance of the components, can be used to calculate: the concentrations of the components in phase A and phase B; the amounts of the stratifier and carrier which go to phase A and phase B compared to the initial amount in the starting monophasic blend; and the volume fraction of phase A and phase B. The results of the calculations are presented graphically in Figures 1-3.

In an ideal case, when full phase separation is realized, the volume fraction of the stratifying layer should be 20%, being equal to the volume fraction of the stratifier in the monophasic system. It can be seen that for the three chosen curing patterns, there is considerable difference between the obtained results.

When the stratifier undergoes curing (line 1, Figure 1), the volume fraction of the stratifying layer exceeds 20%, which indicates that the purity of that fraction is not high enough, thus containing a considerable amount of the carrier.

In contrast to that, when the carrier undergoes curing, the volume fraction of the stratifying layer is rather low, leveling off at about 12% (line 2, Figure 1).

In the intermediate case, when both the stratifier and the carrier undergo curing with the same rate of increase of molecular weight, the stratifying layer nearly reaches the theoretical value of 20%, leveling off at 19.3%.

Figure 2 presents the dependence of the purity of the stratifying layer as a function of the curing pattern. In the case when only the molecular weight of the stratifier increases, the concentration of the stratifier in the stratifying layer levels off at 64% (line 1, Figure 2). This means that the stratifying layer is heavily contaminated with the carrier. In both other cases, when only the carrier undergoes curing or both the carrier and the stratifier undergo curing, the purity of the stratifying layer is rather high, leveling off at 98.3 and 98.9%, respectively (lines 2 and 3, Figure 2).

Figure 3 represents the stratifying efficiency being defined as the ratio between the amount of stratifier present in the stratifying layer compared to the initial amount of the stratifier in the monophasic system. In case (a) (stratifier undergoes curing) and case (c) (both polymers undergo curing), the stratifying efficiency is rather high,

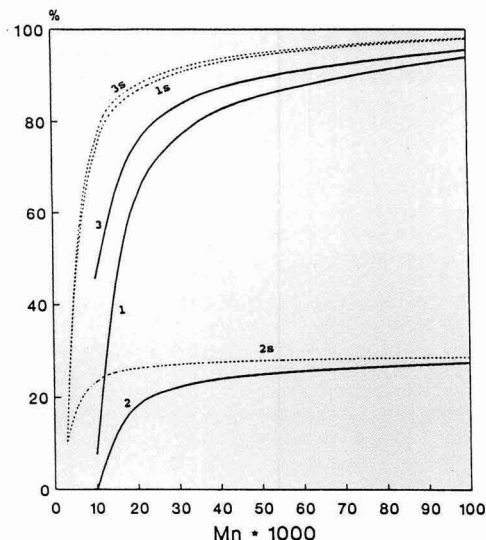


Figure 3—Stratification efficiency as a function of the curing pattern. Case a: stratifier undergoes curing (line 1 solventless, line 1s solvent-based coating). Case b: carrier undergoes curing (line 2 solventless, line 2s solvent-based coating). Case c: both polymers undergo curing (line 3 solventless, line 3s solvent-based coating)

leveling off at 94.1 and 95.7%, respectively (lines 1 and 3, Figure 3). In the case when the carrier undergoes curing only, the stratifying efficiency is rather low, leveling off at 27.4% (line 2, Figure 3).

The following basic rules can be drawn by analyzing Figures 1-3:

(1) The increase of the molecular weight of the carrier results in phase separation, with rather poor stratifying efficiency. The term stratifying efficiency is defined as the percentage of the stratifier in the stratifying layer (the layer with lower thickness composed predominantly from the stratifier) compared to the total amount of stratifier in the system.

(2) For good stratifying efficiency, one should concentrate on the crosslinking of the stratifier. However, the purity of the stratifying layer will not be so high as to contribute exclusively to the properties of the layer in question.

(3) Good stratifying efficiency and high purity of both layers can be provided only in a case when both the carrier and the stratifier undergo molecular weight increase at the same rate.

Since, in practice, curing of both components will take place at the same time, the stratification efficiency and the purity of the layers will be affected by the curing rate of the carrier and the stratifier.

Higher curing rate of the carrier will adversely affect the stratifying efficiency, but not the purity of the stratifying layer. The higher crosslinking rate of the stratifier will not adversely affect the stratifying efficiency, but will certainly decrease the purity of the stratifying layer.

CHOOSING THE SOLVENT BLEND

The presence of the solvent makes the theoretical treatment of the stratification phenomenon more complex. However, the presence of solvent will have at least two positive effects on the stratifying properties of the system. The solvent will decrease the viscosity of the coating, which will have as a consequence, an increase of the stratification kinetic rate. However, as mentioned previously, the solvent can keep the two incompatible polymers in a thermodynamically stable monophase system. The evaporation of the solvent during the film forming process combined with an increase of the molecular weight due to curing will have a positive effect on the stratification process, emphasizing the incompatibility.

The model to be described can be used as a tool in choosing the right components in the system on the basis of their solubility parameters. The following assumptions are made in the treatment:

(a) No curing takes place before evaporation of the solvent during baking or during drying at room temperature;

(b) The carrier and the stratifier are not compatible at room temperature, but their spheres of solubility intersect (*Figure 4*); and

(c) The point whose coordinates in a three-dimensional system represent the solubility parameters of the solvent blend used in the coating formulation is within the space which is mutual for the spheres of solubility of both polymers being equally distant from the surfaces of the intersecting spheres (*Figure 4*).

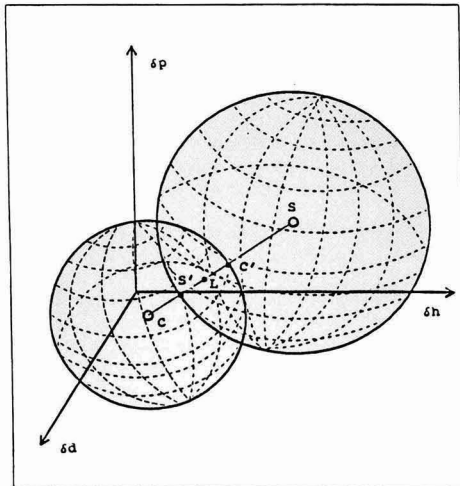


Figure 4—Graphical presentation of the system polymer/polymer/solvent defined by the solubility parameters and the spheres of interaction. Point C—defined with coordinates δ_{cd} , δ_{cp} , and δ_{ch} ; point S—defined with coordinates δ_{sd} , δ_{sp} , and δ_{sh} ; point C'—defined with coordinates $\delta_{cd'}$, $\delta_{cp'}$, and $\delta_{ch'}$; point S'—defined with coordinates $\delta_{sd'}$, $\delta_{sp'}$, and $\delta_{sh'}$; and point L—defined with coordinates δ_{ld} , δ_{lp} , and δ_{lh}

When the carrier and the stratifier are not compatible at room temperature [condition (b)] the following equation is generated:

$$4(\delta_{sd}-\delta_{cd})^2 + (\delta_{sp}-\delta_{cp})^2 + (\delta_{sh}-\delta_{ch})^2 < (R_c + R_s)^2 \quad (4)$$

where R_c , δ_{cd} , δ_{cp} , δ_{ch} , and R_s , and δ_{sd} , δ_{sp} , and δ_{sh} hold for the radius of interaction, dispersion, polar and the hydrogen bond solubility parameters of the carrier and the stratifier.

Condition (c) on the other hand indicates that the point defined with coordinates being equal to the solubility parameters of the solvent, should be located on the line which connects the centers of the spheres of solubility. The analytical form of the equations which describe this line will be:

$$\frac{\delta_d - \delta_{cd}}{\delta_{sd} - \delta_{cd}} = \frac{\delta_p - \delta_{cp}}{\delta_{sp} - \delta_{cp}} = \frac{\delta_h - \delta_{ch}}{\delta_{sh} - \delta_{ch}} \quad (5)$$

The coordinates of the intercept points between this line and the spheres of solubility can be obtained by solving the following systems of equations:

$$4(\delta_d - \delta_{cd})^2 + (\delta_p - \delta_{cp})^2 + (\delta_h - \delta_{ch})^2 = R_c^2 \quad (6)$$

$$4(\delta_d - \delta_{sd})^2 + (\delta_p - \delta_{sp})^2 + (\delta_h - \delta_{sh})^2 = R_s^2 \quad (7)$$

$$\frac{\delta_d - \delta_{cd}}{\delta_{sd} - \delta_{cd}} = \frac{\delta_p - \delta_{cp}}{\delta_{sp} - \delta_{cp}} \quad (8)$$

$$\frac{\delta_d - \delta_{cd}}{\delta_{sd} - \delta_{cd}} = \frac{\delta_h - \delta_{ch}}{\delta_{sh} - \delta_{hp}} \quad (9)$$

The assumption that this point is equally distant from the surface of both spheres, and that it lies on the line which passes the centers of the spheres of interaction (*Figure 4*), generates equations (10)–(12):

$$4(\delta_{cd}' - \delta_{ld})^2 + (\delta_{cp}' - \delta_{lp})^2 + (\delta_{ch}' - \delta_{lh})^2 = 4(\delta_{sd}' - \delta_{ld})^2 + (\delta_{sp}' - \delta_{lp})^2 + (\delta_{sh}' - \delta_{lh})^2 \quad (10)$$

$$\frac{\delta_{ld} - \delta_{cd}'}{\delta_{sd}' - \delta_{cd}'} = \frac{\delta_{lp} - \delta_{cp}'}{\delta_{sp}' - \delta_{cp}'} \quad (11)$$

$$\frac{\delta_{ld} - \delta_{cd}'}{\delta_{sd}' - \delta_{cd}'} = \frac{\delta_{lh} - \delta_{ch}'}{\delta_{sh}' - \delta_{ch}'} \quad (12)$$

where, δ_{sd}' , δ_{sp}' , δ_{sh}' , δ_{cd}' , δ_{cp}' , and δ_{ch}' , are the coordinates of the intersection points between the spheres of solubility and the line passing through their centers obtained as a solution of the systems of equations (6)–(9), while δ_{ld} , δ_{lp} , and δ_{lh} are the solubility parameters of the solvent or solvent blend, which will be a good solvent for both polymers.

The solubility parameters of the solvent blend can be calculated by a simple additive technique using the formula:

$$\delta_{ld} = \sum x_i \delta_{di} \quad \delta_{lp} = \sum x_i \delta_{pi} \quad \delta_{lh} = \sum x_i \delta_{hi} \quad (13)$$

where, x_i is the volume fraction of a specific solvent in the solvent blend and δ_{di} , δ_{pi} , and δ_{hi} are its solubility parameters.

For most of the polymers used in the coating field, the so-called radius of interaction R has a value between 10–16 MPa^{1/2}.⁹ (To be sure that the intercept of the sphere of

solubility falls within the interaction sphere, let us choose a radius of interaction, which is at least half of the smallest value given in literature.) In other words, it means that the distance between the two points having coordinates equal to the solubility parameters of the two resins in the system should not be higher than 5 MPa^{1/2}. Having in mind the finding of Hansen that most of the solvents dissolve the solute at a distance from the respective centers equal to $R \pm 0.5 \text{ cal}^{1/2} \text{ cm}^{-3/2}$ ($R \pm 1 \text{ MPa}^{1/2}$),¹⁰ the previously accepted assumption will ensure in fullest measure a possibility of finding a mutual solvent blend for both polymers. This involves the following equation into the system:

$$4(\delta_{sd} - \delta_{cd})^2 + (\delta_{sp} - \delta_{cp})^2 + (\delta_{sh} - \delta_{ch})^2 < 25 \quad (14)$$

These considerations will now be applied to a model system composed of an alkyd resin (carrier) and acrylic resin (stratifier) with the following composition:

Acrylic Resin	Alkyd Resin
Methyl methacrylate..... 50	Coconut fatty acids..... 36
Butyl methacrylate..... 30	Isophthalic acid..... 40
Hydroxyethyl methacrylate... 20	Trimethylolpropane..... 36

When using Small's method of calculating the solubility parameters of the resins,¹¹ the following values for the solubility parameters for the resins in question were obtained:

Acrylic Resin	Alkyd Resin
$\delta d = 13.87$	$\delta d = 15.54$
$\delta p = 3.49$	$\delta p = 3.62$
$\delta h = 10.19$	$\delta h = 9.20$

The distance between the centers of the solubility spheres will be:

$$4(\delta_{sd} - \delta_{cd})^2 + (\delta_{sp} - \delta_{cp})^2 + (\delta_{sh} - \delta_{ch})^2 = 12.4$$

which is < 25, thus satisfying the condition according to equation (14). Choosing the same volume ratio as before (80/20), and assuming spinodal decomposition, the concentration of the polymers in different phases can be calculated using equation (1). The results, together with the previous ones, for two polymers being on the edge of compatibility in a monophase system without the presence of solvent, are represented in Figures 1-3. As could be expected, the positive influence of the solvent is obvious. Next to increasing the stratifying rate from the kinetic point of view by decreasing the viscosity of the system, it allows creation of a stable monophase system with a potentially high degree of instability. After evaporation of the solvent, such a system will possess much stronger driving forces for more efficient phase separation compared to a solventless selfstratifying coating.

References

- (1) Funke, W., *J. Oil & Colour Chemists' Assoc.*, 59, 398 (1976).
- (2) Vercholantsev, V.V., *Progr. Org. Coat.*, 13, 71 (1985).
- (3) Batar, K., Proc. XVth Int. Conf. Org. Coat. Sci. and Techn., Athens, July 1989, Congress Book, p 13.
- (4) Murase, H. and Funke, W., XVth FATIPEC Congress, Congress Book II, 387, 1980.
- (5) Dainippon Ink & Chemicals, Jap. Patent 240, 369 (1987).
- (6) Shleomenson, Y.B., *Lakkrasochnye Materialy i ikh Primenenie*, 5, 24 (1975).
- (7) Lothian, B.R., Resin and Pigment Exhibition Symposium, Frankfurt, 1989.

- (8) Scott, R.L., *J. Chem. Phys.*, 17, 249 (1949).
- (9) Barton, A.F.M., *Handbook of Solubility Parameters and Other Cohesion Parameters*, CPC Press, Boca Raton, FL, 1983, p 296.
- (10) Hansen, C.M., "The Three Dimensional Solubility Parameter—Key to Paint Component Affinities: II. Dyes, Emulsifiers, Mutual Solubility and Compatibility, and Pigments," *JOURNAL OF PAINT TECHNOLOGY*, 39, No. 511, 505 (1967).
- (11) Small, P.A., *J. Appl. Chem.*, 3, 71 (1953).
- (12) Scatchard G., *Chem. Rev.*, 8, 321 (1931).
- (13) Hildebrand J., *J. Am. Chem. Soc.*, 38, 1452 (1916).
- (14) Hildebrand, J. and Scott, R., "The Solubility of Nonelectrolytes," 3rd ed., Reinhold, New York, 1949.
- (15) van Arkel, *Trans. Faraday Soc.*, 42B, 81 (1946).
- (16) Blanks, R.F. and Prausnitz, J.M., *Ind. Eng. Chem., Fundamentals*, 3, 1 (1964).
- (17) Hansen, C.M. and Skaarup, K., "The Three Dimensional Solubility Parameter—Key to Paint Component Affinities: III. Independent Calculation of the Parameter Components," *JOURNAL OF PAINT TECHNOLOGY*, 39, No. 511, 511 (1967).
- (18) Scatchard, G., *Chem. Rev.*, 8, 321 (1931).
- (19) Patton, T.C., *Paint Flow and Pigment Dispersion*, John Wiley & Sons, New York, 1979, p 310.
- (20) Hoy, K.L., "New Values of the Solubility Parameters from Vapor Pressure Data," *JOURNAL OF PAINT TECHNOLOGY*, 42, No. 541, 76 (1970).
- (21) van Krevelen, D.W. and Hoftyzer, P.J., *Properties of Polymers: Their Estimation and Correlation with Chemical Structure*, 2nd ed., Elsevier, Amsterdam, 1976.
- (22) Sperling, L.H., *Introduction to Physical Polymer Science*, John Wiley & Sons, New York, 1986, p 104.
- (23) Olabisi, O., Robeson, L.M., and Shaw, M.T., in *Polymer-Polymer Miscibility*, Academic Press, San Diego, CA, 1979, p 59.

* * *

APPENDIX

For a system consisting of two phases in equilibrium, the chemical potential μ of a component must be equal in both phases. The chemical potential of a component i is expressed by the following equation:

$$\mu_i = \partial G / \partial N_i \Big|_{p,T,N_i} \quad (15)$$

where, N_i is the number of molecules of the component i in the blend.

The term ΔG is the Gibbs free energy of mixing given by the familiar equation (16), where ΔH_m is the enthalpy of mixing and ΔS_m is the combinatorial entropy of mixing.

$$\Delta G_m = \Delta H_m - T \Delta S_m \quad (16)$$

To use equations (15) or (16) for predicting the behavior of a multicomponent system, the dependence of the enthalpy and entropy of mixing on the parameters relevant for characterization of the polymer blend must be known.

Scatchard¹² made a quantitative interpretation of Hildebrand's idea¹³ of predicting the enthalpy of mixing:

$$\Delta H_m = (x_1 V_1 + x_2 V_2) \Phi_1 \Phi_2 [(\Delta E_1 / V_1)^{0.5} + (\Delta E_2 / V_2)^{0.5}]^2 \quad (17)$$

where:

- ΔH_m = enthalpy of mixing
- ΔE_i = energy of vaporization to a gas at zero pressure or at infinite separation of the molecules
- x_i = mole fraction of component i in the blend
- Φ_i = volume fraction of component i in the blend
- V_i = molar volume of component i

The term $(\Delta E/V)^{0.5}$, which represents the square root of the energy of vaporization per unit volume, was named by Hildebrand and Scott as the solubility parameter,¹⁴ giving it the symbol δ . Thus, δ is proportional to the cohesion of the material or to the strength of attraction between the molecules making up the material.

The molar energy of vaporization for the solvents can be experimentally determined and the solubility parameter calculated from it. For some liquids, many solids, and all polymers, it is necessary to use indirect evaluation methods for estimating the cohesive parameters. An extensive description of these methods is given in Barton's book.⁹ The solubility parameter obtained by the molar energy of vaporization is the so called total solubility parameter. It has been divided by van Arkel, Small, and Prausnitz into two main components: nonpolar and polar parameters.^{11,15,16} Later on, Hansen¹⁷ introduced the third type of solubility parameter related to the cohesive energy of the hydrogen bonding of similar specific association interaction.

If it is assumed that if cohesive energy is made up of a linear combination of the contribution from the nonpolar (or dispersion) interaction ($-U_d$), polar interaction ($-U_p$), and hydrogen bonding ($-U_h$), then:

$$-U/V = -U_d/V - U_p/V - U_h/V \quad (18)$$

or:
$$\delta^2 = \delta_d^2 + \delta_p^2 + \delta_h^2 \quad (19)$$

Although the theoretical justification for application of the solubility parameters of this type had been rather weakened by doubling the scale on the dispersion axis to provide approximate spherical "volumes" of solubility, Hansen's method is rather convenient from a practical point of view and, therefore, used in this work.

Scatchard¹⁸ and Small¹¹ have found a linear relationship between the square root of the molar cohesion energy and the chain length of several homologous series of organic compounds. In other words, the solubility parameter has additive properties. Using this property, the solubility parameter of one compound can be calculated according to equation (20)¹⁹:

$$\delta = (\tau/M)\Sigma G = \Sigma G/V \quad (20)$$

where:

- τ = density of the compound in question
- M = molecular mass
- V = molar volume
- G = group molar attraction constant

The total values of the group molar attraction contributions of many different groups are determined by Hoy.²⁰ These are probably the most reliable values obtained by regression analysis of 614 different compounds. For the polar and hydrogen bonding molar attraction contributions, the values published by van Krevelen and Hoflytzer can be used.²¹ The values of the dispersion molar attraction constants for specific groups can be then determined by means of the following formula:

$$\delta_d = (\delta^2 - \delta_p^2 - \delta_h^2)^{0.5} \quad (21)$$

Knowing the group contribution constants, dispersion, polar, and hydrogen bonding solubility parameters can be calculated by means of equations (8)-(10)²¹:

In case of a dispersion solubility parameter, the calculation is done by simple adding of the dispersion attraction constants of specific groups:

$$\delta_d = \Sigma F_d/V \quad (22)$$

where, ΣF_d is the sum of the dispersion attraction constants of specific groups expressed in $J^{1/2}cm^{3/2}mol^{-1}$, and V is the molar volume of the compound in cm^3/mol .

The polar solubility parameter can be calculated in the same way, as long as only one polar group is present. To correct for the interactions of polar groups, van Krevelen suggests equation (23):

$$\delta_p = (\Sigma F_p)^{0.5}/V \quad (23)$$

where, F_p is the polar molar attraction constant for a specific group expressed in $J^{1/2}cm^{3/2}mol^{-1}$.

This method is not applicable for calculation of the hydrogen bonding solubility parameter. van Krevelen proposes equation (24) which is derived on the statement of Hansen that the hydrogen bonding energy U_h per structural group is approximately constant:

$$\delta_h = (-\Sigma U_h/V)^{1/2} \quad (24)$$

In equation (24), U_h is the molar cohesive energy contribution constant of the hydrogen bond for a specific group expressed in J/mol.

Introducing the solubility parameters in equation (17), the enthalpy of mixing can be written in the following form:

$$\Delta H_m = (x_1V_1 + x_2V_2)\Phi_1\Phi_2(\delta_1 - \delta_2)^{0.5} \quad (25)$$

The second term of equation (15), the combinatorial entropy of mixing, using the well-known Boltzmann's relation, and applying the approximation of Stirling,²² can be expressed by the following equation:

$$\Delta S_m = -k(N_1\ln\Phi_1 + N_2\ln\Phi_2) \quad (26)$$

To be able to make a differentiation of equation (15), and to get the analytical form of equation (16), the volume fractions in equation (26) have to be expressed in terms of the number of molecules introducing the size ratio of the components r ²³:

$$r = V_2/V_1 \quad (27)$$

thus:

$$\Phi_1 = N_1/(N_1 + rN_2), \Phi_2 = rN_2/(N_1 + rN_2) \quad (28)$$

Now equation (15) can be written as:

$$\Delta G_m = kT[N_1\ln \frac{N_1}{N_1 + rN_2} + N_2\ln \frac{rN_2}{N_1 + rN_2}] + V_1(\delta_1 - \delta_2)^2 \frac{rN_1N_2}{N_1 + rN_2} \quad (29)$$

After differentiation of equation (29) and converting back to the volume fractions, the chemical potential in different phases will be:

$$\mu_1 = kT[\ln\Phi_1 + (1-1/r)\Phi_2 + V_1(\delta_1 - \delta_2)^2\Phi_2^2/kT] \quad (30)$$

$$\mu_2 = kT[\ln\Phi_2 + (1-r)\Phi_1 + V_2(\delta_1 - \delta_2)^2\Phi_1^2/kT]$$

The criteria for obtaining the binodal curves representing the full compatibility of the components is:

$$(\mu_1)_a = (\mu_1)_b \text{ and } (\mu_2)_a = (\mu_2)_b$$

or, in other words, the chemical potential of each component in both phases must be equal. This gives a system of two nonlinear equations whose solution generates the binodals:

$$\ln\Phi_{1a} + (1-1/r)\Phi_{2a} + V_1(\delta_1 - \delta_2)^2\Phi_{2a}^2/kT = \ln\Phi_{1b} + (1-r)\Phi_{2b} + V_1(\delta_1 - \delta_2)^2\Phi_{2b}^2/kT \quad (31)$$

$$\ln\Phi_{2a} + (1-r)\Phi_{1a} + V_2(\delta_1 - \delta_2)^2\Phi_{1a}^2/kT = \ln\Phi_{2b} + (1-r)\Phi_{1b} + V_2(\delta_1 - \delta_2)^2\Phi_{1b}^2/kT$$

Substituting $\Phi_1 = 1 - \Phi_2$ and using a suitable computer program, the system can be solved numerically after Φ_{2a} and Φ_{2b} supplying values for r, V, and T.

The spinodals, or the criteria for the metastable state of the system, can be easily calculated equalizing the first derivation of the chemical potential at constant pressure and temperature to zero:

$$\partial\mu/\partial\Phi \Big|_{T,p} = 0 \quad (32)$$

which gives the following equation:

$$(1-1/r)\Phi_1 + 2\Phi_1\Phi_2V_1(\delta_1 - \delta_2)^2/kT - 1 = 0 \quad (33)$$

Substituting again $\Phi_1 = 1 - \Phi_2$ and supplying the values for r, V_1 , and T, the solution after Φ_2 gives the points for the construction of the diagram for the metastable state.

Kinetics of Crosslinking Of Poly(hydroxyethyl acrylate) With Isocyanates

J. Lavrič, A. Šebenik, and U. Osredkar
Boris Kidrič Institute of Chemistry*

Using absorption and ATR IR, NMR, DSC, and the König pendulum, it was possible to follow the crosslinking of poly(hydroxyethyl acrylate) with isocyanate. It was found that in humidity chambers, urethanes are formed on the surface and throughout the film, while substituted urea are formed dominantly on the surface of the film. In a dry box, only urethanes are formed. The heat of the reaction was 45.0 J/g, and the activation energy was 57.7 for catalyzed and 65.0 J/mol of -NCO groups for uncatalyzed systems. The reaction order was two.

INTRODUCTION

Free hydroxyl groups of poly(hydroxyethyl acrylate) react with isocyanates to form hard three-dimensional products with good mechanical properties. Between the hydroxyl and isocyanate groups urethane bonds are formed. In the presence of water biurets and other substituted urea, and at a higher temperature, allophanates are formed as well. All of the reactions lead to highly crosslinked poly(hydroxyethyl acrylates).¹

The urethane bonds are formed homogeneously throughout the film of poly(hydroxyethyl acrylate), while the substituted urea, due to abundance of water, is formed mainly on the surface of the film. Inside the film, urea formation can take place only after the diffusion of water.

In this work, both reactions and side reactions between poly(hydroxyethyl acrylate) and isocyanates were followed by four different methods: absorption IR, ATR IR, NMR spectroscopies, and DSC. In the case of absorption

IR, the concentration of -NCO groups throughout the film was measured, while by ATR IR, it was possible to measure only the -NCO groups on the surface of the film. With NMR, reactions in the absence of water were studied. By DSC, it was possible to follow the reactions at a higher temperature. The degree of crosslinking was estimated by measuring the hardness of the films using a König's pendulum. The measurements were made at different relative humidities, at different reaction times, at different temperatures of crosslinking, and with different quantities of catalyst used for crosslinking. Activation energies were calculated from parameters dependent on reaction time, and thermograms, rate constants, heat of reaction, and reaction orders.

EXPERIMENTAL

Materials

Poly(hydroxyethyl acrylate) Damacryl 522 [Helios, Domžale, (hydroxyl number 150 mg KOH/g)] and isocyanate Desmodur® N [Bayer (11% -NCO groups)] were used. Zinc octoate p.a. was used as a catalyst.

Procedure

Poly(hydroxyethyl acrylate) and isocyanate were mixed in an equimolar ratio of 1:1. The reactions were run without catalyst, or with 0.2% or with 0.4% of catalyst. For absorption IR measurements, the mixtures were put on NaCl plates, and for ATR IR measurements, on Al foils. The thickness in both cases was about 15 μm . The samples were then put in humidity chambers, at 40% or 80% relative humidity, or in a dry box. In regular time intervals, the IR spectra were recorded on a Perkin-Elmer 1220 spectrometer.

*61115 Ljubljana, P.O. Box 30, Hajdrihova 19, Yugoslavia.

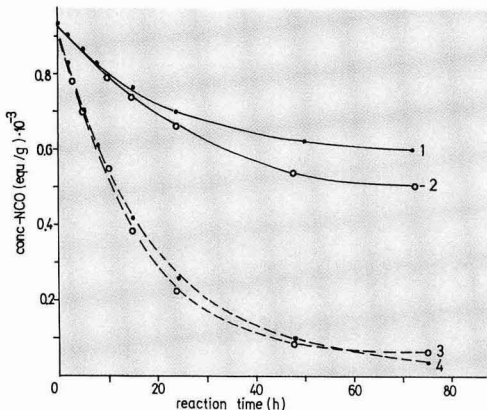


Figure 1—Dependence of concentration of –NCO groups in poly(hydroxyethyl acrylate) films on reaction time: 1—absorption IR, dry box; 2—ATR IR, dry box; 3—ATR IR, humidity chamber; and 4—absorption IR, humidity chamber

For ¹³C NMR measurements, the samples were dissolved in CDCl₃ and recorded on a Varian VXR 300 NMR superconducting magnet at regular time intervals. The catalyzed samples were measured at 20°C while the uncatalyzed were measured at 45°C. All signals in the ¹³C NMR spectra were proton-decoupled. TMS was used as the internal standard.

For DSC measurements, the isocyanate was first precipitated in a dry box with n-pentane, dried, and then mixed with an equimolar quantity of poly(hydroxyethyl acrylate). A percentage (0.2 or 0.4%) of catalyst was added. The mixture was immediately weighed in a DSC pan and hermetically closed. The evolved heat was measured, depending on the temperature range between 30 and 200°C. The rate of heating was 1°C/min. A Perkin Elmer DSC 7 was used.

Catalyzed and uncatalyzed samples were applied to glass plates and then stored in a dry box, and in humidity chambers at 40 and 80% of relative humidity. The hardness of the films was measured in regular time intervals with a König pendulum according to DIN 53157. The pendulum weight was 200 g and the diameter of the steel ball was 5 mm. The time of the oscillation of the pendulum(s) depended on the hardness of the film.

RESULTS AND DISCUSSION

For IR measurements, the signals of –NCO groups at 2270 cm⁻¹, urethanes at 1690 cm⁻¹, and substituted urea at 1650 cm⁻¹ were used. The urethane crosslinking was calculated from the ratio of intensities of signals of –NCO groups and ester groups at 1725 cm⁻¹ of poly(hydroxyethyl acrylate). Meanwhile, the biuret crosslinking was calculated² from the ratio of intensities of –NCO groups and of substituted urea. The initial concentration of –NCO groups in isocyanate was determined by titration. The concentration of –NCO groups in the initial mixture was calculated from the compositions of isocya-

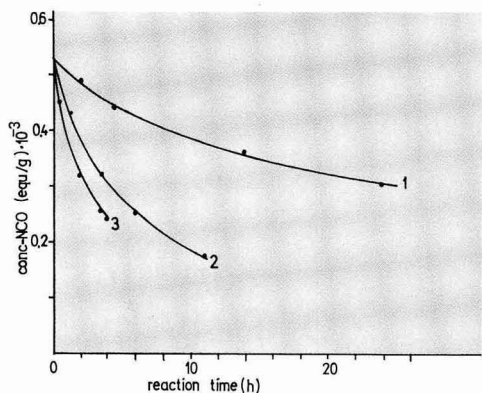


Figure 2—Dependence of concentration of –NCO groups in poly(hydroxyethyl acrylate) on reaction time, NMR measurements: 1—uncatalyzed sample, 20°C; 2—catalyzed sample, 20°C; 3—uncatalyzed sample, 45°C

nate and resin which included the experimental errors of measurements of titration and IR spectroscopy.

The rate of reaction of the –NCO groups depended on the relative humidity. Of the samples kept in a dry box, after 75 hr, only half of the –NCO groups disappeared. Of the samples kept for the same time at 80% relative humidity, 90% of all –NCO groups reacted to form urethane and urea groups. The difference in the course of reaction in the dry box and in the humidity chamber was ascribed to the formation of substituted urea.

The –NCO groups on the surface of the film reacted primarily with water. The concentration of –NCO groups on the surface of the films kept in humidity chambers, measured by the ATR IR technique, was slightly lower compared to the concentration of –NCO groups throughout the films, and measured by the absorption technique due to the reaction with water. The sufficient quantity of water in humidity chambers evidently allows for the reaction of –NCO groups with water throughout the film. The differences were greater for samples kept in the dry box, where practically no water was present (Figure 1).

In ¹³C NMR measurements, the disappearance of signals of –NCO groups at 122 ppm and the formation of urethane groups at 155.9 ppm followed. In the NMR spectra, no evidence of formation of substituted urea could be seen.³ With the integration of the signals of the –NCO groups, the concentration of the groups, depend-

Table 1—Rate Constants of Formation of Urethanes Measured by IR Spectroscopy

IR Technique	Type of System	k _{1 exp} (g/equ.s)
Absorption	uncatalyzed, 20°C	4.2 × 10 ⁻³
Absorption	catalyzed, 20°C	4.5 × 10 ⁻³
ATR	uncatalyzed, 20°C	4.6 × 10 ⁻³
ATR	catalyzed, 20°C	5.0 × 10 ⁻³
Absorption	uncatalyzed, 60°C	126.0 × 10 ⁻³
Absorption	uncatalyzed, 70°C	163.0 × 10 ⁻³
Absorption	uncatalyzed, 80°C	264.0 × 10 ⁻³

Table 2—Rate Constants of the Formation of Urethanes in Solution, NMR Measurements

Samples	Type of System	$k_{1 \text{ exp}}$ (g/equ.s)
Solution in CDCl_3 ...	uncatalyzed, 20°C	1.7×10^{-2}
Solution in CDCl_3 ...	0.4% catalyst, 20°C	9.9×10^{-2}
Solution in CDCl_3 ...	uncatalyzed, 45°C	13.9×10^{-2}

ing on reaction time, was calculated (Figure 2). The reaction was followed until gelation took place.

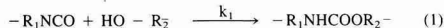
Comparing the results obtained by IR and NMR measurements for the disappearance of -NCO groups, it can be concluded that the reaction in the solution (NMR measurements), is faster than the reaction in the solid state (IR measurements) (Tables 1 and 2). The rate of the reaction depends on the possibility of motion of the macromolecules. In the hard film, the motion of the reactive groups is sterically hindered or even impossible, which decreases the rate of reaction.

Using DSC measurements, it was determined that the reaction started at about 35°C, reached the maximum at about 68°C, and ended at about 130°C. Exact values depend on the quantity of catalyst (Figure 3). The heat of reaction was, in all cases, 45 J/g regardless of the catalyst's concentration.

Film hardness increased with reaction time. The samples from the dry box were less hard than the samples from the humidity chambers. From the results given in Figures 1 and 4, it can be concluded that the biuret crosslinking does not contribute to the hardness of films in correlation to the concentration of -NCO groups.

As mentioned previously, several simultaneous reactions take place. To distinguish them is very difficult. However, since formation of the urethanes and the substituted urea is quantitatively most important, in the first approximation the formation of, for example, alophanates or isocyanurates, can be neglected.

The main reactions are as follows:



The rate of the reactions can be written as a second order equation for urethane and biuret:

$$-\frac{d/\text{NCO}/}{dt} = k_{1 \text{ exp}}/\text{NCO}/ / \text{OH}/ + k_2 / \text{NCO}/ / \text{H}_2\text{O}/ \quad (3)$$

where $k_{1 \text{ exp}}$ represents the experimental rate constant of the formation of all individual urethane reactions and k_2 represents all the biuret reactions.

Since the molar ratio between -NCO and -OH groups was 1:1, the concentration of /NCO/ = /OH/. For reactions in the dry box, where water was not present, the second part disappears and equation (3) can be integrated.

$$\frac{1}{/\text{NCO}/} - \frac{1}{/\text{NCO}/_0} = k_{1 \text{ exp}} t \quad (4)$$

The slope of the line in the plot of $\frac{1}{/\text{NCO}/}$ vs t is the value for $k_{1 \text{ exp}}$. The reaction is of second order up to 40% of conversion of -NCO groups.

A conclusion can be reached from the dependence of the -NCO groups concentration on reaction time. Even

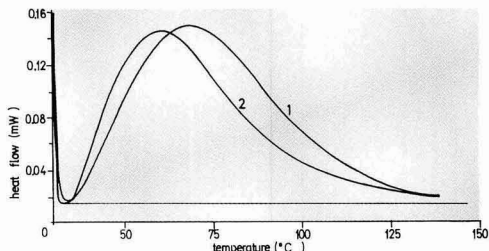


Figure 3—DSC thermogram of crosslinking of poly(hydroxyethyl acrylate): 1—uncatalyzed sample; and 2—catalyzed sample. Heating rate was 1°C/min

after 75 hr of reaction, the curve is an asymptote up to 50% concentration of all -NCO groups. The change of reaction order can be attributed to steric hindrances. The values for $k_{1 \text{ exp}}$ are given in Table 1.

In the humidity chamber, both the urethane and the substituted urea reactions must be taken into consideration. Due to the unknown concentration of water [from equation (3)], it is not possible to calculate the value for k_2 . It can only be assumed that the rate of formation of urethane bonds is equal in both the humidity chamber and the dry box. Therefore, differences in concentration between -NCO groups reacted in the dry box and in the humidity chamber should be ascribed to substituted urea.

The concentration of water which reacts with -NCO groups in the film depends on the relative humidity and on the diffusion of water into film. Since the concentration of water in the humidity chamber in the first approximation is constant, it can be assumed that flow of the water into the film is constant and

$$/ \text{H}_2\text{O}/_{\text{film}} = D / \text{H}_2\text{O}/_{\text{HC}} \quad (5)$$

where D is the proportional diffusion coefficient.

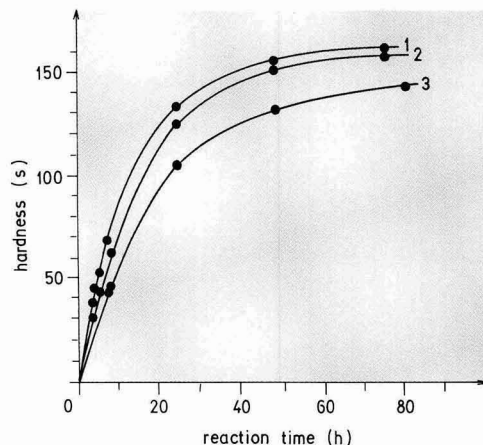


Figure 4—Dependence of film hardness on reaction time of catalyzed film: 1—humidity chamber (80%); 2—humidity chamber (40%); 3—dry box

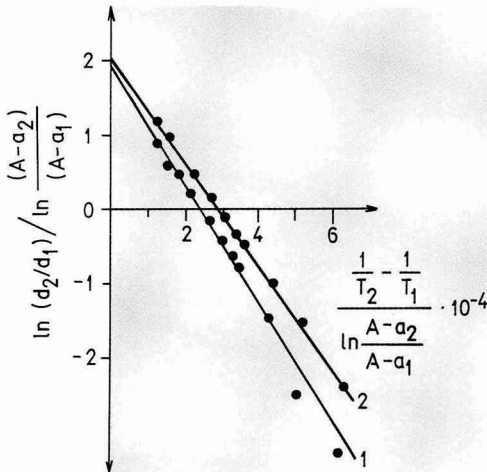


Figure 5—Plots used for calculation of the activation energy and reaction order for crosslinking of poly(hydroxyethyl acrylate): 1—uncatalyzed sample; and 2—catalyzed sample

Therefore, equation (3) for the stationary state can be written:

$$-\frac{d/\text{NCO}/_b}{dt} = K_2 D/\text{NCO}/_{/H_2O/_{HC}} \quad (6)$$

and

$$k_2 D/H_2O/_{HC} = K_2 \text{ exp} \quad (7)$$

where HC is an abbreviation for the humidity chamber, and /NCO/_b the concentration of the -NCO groups reacted as substituted urea.

With the integration of equations (6) and (7) from the plot of $\ln \frac{[NCO]_0}{[NCO]}$ vs t , the slope of the line which is equal to $k_2 \text{ exp}$ can be calculated. Similar to the behavior in the dry box, the slope is linear only up to 40% of conversion. In Table 3, the values for $k_2 \text{ exp}$ are given.

The rate constants for the formation of urethane in solution can be calculated from NMR spectra.⁴ Due to a higher mobility in the solution than in the solid state, the reaction rates in the solution were higher than in the films. The rate constants, calculated from equation (4), are given in Table 2.

Table 3—Rate Constants of Formation of Substituted Urea Measured by IR Spectroscopy

IR Technique	Type of System	$k_2 \text{ exp} \text{ (s}^{-1}\text{)}$
Absorption	uncatalyzed, 20°C	9.3×10^{-6}
Absorption	catalyzed, 20°C	9.6×10^{-6}
ATR	uncatalyzed, 20°C	9.7×10^{-6}
ATR	catalyzed, 20°C	10.2×10^{-6}

At the low heating rate of 1°C/min, the kinetic parameters do not depend on the heating rate.

The activation energies and the reaction order were calculated from the DSC thermograms^{5,6} using the following equation

$$\ln \frac{d_2}{d_1} = -\frac{E}{R} a \frac{1}{\ln \frac{A-a_2}{A-a_1}} + n \quad (8)$$

where A is the total heat of the reaction and a and d the heat and heat flow at the temperature T, respectively. By plotting the left side of equation (8) vs $(1/T_2 - 1/T_1) / \ln(A-a_2/A-a_1)$, the activation energy is obtained from the slope of the resulting straight line; its intersection with the axis ordinate gives the reaction order (Figure 5).

The reaction order of crosslinking of poly(hydroxyethyl acrylate) is two and the activation energies are 65.0 for uncatalyzed and 57.7 kJ/mol for the catalyzed reaction.

CONCLUSION

The results obtained with different methods give a more complex insight into the crosslinking of poly(hydroxyethyl acrylate) with isocyanate. The course of the reaction depends on the relative humidity, the temperature, and quantity of the catalyst.

References

- (1) Saunders, J.H. and Frisch, K.C., *Polyurethanes*, Interscience Publishers, New York, 1963.
- (2) Mondt, J., *Polym. Paint. Col. J.*, 176, 173 (1986).
- (3) Mclennaghan, A. and Petrick, R.A., *Polimeri*, 7, 155 (1986).
- (4) Šebenik, A., *Chroat. Chem. Acta*, 60, 121 (1987).
- (5) Borchardt, H.J. and Daniels, F., *J. Am. Chem. Soc.*, 79, 41 (1957).
- (6) Šebenik, A., Vizovišek, I., and Lapanje, S., *Eur. Polym. J.*, 10, 273 (1974).

Regulatory UPDATE

APRIL 1991

This digest of current regulatory activity pertinent to the coatings industry is published to inform readers of actions which could affect them and their firms, and is designed to provide sufficient data to enable those interested to seek additional information. Material is supplied by National Paint and Coatings Association, Washington, D.C.

The Privacy for Consumers and Workers Act—Sen. Paul Simon (D-IL) and Rep. Pat Williams (D-MT) have introduced legislation that would attempt to prevent potential abuses from secret electronic monitoring in the workplace. The Privacy for Consumers and Workers Act (S.516, H.R. 1218) requires employers to notify workers in writing of any type and frequency of any surveillance that will take place, and specifically prohibits secret monitoring.

According to a 1987 report by the Office of Technology Assessment, the pay and performance of six million office workers were being evaluated by employers using concealed computer monitoring systems.

The report also revealed that computers are used to monitor telephone conversations between workers and customers, "recording the length of time an employee spends handling a business call."

In his statement of introduction, Sen. Simon said that secret electronic surveillance is also used to check production progress of employees who use video display terminals and other computer equipment. He added that this type of constant supervision is harmfully stressful.

Specific provisions of the bill include:

"The promulgation of regulations to implement the act by the Secretary of Labor within six months.

A prohibition on using computer monitoring data as the exclusive basis for individual performance evaluations or for disciplinary action, unless the employee is allowed to review the personal data within a reasonable amount of time.

A prohibition on using the data as the sole basis for setting production quotas; and

Civil penalties up to \$10,000 to enforce the act."

The bills have been referred to the Senate Labor and Human Resources Committee and the House Education and Labor Committee.

The Department of the Environment—Legislation that would elevate the U.S. Environmental Protection Agency (EPA) from an agency to a cabinet level Department of the Environment has been introduced by Sen. John Glenn (D-OH). The bill is a revised version of legislation Sen. Glenn had introduced last year. The new bill addresses the major con-

cerns raised by the administration and reportedly has the backing of the White House.

The legislation has 21 cosponsors and is an agreement worked out between three separate committees with concerns about certain provisions. Last year's contentious issues were provisions which allowed states to impose fines on federal facilities for violating environmental laws and the creation of a Bureau of Environmental Statistics which was to act independently of the Administration. The new legislation designates specific authority for data collection.

There is also a provision for the establishment of a Presidential Commission on Improving Environmental Protection to study the organization on environmental protection within the new Department. Also included in the bill, is a requirement for an international meeting on energy efficiency and renewable energy resources, and the potential establishment of an office within the United Nations to monitor greenhouse gas emissions on a country-by-country basis.

The OSHA Criminal Penalty Reform Act—Sen. Howard Metzenbaum (D-OH) has introduced legislation that would severely penalize violators of work-place health and safety standards. The Occupational Safety and Health Administration (OSHA) Criminal Penalty Reform Act, S-445, targets the most serious violators—those who willfully violate OSHA standards in cases where the violation results in death or serious injury to a worker.

Under current law, the maximum sentence for an employer whose violation ends in the death of a worker is six months. The new legislation calls for a maximum sentence of up to 10 years for a first offense and 1-20 years for a second offense. The legislation also establishes maximum prison terms, for willful violations that result in "serious bodily injury," of five years for a first offense and 10 years for a second offense.

Under this legislation, the fine schedule contained in the Occupational Safety and Health Act would be replaced by the schedule of Title 18, United States Code. Also, an individual corporate officer convicted of a criminal offense would be prohibited from using corporate funds to pay the fines. Rep. Tom Lantos (D-CA) has introduced essentially the same legislation in the House.

The Regulatory Update is made available as a service to FSCT members, to assist them in making independent inquiries about matters of particular interest to them. Although all reasonable steps have been taken to ensure the reliability of the Regulatory Update, the FSCT cannot guarantee its completeness or accuracy.

**Environmental Protection Agency
February 26, 1991—56 FR 7849
Pollution Prevention Strategy**

Action: Notice

In response to a mandate by Congress, EPA has published its comprehensive national pollution prevention strategy. The purpose of the strategy is twofold. First, it is designed to help EPA (headquarters and regional offices) incorporate pollution prevention into its existing regulatory and nonregulatory programs. Secondly, it establishes a voluntary industry program to greater reduce certain toxic substances within a "reasonable time frame."

The strategy takes into consideration comments the agency received on its draft policy statement published in the Federal Register in January 1989. It takes effect immediately as a nonregulatory action, however, EPA will consider public comments on a continuing basis.

For further information, contact Julia Shannon, Office of Policy, Planning and Evaluations (OPPE), Office of Pollution Prevention (OPP), Mail Code PM-219, U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460, (202) 382-2736.

**Environmental Protection Agency
February 21, 1991—56 FR 7134
Burning of Hazardous Waste in Boilers and Industrial Furnaces**

Action: Final Rule

Taking into consideration public comment on rules proposed on May 6, 1987, and subsequent notices on October 26, 1989 and April 27, 1990, EPA has published a final rule regulating air emissions from the burning of hazardous waste in industrial furnaces and boilers. This type of burning has, until now, been exempt from regulation.

The purpose of the rule is to control emissions of toxic organic compounds, toxic metals, hydrogen chloride, chlorine gas, and particulate matter from boilers and industrial furnaces that burn hazardous waste. Additionally, owners and operators are required to comply with the general facility standards that apply to hazardous waste treatment, storage, and disposal facilities. The final rule also requires hazardous waste storage units at regulated facilities to comply with 40 CFR part 264 permit standards. Up until now, burner storage operations at existing facilities were subject only to interim status standards under 40 CFR part 265.

There are several technical corrections to the regulations regarding the loss of interim status for facilities that achieved interim status as of November 7, 1984.

The final rule becomes effective on August 21, 1991.

For further information, contact the RCRA Hotline at (800) 424-9346.

**Environmental Protection Agency
March 6, 1991—56 FR 9315
National Emission Standards for Hazardous Air Pollutants; Announcement of Negotiated Regulation for Equipment Leaks**

Action: Notice of agreement on negotiated regulation

On September 12, 1989, EPA announced the formulation of an Advisory Committee to negotiate issues that would result in a new regulatory approach for fugitive emissions of

VOC's from equipment leaks (pumps, valves, etc.) associated with chemical production process units.

The committee, which included representatives from various affected industry and trade groups, state and local pollution agencies, and an environmental group, agreed in principle to provisions and language of an equipment leak regulation. The committee still must come to a final agreement, and plans to do so after the completion of the preamble for the proposed rule. EPA expects to publish the rule late in 1991 as part of Hazardous Organic National Emission Standards for Hazardous Air Pollutants (NESHAP).

For further information, contact Janet Meyer or Rick Colyer, Standards Development Branch (MD-113), Emission Standards Division, U.S. EPA, Research Triangle Park, NC 27711, (919) 541-5254 or (919) 541-5262,

**Environmental Protection Agency
March 6, 1991—56 FR 9518
Protection of Stratospheric Ozone
Action: Temporary final rule**

EPA has promulgated temporary regulations that revise the Agency's existing regulations implementing the Montreal Protocol on substances that deplete the ozone layer, ratified by the U.S. in 1988, (except for the revisions made by the rule, those regulations remain in effect).

This rule implements the 1991 limits in consumption and production of ozone-depleting chemicals required under Section 604 of the 1990 amended Clean Air Act, so they are consistent with the United States obligation under the Protocol. Each country that ratifies the agreement is required to limit its production and consumption (defined as production plus imports minus exports) of chlorofluorocarbon; CFC-11, trichlorofluoromethane; CFC-12, dichlorodifluoromethane; CFC-113, trichlorotrifluoroethane; CFC-114, dichlorotetrafluoroethane; CFC-115, chloropentafluoroethane; and Halon-1211, bromochlorodifluoromethane; Halon-1301, bromotrifluoromethane; and Halon-2402, dibromotetrafluoroethane, according to a specified schedule.

The rule apportions to companies baseline allowances for the chemicals not previously regulated under the Protocol, but subject to reduction requirements under Section 604 of the Clean Air Act (CFC-13, -117, -112, -211, -212, -213, -214, -215, -216, and -217, carbon tetrachloride and methyl chloroform) based on each company's level of production and import of those chemicals, in 1989. Companies are then allocated 100% of their baseline allowances for carbon tetrachloride and methyl chloroform. For all regulated CFCs and Halons for 1991, 85% of their baseline allowances will be allocated.

As opposed to the protocol which permits exports to be subtracted from consumption until January 1, 1998, Section 601(6) of the Clean Air Act defines consumption as production plus imports minus only exports to other protocol parties. The rule amends the current regulations to the extent that additional consumption allowances will be made only for participating parties. Further provisions include record keeping and reporting requirements for determining compliance with the limits on newly regulated chemicals.

For further information, contact David Lee, Stratospheric Ozone Protection Branch, Global Change Division, Office of Atmospheric and Indoor Air Programs, Office of Air & Radiation, ANR-445, 401 M Street, S.W., Washington, D.C. 20460, (202) 475-7497.

States Proposed Legislation and Regulations

Alaska

Toxic Substances—H. 49 (Ulmer) amends the definition of slow-leaching TBT-based marine antifouling paint.

Arkansas

Hazardous Waste—H. 1667 (McCoy) requires anyone who stores hazardous waste for more than 90 days or disposes of waste in a manner unauthorized by law to publish a notice 90 days before so doing.

Occupational Safety and Health—S. 476 (Pagan) same as H. 1722—relates to hazardous materials and the Public Employee's Chemical Right-To-Know Act; concerns manufacturers and public health.

Arizona

Labeling—H. 2253 (McCune-Davis) requires motor oil, degreasers, varnishes, thinners, oven cleaners, drain cleaners, and various other products listed in law as "environmentally hazardous" to carry labels warning of their dangerous environmental effect; makes it illegal to sell them without the label.

Household Hazardous Waste—S. 1191 (English/Blanchard) provides that before 1992, every county, city, and town with a population of more than 25,000, would have to provide collection programs for household hazardous waste.

Toxic Substances—S. 1259 (Walker/Henderson) provides that interior finish and trim products and structural members could not be used until it was tested for combustion toxicity. Provides for test results to be public information. Requires manufacturers to pay for the tests and establishes that the Fire Marshal may sue for noncompliance.

Environmental Issues—S. 1379 (Blanchard) adds a wide-ranging general-purpose "pollution prevention" chapter to the Environment Code; requires businesses to prevent pollution; imposes fees.

California

Air Quality—A. 157 (Roybal-Allard) authorizes an air pollution control officer to require specified information from a supplier of volatile organic compounds or chemical substances, and requires the supplier to disclose that information. Makes failure to comply a misdemeanor.

A. 405 (Eaves) authorizes air pollution control districts and air quality management districts, with respect to mobile and stationary sources, to establish and implement a system to use emission reductions to offset future increases. Establishes a State Panel to develop guidelines for mobile source offset programs, which the State Air Resources Board will be required to adopt.

Packaging—A. 1423 (Gotch) requires each steel, bi-metal, and aluminum rigid container manufacturer to use specified amounts of post-consumer material in the manufacture of rigid containers.

Toxic Substances—A. 1519 (Lee) enacts the Toxics Reporting and Use Reduction Act of 1991. Makes a statement of legislative intent, would define terms, and would require the Environmental Affairs Agency, in cooperation with each state and local agency which collects hazardous materials data, to establish systems and procedures for collecting, storing, and distributing hazardous materials data to the public and among state and local agencies.

A. 1565 (Lee) imposes an excise tax upon all retailers in an amount equal to \$0.50 per gallon of paint from the sale of

all paint sold at retail in this state. Requires that the monies from the excise tax be deposited in the Lead Based Paint Fund, which the bill would create. Requires that the monies in the fund, upon appropriation, be used for specified purposes.

Household Hazardous Waste—A. 2178 (Brulte) would require a retailer, as of July 1, 1992, to accept unused latex paint and would exempt a retailer, collection location, or intermediate collection location which receives or transports used latex paint from specified requirements concerning the receipt, storage, and transportation of hazardous waste, if certain conditions are met.

Hazardous Waste—S. 428 (Ayala) requires any business which sells or delivers any hazardous material to any person to accept back from that person the empty container used to transfer that hazardous material, if the container has a capacity of five gallons or more.

Colorado

Criminal Law—H. 1057 (Prinster) creates the crime of abusing toxic vapors and provides a penalty. Defines "toxic vapors" and lists the substances which are toxic vapors.

Toxic Substances—H. 1205 (Jones) establishes a statewide goal to reduce use or generation of toxic or hazardous chemicals in Colorado. Requires large-quantity toxic or hazardous chemical users to prepare and file a toxic or hazardous chemical reduction plan which sets forth users goals for reduction of use or generation of toxic or hazardous chemicals, and provides that said plan be updated biennially.

Georgia

Packaging—H. 124 (Dobbs) relates to waste management, so as to provide for the regulation of toxic heavy metals in packaging waste.

Occupational Safety and Health—H. 217 (Brown) deletes provisions of the Public Employees Hazardous Chemical Protection and Right-To-Know Act of 1988 requiring the promulgation and review of the Georgia Hazardous Chemical List.

Hawaii

Household Hazardous Waste—H. 270 (Hiraki) makes an appropriation for the collection and disposal of household hazardous wastes.

H. 1080 (Bainum) relating to household hazardous substance recycling.

H. 1549 (Hiraki) relates to the development of coordinated county and state management of household hazardous waste; makes an appropriation for statewide collections of household hazardous waste.

Illinois

Household Hazardous Waste—H. 114 (Novak) creates the Local Hazardous Waste Collection Program Act; requires the EPA to formulate a pilot plan for the collection of small quantities of hazardous waste from households, farmers, and businesses in the state by March 1, 1992; requires the establishment of a statewide plan by March 1994.

Toxic Substances—S. 76 (Topinka) provides that a household product that is required to bear a warning label because it is likely to be harmful if ingested may not be sold after January 1, 1992 unless it is naturally bitter or contains a bittering agent designed to discourage its ingestion by children.

Hazardous Waste—The Pollution Control Board has proposed regulations to correspond with U.S. EPA amendments during the period of April 1 through June 30, 1990. The proposals pertain to identification and listing of hazardous waste, interim status standards for owners and operators of hazardous waste treatment, storage and disposal facilities, land disposal restrictions, the Resource Conservation and Recovery Act, and standards applicable to generators of hazardous waste. For more information, contact Dorothy M. Gunn, Clerk, Illinois Pollution Control Board, State of Illinois Center, Suite 11-500, 100 W. Randolph Street, Chicago, IL 60601.

Transportation—A proposed Department of Transportation regulation changes the incorporation by reference date for Federal regulations, makes limited changes in the Department of Transportation's regulations to bring them in line with the Federal regulations, pertains to the hazardous materials table and hazardous materials communications. For more information, contact Tom Crawford, Manager, Regulations and Training Unit, Department of Transportation, Division of Traffic Safety, 2300 South Dirksen Parkway, Springfield, IL 62764, (217) 785-3064.

Indiana

Household Hazardous Waste—H. 1311 (Lutz/Bosma) allows the Department of Environmental Management to provide matching grants to solid waste management districts and local units of government for projects involving the collection and disposal of household hazardous waste.

Louisiana

Hazardous Waste—This Department of Environmental Quality/Office of Solid and Hazardous Waste proposal revises the existing procedure being used to identify wastes which are hazardous and replaces it with the toxicity characteristic leaching procedure. For more information, contact David Hughes, Enforcement and Regulatory Compliance Division, Box 44066, Baton Rouge, LA 70804.

Maryland

Packaging—H. 923 (Frosh) prohibits, on or after July 1, 1993, manufacturers or distributors from selling or offering for sale or for promotional purposes any package or packaging component or any product in a package or packaging component to which lead, cadmium, mercury, or hexavalent chromium was intentionally added during manufacture or distribution; specifies exceptions; phases in maximum allowable concentration levels of those toxics incidentally present in packaging materials; settles reporting and regulatory requirements.

Massachusetts

Right-To-Know—H. 1610 (Walrath) provides for a Consumer Right-To-Know Protection Law.

Toxic Substances—H. 2290 (McDonough) prevents lead poisoning through increased lead paint abatement.

H. 2450 (Morrissey) extends the time in which owners of residential premises may remove lead paint.

H. 4930 (Poirier) regulates the lead poisoning prevention and control law.

Household Hazardous Waste—H. 2881 (Hynes) provides for local collection of household hazardous waste in the Commonwealth of Massachusetts.

H. 2888 (Travis) relates to disposal of household hazardous waste.

H. 4864 (Murray) provides for a paint recycling program.

Minnesota

Air Quality—H. 160 (Munger) appropriates funds to the Pollution Control Agency to establish a statewide monitoring system for toxic air pollutants and an inventory of emission sources or probable sources of listed toxic air pollutants and, by January 1, 1993, a list of toxic air pollutants.

H. 314 (Lourey) appropriates \$1.8 million to the Pollution Control Agency to establish, by January 1, 1992, a statewide monitoring system for toxic air pollutants and an inventory of emission sources or possible sources of listed toxic air pollutants and, by January 1, 1992, a list of toxic air pollutants, and rules governing release or emission of such pollutants which will ensure a 50% reduction in emissions by 1998.

Toxic Substances—This Pollution Control Agency proposal specifies the procedures to be used when removing lead paint by abrasive blasting of residences, child care, and school buildings. For more information, contact Gordon P. Anderson, Minnesota Pollution Control Agency, 520 Lafayette Road, N., St. Paul, MN 55155, (612) 296-7667.

Missouri

Right-To-Know—S. 345 (Quick) relates to emergency planning and community right-to-know.

Hazardous Waste—This Department of Natural Resources/Hazardous Waste Management Commission proposal requires hazardous waste generators to submit completed manifests to the Department of Natural Resources within seven days of receipt, rather than every six months as currently required.

This Department of Natural Resources/Hazardous Waste Management Commission proposal establishes standards and requirements that identify hazardous wastes that are restricted from land disposal. For more information about either or both proposals, contact Director, Waste Management Program, P.O. Box 176, Jefferson City, MO 65102.

Montana

Hazardous Waste—This Department of Health and Environmental Sciences proposal adopts federal EPA regulations to achieve parity with the federal regulations; establishes a hazardous waste program equivalent to the federal Hazardous Waste Program already in existence; establishes definitions and sampling methods for toxicity, and PCBs. For more information, contact Roger Thorvilson, Department of Health and Environmental Sciences, Cogswell Building, Capitol Station, Helena, MT 59620.

Household Hazardous Waste—H. 858 (Gilbert) establishes the Statewide Household Hazardous Waste Public Education Program.

New Hampshire

Toxic Substances—H. 630 (Walsh) establishes a committee to study methods of providing assistance to remove lead paint from certain homes.

Household Hazardous Waste—H. 776 (A. Merrill) establishes a household hazardous waste management program and advisory committee and a consumer education program on household hazardous wastes.

New Mexico

Packaging—H. 481 (Picraux) authorizes the State Environmental Improvement Division to promulgate regulations to require packaging to be reusable, recyclable, or made of recyclable materials to reduce the amount of solid waste in landfills; provides that fees may be charged to packagers who do not meet standards.

Nevada

Aerosols—S. 299 (Committee on Taxation) authorizes counties to impose a tax upon the sale of aerosol paint containers.

New York

Hazardous Waste—A. 1794 (Hinchev) provides the state Department of Environmental Conservation with additional authority and means to undertake background review of those engaged or about to be engaged in the management, generation, collection, storage, transportation, or disposal of solid, industrial-commercial, and regulated or hazardous wastes.

Occupational Safety and Health—A. 3092 (Nolan) same as S. 2003 (Onorato)—mandates that employers keep record of use of toxic substances by employee noting which substance is handled or used by which employee.

A. 5987 (Proskin) same as S. 3587—authorizes contents of signs to be posted in each workplace where toxic materials are found and directs the Department of Health to develop posters and information sheets for this purpose.

Environmental Issues—A. 3845 (Hinchev) enacts the multi-media toxic chemical release inventory act. Requires reporting on facilities where toxic chemicals are stored.

Toxic Substances—A. 5739 (Eve) requires the Department of Health to establish a statewide program for prevention, diagnosis, and treatment of lead poisoning in children under six and high risk pregnant women.

A. 5818 (Nadler) same as S. 371—enacts the "Children's Poison Protection Act of 1991" to regulate toxic household products by requiring the inclusion within enumerated toxic household products, a bittering agent which is nontoxic, so as to render the product aversively bitter.

Aerosols—A. 5784 (Wertz) prohibits the possession or sale to persons under 18 years of age, or display other than in a secure cabinet or display, of aerosol paint cans or broad tipped markers.

S. 2369 (Padavan) same as A. 3620—authorizes the New York City Departments of Consumer Affairs, Sanitation, Environmental Protection and Transportation, and the New York City Police Department to issue summons for violations involving the sale of aerosol spray paint cans and broad tipped indelible markers.

Oregon

Packaging—H. 3431 (Stein) prohibits the sale of toxic packages or packing components; establishes exemptions; requires manufacturer or distributor to provide certificate of compliance to purchaser; and permits citizen to request certificate of compliance.

Rhode Island

Toxic Substances—S. 719 (Izzo/Walton) relates to the Rhode Island Lead in the Environment Abatement and Detection Act.

South Carolina

Right-To-Know—S. 635 (Land) enacts the Hazardous Chemicals Right-To-Know Act.

South Dakota

Toxic Substances—H. 1348 (Frederick) allows the dispensing of flammable and combustible liquids from aboveground storage tanks for retail sales.

Texas

Household Hazardous Waste—H. 1581 (Jackson) relates to the inclusion of a household hazardous waste collection program in a local or regional solid waste management plan.

Utah

Household Hazardous Waste—S. 86 (Steele) establishes a task force to study ways to encourage proper disposal of household hazardous waste; directs the efforts of the task force; and provides staffing.

Virginia

Toxic Substances—S. 748 (Schewel) relates to the sale of a residential structure having lead-based paint levels exceeding Uniform Statewide Building code standards.

Vermont

Hazardous Waste—H. 39 (O'Brien) proposes to provide that waste oil, and discarded paint, paint thinner and paint remover, and their respective containers shall not be considered hazardous waste for purposes of their being transported. Prohibits landfilling of paint, paint thinners, paint remover, and their respective containers.

S. 111 (McCormack/Delaney) adjusts the regulation of hazardous waste by decreasing the small quantity generator exemption to 22 lbs per month (10% of the current level), by January 1, 1993, and removes the exemption by January 1, 1994.

Household Hazardous Waste—S. 133 (McCormack/Webster) requires that manufacturers of paint sold in Vermont, develop and finance a system to collect, recycle, reuse, treat, and properly dispose of unused paint.

Washington

Air Quality—This Department of Ecology proposal regulates the discharge of toxic pollutants from new air pollution sources and certain existing air pollution sources. It establishes technology, emission quantification, and health protection requirements for industrial sources of toxic air pollutants. Requires industrial facilities to show that emissions do not exceed set screening levels, or to demonstrate health protection through a second tier analysis health assessment. Requires additional control measures if the cancer risk exceeds 1 in 100,000. For more information, contact Leslie Carpenter, Department of Ecology, 4350—150th, N.E., Redmond, WA 98052.

West Virginia

Hazardous Waste—H. 2876 (Chambers/Grubb) relates to toxics use and waste reduction, liability for toxics damages, and the imposition of a toxics tax.

Wisconsin

Air Quality—This proposed regulation, pertaining to volatile organic compound emissions from process lines eliminates the term "photochemically reactive organic compound," and requires all sources regulated under the rule to control emissions of volatile organic compounds. For more information, contact Robert Eckdale, Bureau of Air Management, P.O. Box 7921, Madison, WI 53707.

Effects of Immersion on the Electrochemical Properties and Water Uptake Of an Epoxy/Mild Steel System

Greg S. Shaw, Charles E. Rogers, and Joe H. Payer
Case Western Reserve University*

Edward A. Cuellar
BP Research†

This paper presents the changes in the properties of a polymer system and its ability to protect steel from corrosion as a function of exposure time and pH. The polymer system was based on Epon® 828 epoxide resin and Versamid® 140 polyamide hardener. These changes are related to the effect of water and the effect of the calcium carbonate filler. Electrochemical impedance spectroscopy, nuclear magnetic resonance, weight gain tests, and x-ray photoelectron spectroscopy were used to evaluate the electrochemical behavior of the system, the absorption of water by the system, and the effect of the calcium carbonate filler on the corrosion protection of the system.

INTRODUCTION

The effect of environmental exposure on the water absorption and protective properties of adhesives and coatings will control the reliability of polymer/metal systems. The objective of this study was to evaluate the changes in the properties of a polymer and its ability to protect steel from corrosion on exposure to an aqueous environment as a function of time and pH. The polymer system was applied as a thin coating in order to facilitate examination. The electrochemical response of the system was evaluated in pH 7, 11, and 14 sodium chloride solution. Because polymers are known to absorb water, the total amount of absorbed water and the form of water within the polymer were also evaluated.

Electrochemical impedance spectroscopy (EIS) was used to evaluate the resistance to corrosion afforded by

the polymer system. Weight gain samples were used to determine how much water was absorbed by the polymer. Nuclear magnetic resonance (NMR) was used to determine the form of the water in the polymer. X-ray photoelectron spectroscopy was used to determine the presence of calcium carbonate at the interface.

EIS is an established technique for evaluating the protective properties of organic coating systems. Studies have ranged from model systems, such as polybutadiene, to complete paint systems.¹⁻³ The general trend observed in the literature is for a steady decline in pore resistance of the coatings upon exposure to electrolyte. Pore resistance is the resistance attributed to the coating on the metal surface; however, it is not simply the bulk resistivity of the polymer. It is also related to surface chemistry and preparation.⁴ In commercial systems, which may contain several layers and be a few hundred microns thick, the coatings retain almost purely capacitive behavior for weeks or even several months. Eventually a mixed capacitive-resistance regime is reached which continues to deteriorate with time.⁵ Other studies have used model systems, that is, noncommercial coatings which are more amenable to study, such as polybutadiene. These systems are often less than 10 μm thick. Such systems display capacitive-resistive behavior from the outset, which degrades rapidly upon exposure to electrolyte.⁴ The coating in the study cited here had an impedance of less than 150 ohms after two weeks exposure. Generally, 1,000,000 ohms is considered the boundary between protective and nonprotective behavior. Coatings with less resistance than this do not provide sufficient corrosion protection.

Several authors have studied the effects of sodium chloride exposure on the impedance properties of unfilled epoxy polyamide coatings. Standish and Leidheiser⁶ noted that the impedance at three hertz fell four orders of magnitude in five days. Scully⁷ also looked at the effects

*Dept. of Material Science and Engineering, 10900 Euclid Ave., Cleveland, OH 44106.
†Warrenssville Heights, OH.

of exposure on epoxy polyamide coatings. His results indicated that such coatings never have properties which can be considered protective. The coatings which were $20 \pm 6 \mu\text{m}$ thick had less than 100,000 ohms resistance at the outset, which fell to less than 1,000 ohms in under six months. Coatings $55 \pm 1 \mu\text{m}$ thick were about one order of magnitude more resistive at all exposure times. None of the experiments presented had a capacitive regime, characterized by a high frequency phase angle near -90° .

Increased resistance, upon exposure to aqueous solutions, has been noted in isolated references. Moreland and Padgett⁸ reported an increase of the impedance of a chlorine containing vinyl coating system after an initial decrease. The impedance decreased for the first one to three weeks, but then increased again over the subsequent several weeks. An underfilm darkening was noted and it was associated with the rise in impedance. Floyd et al.⁹ have also observed this phenomena.

The effects of water on degradation of coatings have received a great deal of attention over the last several years. Leidheiser and Funke¹⁰ have reviewed the literature and presented an interpretation of water disbondment phenomena. They have theorized two mechanisms. The first entails bond rupture by one or a few monolayers of water at the interface. The second is the formation of an aqueous phase at locally unbonded areas of the coating. This aqueous phase creates a stress which mechanically ruptures the bonds at the interface, allowing the disbondment front to advance.

Spadafora and Leidheiser¹¹ used attenuated total reflection FTIR to study water degradation and found that water ingress did not affect the portion of the spectrum attributed to the interfacial bonding. It can be concluded that bond breakage was limited or nil.

Various techniques have been employed to determine the form and amount of water in a polymer coating. Calorimetric and coulometric techniques have been reported which differentiate between bound and clustered water.¹² This study on free polymer films concluded that cluster formation only occurs when the polymer is exposed to aqueous solutions above its glass transition temperature (T_g), and after significant breakdown of the polymer. Their experiments included polycarbonate, polyethylene, polysulfone, and polyvinyl acetate. When exposed at temperatures below T_g the water was only present in the bound state.

Work on polymer coatings has led to a different description of events. Several authors^{13,14} have proposed, from studies conducted at room temperature, that deterioration begins by random uptake of water, followed by establishment of pores normal to the metal surface, and eventually ionic transport. Once ionic paths are established, the corrosion reaction can initiate. This mechanism differs from the mechanism described for free films, in that aqueous phase regions are developed through the coating at temperatures below the T_g . This may be due to electromigration forces or osmotic forces which cannot develop in the absence of a substrate. These pathways may develop at pre-existing defects in the coating.¹⁵

Electrical properties are frequently used as a source of information about water sorption. Several theoretical expressions have been forwarded to explain the dielectric

properties of heterogeneous materials, such as polymer with sorbed water. They have been summarized by Lindqvist.¹⁶ He compared the results of these expressions with both gravimetric data and the empirical Brasher Kingsbury equation:

$$X_v = \frac{100 \log (C_m / C_0)}{\log 80}$$

where:

- X_v = volume percent water,
- C_m = capacitance at any arbitrary time, and
- C_0 = capacitance at time zero.

This empirical equation gave much better correlation with the gravimetric data than any of the theoretical treatments.

NMR has been used to study permeation of solvents in polymer matrices.¹⁷ NMR spectroscopy is useful in determining the state of water in the polymer. Tightly bound water has a very short relaxation time; the rigid nature of the bond means that the spin energy can be dissipated very rapidly. Free water has a much longer relaxation time. This difference is manifested in the spectrum as a difference in the width of the peak; though the relative position remains unchanged. The spectrum is displayed as a function of frequency; the short relaxation time corresponds to many hertz, or a wide peak. The long relaxation time of the free water corresponds to a very small number of hertz—a narrow peak.

EXPERIMENTAL PROCEDURE

Electrochemical Impedance Spectroscopy

Specimens for electrochemical impedance testing were prepared at BP Research (Warrensburg Heights, OH). Steel sheet stock was GM-16-05E, 1010 aluminum killed cold-rolled steel. Disks (50mm diameter) were punched from the sheet stock, leaving the surface finish undamaged. The specimens were washed in a dilute mixture of Alconox[®] detergent in an ultrasonic cleaner, ultrasonically rinsed in distilled water to remove the detergent, and then ultrasonically rinsed in acetone to remove any residual oils and any of the remaining water.

One hundred parts Epon[®] 828 with 30 parts calcium carbonate, and 130 parts Versamid[®] 140 were each diluted with methyl ethyl ketone in a 1:1 ratio by weight in order to reduce the viscosity and improve spinnability. The two mixtures were then combined in equal parts by weight. The final mixture was applied dropwise onto the metal disks already spinning, on a Headway Research photoresist spinner, at 6,000 rpm. Ten drops were applied in this manner, and then the coating was allowed to cure for 20 min in an oven at 90°C. This process was repeated six times until a coating of 25 ± 1 micron was achieved (as measured by an induction coating thickness probe). Similar samples were prepared without calcium carbonate filler.

Alconox is a registered trademark of Alconox, Inc., New York, NY.

Epon is a registered trademark of Shell Oil Company, Houston, TX.

Versamid is a registered trademark of General Mills Chemicals, Inc., Minneapolis, MN.

The coated disks were mounted as cells using 25mm 'O'-ring joints. The coated disks were mounted at the bottom of the cell. Tests were performed over a seven month period using solutions of five percent sodium chloride adjusted to pH 7 and pH 11, and one normal sodium hydroxide with five percent sodium chloride (pH ~14). Platinum sheet was the counter electrode; a saturated calomel electrode was the reference. The calomel electrode was capacitatively coupled to a platinum wire, also in the solution. This was done to avoid anomalous phase shift at high frequency which may occur due to the inherently slow response time of the calomel electrode.

Spectra were obtained using a Solartron model 1250 Frequency Response Analyzer and a Princeton Applied Research model 273 potentiostat. Experiments were conducted at the rest potential with a perturbation signal of 10mV. The potentiostat input impedance was controlled such that the cell impedance was at least twice as large, but not more than $50\times$ larger than the input impedance. When the potentiostat was at the largest input impedance value, this condition could not always be maintained. Deviating from this condition, especially at high frequency, led to anomalous capacitance or inductance.

Spectra were recorded immediately upon exposure, during the second hour of exposure, after one day, one week, one month, and monthly after that for an additional six months.

Nuclear Magnetic Resonance

Specimens for NMR spectroscopy were prepared from 100 parts Epon 828, 130 parts Versamid 140, and 30 parts calcium carbonate filler. The adhesive mixture was used to glue four alumina sheets, 25 mm \times 25 mm \times .625 mm, together into a sandwich structure. Bond thickness was maintained at .125 mm by including a small quantity of glass beads in the adhesive mixture. The sandwiches were then cut to a width of 3 mm using a low speed diamond cutoff saw. The final samples were 25 mm \times 3 mm \times 2.9 mm. Alumina was used in place of steel because ferromagnetic materials are incompatible with NMR.

NMR spectra were recorded using a Bruker MSL400 spectrometer. Spectra were recorded before exposure at both ambient temperature and at 50° C, after 12 weeks exposure to sodium chloride electrolyte, and again after drying the samples. A spectrum of pure water also was recorded.

Weight Gain Tests

Weight gain tests were conducted on the polymer, without a metallic substrate, in order to avoid ambiguity due to metal loss or corrosion product formation. The epoxy was prepared as previously stated and cast into 25 mm cylindrical molds. After curing, the cylinders were cut into thin discs using a metallographic saw. The remnants of the mold were then removed. The samples were weighed, using an electronic balance, to the nearest 1 mg. Two samples were then immersed in each of three solutions: distilled water, 5% sodium chloride pH 7, and 1N sodium hydroxide 5% sodium chloride. The samples were weighed periodically over 15 weeks. Before weighing, the samples were removed from the solution with

tweezers, rinsed with distilled water, and blotted dry to remove any excess water. After the 15-week exposure, the samples were weighed, dried in an oven, and reweighed.

X-Ray Photoelectron Spectroscopy

X-ray photoelectron spectroscopy was performed on the impedance specimens after the cells were disassembled and the coatings removed. The metal surface was analyzed for steel corrosion products, polymeric residue, and calcium carbonate. Spectra were recorded using a Perkin Elmer PHI 5400 electron spectrometer with a spot size of 1mm \times 1mm.

Representative solutions were tested for the presence of calcium ions by adding drops of 5M sodium carbonate solution. Calcium ions were revealed by the presence of milky precipitate of calcium carbonate in the solution. This test only gives a qualitative indication of the presence of calcium.

RESULTS

Electrochemical Impedance Spectroscopy

The EIS results are summarized in *Figure 1*. At the outset of each of the tests, the values are all well above the minimum value considered to be protective. Two different trends are evident. For the specimens exposed to the neutral and mildly alkaline (pH 11) environments, the low frequency impedance decreased over the first hours of exposure and then began to increase monotonically over many months. For the sample exposed to strongly alkaline conditions, resistance decreased immediately upon exposure and continued to degrade throughout the length of the test, indicating degradation of the coating.

The sample exposed to pH 14 electrolyte initially showed decreasing impedance as well, but this did not reverse as in the other exposures. In the fourth month the impedance dropped quite rapidly. By the fifth month, corrosion spots had begun to appear under the coating and

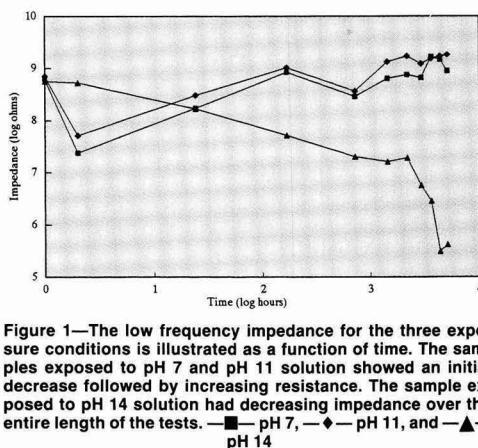


Figure 1—The low frequency impedance for the three exposure conditions is illustrated as a function of time. The samples exposed to pH 7 and pH 11 solution showed an initial decrease followed by increasing resistance. The sample exposed to pH 14 solution had decreasing impedance over the entire length of the tests. —■— pH 7, —◆— pH 11, and —▲— pH 14

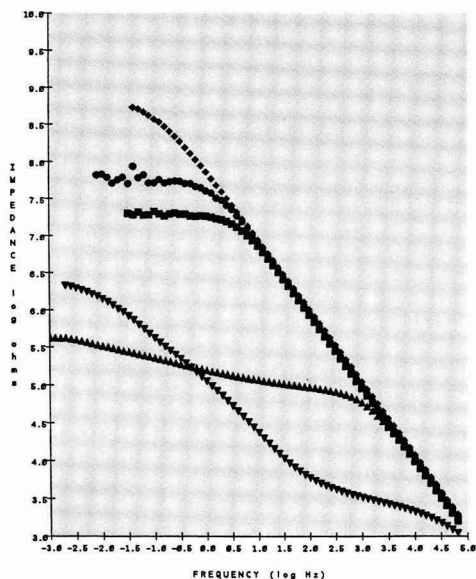


Figure 2—Impedance behavior of the sample exposed to pH 14 solution. The pattern of behavior changed during the fifth month, concurrent with the appearance of corrosion spots. ♦ — Two hours, ● — one week, ■ — three months, ▼ — five months, and ▲ — seven months

the impedance spectrum looked radically different as can be seen in *Figure 2*. This persisted for two months, until the corrosion spots stopped growing and the impedance curve returned to the shape indicating capacitive-resistive behavior, but at a level below that which is considered protective.

The initial impedance of the unfilled coatings was approximately equal to the initial impedance of the filled coatings. However, the unfilled coatings all degraded very rapidly when exposed to the various environments. This is in good agreement with the work of other authors which has been noted. The sample exposed to the highest pH solution degraded faster than the sample exposed to the moderate pH and the sample exposed to the neutral sodium chloride solution. After two weeks, none of the coatings could be considered protective.

Precipitation Tests

The precipitation test revealed the presence of calcium ions in the solutions of pH 7 and 11, but not in the solution of 1 N NaOH when tested after seven months exposure to the samples. The solutions from the tests on unfilled coatings showed no calcium ions.

X-Ray Photoelectron Spectroscopy

All of the coatings, filled and unfilled, delaminated quite readily from the substrates after exposure. They were removed by scoring the specimens with a razor blade and lifting the coating with tweezers. However, if

the samples were allowed to dry, the coating once again became brittle and strongly adherent.

After the coatings were removed, x-ray photoelectron spectroscopy indicated the presence of calcium on the metal surface for those samples exposed to the pH 7 and pH 11 solution, but not on the surface of the sample exposed to 1 N NaOH, nor on the surface of the unfilled coatings. The only source of calcium was the calcium carbonate filler. This indicates that calcium carbonate did migrate from the filler in the bulk of the polymer to the interphase.

Weight Gain Tests

The results of the weight gain tests are displayed graphically in *Figure 3*. The total amount of absorbed water (as a percentage) is dependent on electrolyte composition. *Table 1* shows the weight gain as a function of thickness. It can be seen that the time to saturation is a stronger function of the thickness than of the electrolyte. In other words, the thinner samples reached saturation first, but the steady state value was dependent only on the solution.

Nuclear Magnetic Resonance

NMR was used to determine the form of the water within the polymer. *Figure 4* is the proton NMR spectrum of the cured epoxy adhesive before exposure to the electrolyte. It can be seen that there is little spectral detail. Another spectrum was recorded at higher temperature (50° C) to allow more freedom of motion within the structure, in an effort to reveal peaks which may not appear in the room temperature spectrum. No further spectral detail was observed, indicating that the polymer remains rigid. *Figure 5* shows the spectrum of the adhesive after being exposed to electrolyte for a period of 10 weeks. The spectrum of the electrolyte alone is shown in *Figure 6*. The peaks are in the spectral region assigned to water. Although the spectrum from the electrolyte alone has the same relative position in the spectrum, it has a full width at half maximum of only 24 hertz, as compared to the polymer with absorbed electrolyte which has a very broad peak, 400 hertz. There is no detectable difference between the spectrum taken after oven drying and the

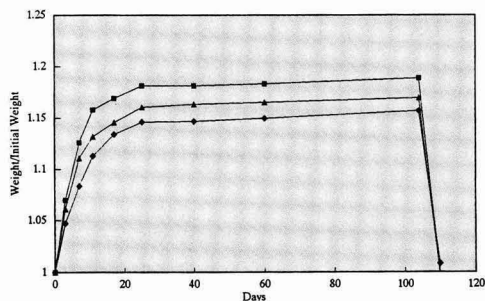


Figure 3—Weight gain of polymer samples exposed to different electrolytes. The steady state weight gain is dependent on the immersion solution. —■— NaCl, —♦— NaOH, and —▲— H₂O

Table 1—The Effect of Thickness on the Time to Saturation for Epoxy Polyamide Immersed in Sodium Chloride Electrolyte and Distilled Water

Solution	Initial Weight (grams)	Normalized Weights					
		Day 1	Day 3	Day 7	Day 11	Day 17	Day 40
H ₂ O	.676	1.00	1.084	1.146	1.160	1.158	1.160
pH 7	.781	1.00	1.086	1.147	1.173	1.177	1.186
pH 14	1.042	1.00	1.048	1.086	1.118	1.135	1.144
pH 14	1.241	1.00	1.047	1.081	1.107	1.132	1.149
pH 7	1.324	1.00	1.054	1.104	1.143	1.162	1.177
H ₂ O	1.695	1.00	1.038	1.074	1.104	1.133	1.167

At the outset, the weight gain is only dependent upon sample thickness (directly proportional to initial weight). As time goes on, the weight gain is dominated by the immersion electrolyte.

spectrum obtained before exposure. Therefore, it was assumed that the water absorption was a reversible process.

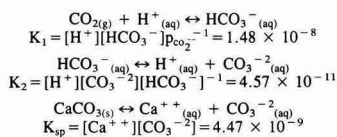
DISCUSSION

Water Content

The total amount of water absorbed by this polymer system is quite large, nearly 20%. The water is absorbed quite rapidly at first, averaging about 1 wt% per day for the first 10 days, and then more slowly as the system approaches saturation. The rate of water uptake is governed by the thickness of the initial sample. The total amount gained, however, is a function only of the solution in which it has been immersed. After 15 weeks exposure, the samples were still slowly gaining weight.

The samples exposed to the neutral sodium chloride solution absorbed the greatest percentage of water, the samples exposed to distilled water were next, and the samples exposed to 1 N NaOH absorbed the least amount of water. It is believed that the solubility of the calcium carbonate filler is responsible for this difference. If a small amount of the calcium carbonate is dissolved and allowed to migrate or diffuse within the polymer, then fresh calcium carbonate is exposed, which can act as a getter for more water. The solubility of calcium carbonate is highly dependent on pH.

The solubility of calcium carbonate was calculated based on thermodynamics. The calculation was performed under the assumption that the solutions were saturated with carbon dioxide from the atmosphere. The following equations of chemical equilibrium were used in determining the calcium solubility:



Calculation of the solubilities indicates that there is a vast difference in solubility as a function of pH. That

difference is 14 orders of magnitude between the pH 7 and pH 14 solutions. The other key factor is that the dominant dissociation product changes. This calculation and observation are in agreement with Pourbaix.¹⁸ Although there is also a significant solubility difference between the pH 7 and pH 11 solutions, they have the same dominant dissociation product, bicarbonate ions. In pH 14 solution, the dominant dissociation product is the carbonate ion.

That this is significant is born out by the results of the precipitation tests. When aqueous sodium carbonate was added to the pH 7, pH 11, and distilled water solutions, milky clouds formed which then disappeared, indicating that the solution contained calcium ions. That the clouds disappeared indicates that the concentration of calcium ions was less than the solubility limit. When the sodium carbonate was added to the solution containing 1 N NaOH no such reaction occurred.

In neutral and moderately alkaline solution, ion pairs can be hydrated and can begin to diffuse away from the carbonate particles, exposing fresh molecules to the solution which can then be hydrated themselves, increasing the amount of water which can be absorbed as a direct result of the presence of the calcium carbonate. In the caustic environment, however, the ion pairs do not dissociate or leave the surface, restricting the amount of water which can be associated with the presence of the carbonate.

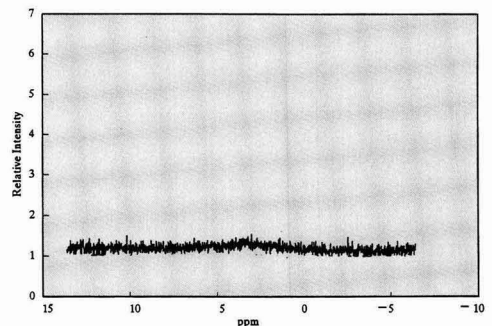


Figure 4—1-H NMR spectrum of unexposed polymer sample. There is essentially no spectral detail because the polymer is very rigid

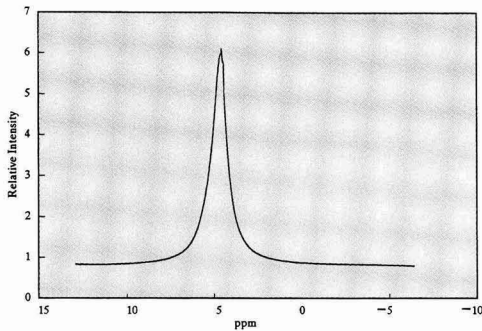


Figure 5—1-H NMR spectrum of the same sample after exposure to pH 7 sodium chloride solution. The single broad peak is in the spectral region assigned to water. The full width at half maximum is 1 ppm

The water causes the polymer to become highly plasticized. After soaking, the samples can be easily bent and unbent without doing any damage—they are quite soft. Before being soaked and after being dried, the samples are stiff and brittle. The plasticization is reversible.

Upon drying in an oven, not all of the samples returned to their pre-exposure weights. The samples exposed to distilled water returned nearly to the same weight at which they began. The samples exposed to the 1 N NaOH retained more water than those exposed to the distilled water, but not quite as much as those exposed to the pH 7 solution. It is believed that some sodium chloride remains in the samples after drying. Also, the remaining salt, being hydrophilic, retains some water with it. The reason that the samples exposed to the pH 7 solution retained the most weight is that the calcium carbonate which dissolved retained some of its water of hydration.

The form of the water within the polymer was determined. As noted in the Introduction, moieties which are free to move in their local surroundings have long relaxation times after being aligned by a NMR spectrometer. Since hertz (the abscissa scale for NMR spectra) is inverse time, this corresponds to a very narrow peak. Conversely, bound moieties act like a strong spring after being aligned, and hence have a short relaxation time; and, by the same argument, a broad peak.

The spectrum from the water in these specimens had a very broad peak, 20 × broader than the peak observed in this study for bulk water. Clearly then, the water is tightly bound within the polymer system. A single monolayer on the filler surface would only account for approximately one one-hundredth of a wt% of water. The calculation is based on the following assumptions: (1) the filler particles are spherical and have a diameter of one micron, (2) the calcium carbonate is in the calcite form (specific gravity is 2.71), and (3) a water molecule covers an area of 10 square angstroms.

Dissolution of the calcium carbonate could account for the differences in the steady state weight of the samples. The calcium carbonate molecule is hydrated by six water molecules. An additional 2 wt% would only necessitate the dissolution of 16 wt% of the original calcium carbon-

ate. It should be noted that more than six water molecules would be necessary to hydrate a calcium carbonate ion pair. It is known that some of the calcium carbonate actually leaves the system (by the precipitation test). It can be assumed that these two effects: migration out of the polymer, and underestimating the hydration number of calcium and carbonate/bicarbonate ions, approximately offset one another and that 16% dissolution is a reasonable estimate. This dissolution would only require a particle diameter change of about six percent.

Electrochemical and Corrosion Protection Properties

The electrical properties of the unfilled coatings are consistent with most of the results reported in the literature. The impedance of coating systems generally decreases with time. Epoxy polyamide coatings especially have been shown to be ineffective, as discussed in the Introduction. The unfilled coatings underwent severe degradation in a short period of time.

Those samples which had calcium carbonate filler, however, had significantly different behavior. The samples exposed to pH 7 and pH 11 solution had some degradation over the first hours of exposure, but the impedance recovered and actually increased over the seven months of the test. However, the samples exposed to 1 N NaOH solution degraded from the outset. They did not show recovery behavior as the other filled samples had. After several months, corrosion spots began appearing under the coatings exposed to strong alkaline solution. It should be noted, however, that the degradation of these samples was not as rapid as the unfilled sample.

The calcium carbonate controls the deleterious effects of ambient or cathodically produced hydroxyl ions by dissolving in slight amounts and migrating to the interface where it acts as a buffer. The mildly alkaline solution below the coating may then act to passivate the steel, further controlling corrosion. Because calcium carbonate is stable in highly alkaline conditions, diffusing hydroxyl ions from the 1 N NaOH exposure suppresses or eliminates the dissolution of the calcium carbonate, allowing

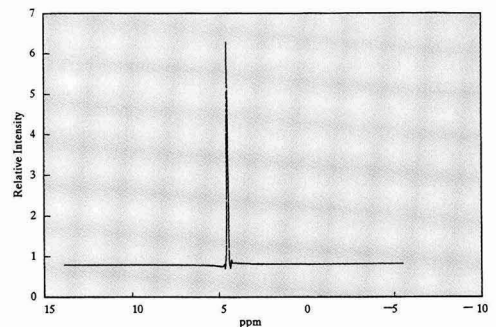


Figure 6—1-H NMR sample of the pH 7 sodium chloride electrolyte. The peak is in the same position as the peak in the spectrum of the exposed polymer. The full width at half maximum is 0.048 ppm

the hydroxyl ions to degrade the polymer. Furthermore, the strong alkaline solution below the coating may activate the steel surface, causing corrosion.

The carbonate may also act as a getter for diffusing water, tying it up so that it can not adversely affect the properties. The swelling associated with this may then block micropores. This effect is consistent with the increase in the pore resistance of the samples exposed to neutral and moderately alkaline solutions. That this effect is not seen in the high pH solution can be explained in terms of the dissolution behavior previously described. The carbonate may be tying up the water on its surface as in the other cases, but it is not dissolving, so no more water can be tied up. Furthermore, the hydroxyl is causing damage at a faster rate, resulting in an overall lowering of the resistance.

Both the gettering of water and the buffering effect may be operating simultaneously. The calcium carbonate may hold the water until enough has accumulated to hydrate a pair of ions. When that has occurred, the pair can migrate through the coating. Once at the interface, they can act as a buffering agent. Such an explanation also has been used to explain the higher weight gain of the samples exposed to neutral solution, as compared to those exposed to sodium hydroxide solution.

There is direct evidence for the dissolution of the calcium carbonate. The precipitation tests indicated dissolution in each of the cases where the (previously) enigmatic behavior had been observed. There is further evidence for dissolution and the buffering mechanism. After the seven month exposures, the cells were disassembled and the coatings stripped off as described. X-ray photoelectron spectroscopy was performed on the samples. Relevant to this discussion, is the fact that there was calcium present in the spectra from the samples exposed to the pH 7 solution and those exposed to the pH 11 solution, but not those exposed to the 1 N NaOH solution. Thus, there is direct evidence of calcium carbonate migration to the interfacial region in the pH 7 and pH 11 solutions, but no migration in the pH 14 solution.

CONCLUSIONS

The effect of pH on the electrochemical properties of a calcium carbonate filled epoxy polyamide adhesive has been shown. It was determined that the excessive amount of water absorbed by the polymer and the calcium carbonate filler dominate the electrochemical properties. The calcium carbonate dissolves when the samples are exposed to pH 7 and pH 11 solution, but not when exposed to pH 14 solution. This results in larger weight gain in the pH 7 and pH 11 solutions than in the pH 14 solution. It also results in very high impedance over many months for the coatings exposed to pH 7 and pH 11 solution. The high impedance may be due to the formation of a blocking layer (although such a layer could not be visually identified), by causing the polymer to swell, or by passivating the underlying steel. The samples exposed to the pH 14 solution degraded much more rapidly.

The total amount of water within the polymer is quite large, nearly 20%. The kinetics of its ingress are only dependent on the initial thickness of the sample, but the

total amount absorbed is dependent on the electrolyte in which the sample has been immersed. Dissolution of the calcium carbonate in neutral solution has been shown to be the reason why the samples in neutral solution absorbed more water than the samples exposed to strongly alkaline solution. The form of water in the polymer was also determined. It was found that the water was tightly bound in the polymer, as opposed to clusters of free water.

The electrochemical properties of the unfilled coatings are consistent with those previously reported in the literature for epoxy polyamide coatings. The filled coatings, however, behaved radically differently. The samples exposed to strongly alkaline solution degraded similarly to those in the literature, but much more slowly. Those samples exposed to the pH 7 and pH 11 solution actually had increasing impedance after a short initial decline. This was shown to be a result of the gettering of the water by the calcium carbonate, reducing the total amount of water capable of forming an electrolyte phase at the interphase, and, also due to the buffering effect of the calcium carbonate at the interphase. The sample exposed to the 1 N NaOH did not show this effect because the solubility of calcium carbonate in strong basic solutions is so limited. It behaved more like the unfilled coatings.

Evidence from precipitation tests and by x-ray photoelectron spectroscopy was presented which showed that the calcium carbonate dissolves and migrates to the interface when the samples were exposed to neutral or moderately alkaline solution, but not when exposed to strong alkaline solution. This was justified by thermodynamic solubility calculation.

ACKNOWLEDGMENTS

This work was supported by the Center for Adhesives, Sealants, and Coatings at Case Western Reserve University. Materials for these experiments were provided by Lord Corporation, Erie, PA. Specimens were prepared and impedance tests were conducted at BP Research, Warrensville Heights, OH. NMR was performed at the Major Analytical Instruments Facility at Case Western Reserve University. Mr. Shaw was partially supported by a fellowship from the Whirlpool Corporation.

References

- (1) Leidheiser, H., *Corrosion*, 39, No. 5 (1983).
- (2) Narain, S., Bonanos, N., and Hocking, M.G., *J. Oil & Colour Chemists' Assoc.*, 66, 48 (1983).
- (3) Hubrecht, J., Vereecken, J., and Piens, M., *J. Electrochem. Soc.*, 131, 2010 (1984).
- (4) Kendig, M., Mansfield, F., and Tsai, S., *Corrosion Sci.*, 23, 317 (1983).
- (5) Feliu, S., Utrilla, S., and Morcillo, M., "Marine Corrosion Fouling," 1, Sixth International Congress of Marine Corrosion, p 417, 1984.
- (6) Standish, J.V. and Leidheiser, H., in "Corrosion Control By Organic Coatings," Leidheiser, H. (Ed.), NACE, 1981.
- (7) Scully, J.R., "Electrochemical Impedance of Organic Coated Steel: Correlation of Impedance Parameters with Long Term Coating Deterioration," Navy Report DTRC/SME-86/108, April 1988.
- (8) Moreland, P.J. and Padget, J.C., in "Polymeric Materials for Corrosion Control," ACS Symposium Series #322, Dickie, R.A. and Floyd, F.L. (Eds.), American Chemical Society, 1986.

- (9) Floyd, F.L., personal communication, October 1988.
 - (10) Leidheiser, H. and Funke, W., *J. Oil & Colour Chemists' Assoc.*, 70, 121 (1987).
 - (11) Spadafora, S.J. and Leidheiser, H., *J. Oil & Colour Chemists' Assoc.*, 71, 276 (1988).
 - (12) Johnson, G.E., Bair, H.E., and Anderson, E.W., in "Corrosion Control By Organic Coatings," Leidheiser, H. (Ed.), NACE, 1981.
 - (13) Leidheiser, H. and Kendig, M.W., *Corrosion*, 32, 69 (1976).
 - (14) Touhasent, R. and Leidheiser, H., *Corrosion*, 28, 435 (1982).
 - (15) Gowers, K.R., Hepburn, N.J., Sussex, G.A.M., and Scantlebury, J.D., *Materials Sci. Forum*, 8, 289 (1986).
 - (16) Lindqvist, S.A., *Corrosion*, 41, 69 (1985).
 - (17) Weisenberger, L.A. and Koenig, J.L., *J. Polymer Sci., Polymer Lett. Ed.*, accepted for publication.
 - (18) Pourbaix, M., "Lectures on Electrochemical Corrosion," translated by Green, J.A.S., Plenum Press, New York-London, 1973.
-

Substrate Factors Affecting The Performance of Organic Coatings On Steel Sheet Surfaces

Bruno M. Perfetti
USX Corporation*

The typical responses of carbon steel and coated steel sheets to coating processes are discussed in terms of the characteristic surface variables which apply to each of these materials. Steel sheet products are normally coated or painted for purposes of protection or decoration. The coatings used for a particular application are selected on the premise that the sheet surfaces will be receptive to the coating and, otherwise, compatible with it to assure the suitable performance of the resulting coated system. When the coated or painted surfaces fail to meet the durability and protective qualities expected of them, it is usually because the surfaces were not in a suitable condition for coating. This report reviews the various substrate factors which affect the adherence and corrosion properties of the painted sheet system. The discussions include comments on the effects of surface composition, preparation, and pretreatments, and the responses of the organic-coated sheets to various conditions of exposure and service.

INTRODUCTION

Steel flat-rolled products as a class include a broad range of hot-rolled and cold-rolled low-carbon sheet and strip grades, numerous high strength-low alloy sheet grades, and a variety of coated sheets bearing several different nonferrous metallic coatings (see *Table 1*). Most of these products are generally available in commercial quality (CQ), drawing quality (DQ), drawing quality-special killed (DQSK), and various interstitial-free or fully stabilized (FS) steel grades and in various surface finishes.

Fortunately, the unique metallurgy of these various products within a specific class of materials does not change their response to a given cleaning, treating, and painting or plating process unless there is a surface anomaly which interferes with the chemistry of some phase of the process. Thus, the effects of treating and finishing operations on steel sheets are usually predictable and controllable once the typical characteristics of these products are properly understood.

The surfaces of most materials, including steels, are dynamic rather than static entities and are thus constantly undergoing chemical change unless extreme measures are taken to prevent such changes. Steel surfaces characteristically are interacting with their surrounding environ-

Table 1—Classifications of Steel Sheet Products

Carbon and High Strength-Low Alloy Sheets

Hot-rolled sheet, as-rolled or pickled and oiled
Cold-rolled sheet, various grades (CQ, DQ, DQSK, and FS), various tempers, and finishes

Coated Steel Sheets

Hot-dip galvanized sheet, variously spangled and treated
Electrogalvanized sheet, various finishes
Electrocoated-alloyed zinc sheet, various alloys, various finishes
Galvannealed sheet
Aluminum-coated sheet
Galvalume™ sheet
Galfan™
Terne-coated sheet

Tin-Mill Products and Prepainted Sheets

Tin-mill products
Blackplate
Tinplate
TFS (Cr/CrO₂-coated blackplate)
Prepainted HRS and CRS
Prepainted coated-sheets

Presented at the 68th Annual Meeting of the Federation of Societies for Coatings Technology, in Washington, D.C., on October 29, 1990.

*USS Div., 4000 Tech Center Dr., Monroeville, PA 15146.

Table 2—Properties of Principal Interest in Assessment of Performance of Organic Coatings on Steel Substrates

Adherence of coating
Moisture and corrosion resistance
Coating film quality and cure (where applicable)
Color, gloss, and reflectivity
Abrasion and wear resistance
Hardness and mar resistance
Fabrication and handling resistance
Weathering resistance
Chemical and stain resistance

ments, and the state of dynamic equilibrium which exists at any instant on a steel surface will shift to accommodate the changes in the surroundings as these changes occur. The sorption and desorption of water vapor and gases is a typical example of such occurrences. To the extent that the changes are reversible, they are, in effect, normal states of the steel surfaces and the surfaces will respond as expected to the preparative and coating practices to which they are subjected. However, when any condition develops which substantially alters the normal state existing at the steel surface, then that surface may well become entirely intractable to treatment and organic coating operations to which comparable surfaces were known previously to be entirely compatible. The commentary to follow is intended to address these considerations and present a view of the subject from the perspective of the properties of the steel substrate.

GENERAL CHARACTERISTICS OF STEEL SURFACES WHICH INFLUENCE COATING ADHERENCE AND CORROSION RESISTANCE

Finished steel sheet surfaces, for practical purposes, consist of a profusion of mixed oxides and hydrates, traces of metallic fines, oils and other carbonaceous materials and salts, and various residues of other compounds remaining from prior processing of the steel sheet. Non-ferrous-metallic coated steel sheet surfaces will also carry these same constituents except that the oxides and hydrates will be those of the coating metal rather than those of iron. These surface constituents are superimposed on a macroscopic surface profile, the geometry of which is determined by the various mechanical parameters imposed by the rolling, annealing, deformation, and/or coating processes to which the sheets were subjected beforehand. Thus, it is this complex matrix of materials and textures that is the true surface being dealt with in the preparative and coating operations employed with steel products. This is also the type of surface being addressed in the assessment of the property of steel sheets broadly referred to as paintability in the discussions to follow.

Paintability of steels is essentially assessed in terms of two principal properties, the paint or coating adherence and the corrosion resistance of the coated product (see Table 2). Only if these two properties are adequate for a particular application are the numerous secondary characteristics of the painted product important. The latter may include factors such as appearance, color, gloss, reflectivity, fabricability, chemical resistance, etc., but, in all cases, these complimentary requirements presuppose an inherently satisfactory paint adherence and corrosion resistance for the system. In any case, both adherence and corrosion resistance are properties as critically dependent on the surface parameters of the steel as they are on the characteristic properties of the coating vehicles of the organic coatings applied to it.

Types of steel sheets and their response to organic coating processes

TYPES OF STEEL SHEETS AND THEIR RESPONSE TO ORGANIC COATING PROCESSES

Hot- and Cold-Rolled Carbon and High Strength-Low Alloy Sheets

A brief descriptive review of the range of steel products of commerce will be helpful as a background for the discussions to follow. One may recall that steel flat-rolled products of about 0.230 in. thickness or less are designated as sheet products. Further, as a rule, hot-rolled sheet is rarely available under 0.050 in. in thickness, whereas cold-rolled sheet is readily available as thin as 0.014 in. and cold-rolled strip as thin as 0.005 in. Hot-rolled sheet can be made in a broad range of hardness, ductility, and strength properties, but it is most often used in the form of a ductile, relatively soft product. Like hot-rolled sheet, cold-rolled sheet is also available in a broad choice of hardness, ductility, and mechanical variations and, in addition, is supplied in a variety of surface finishes.

The regular grades of carbon sheet will have carbon contents ranging between 0.02-0.20, but mostly between 0.05-0.12% C (see Table 3). The so-called extra-low carbon grades of sheet will have less than 0.01% C. The high strength-low alloy (HSLA) grades of sheet will have similar carbon levels, but contain various alloying elements as well, such as Si, P, Mn, Ti, Nb, V, etc. which serve to increase the yield strength and provide more favorable strength-to-thickness ratios in these sheets.

As delivered from the producing mills, the hot- and cold-rolled sheet products will generally carry oils on the surfaces of the sheets unless the buyer specifies otherwise (see Table 4). The oils are essentially rust preventives intended to retard rusting of the sheets in transit and storage. Their use is almost mandatory for products

Table 3—Typical Compositions for Steel Sheets, %

Grade	C	Mn	Al	Other
CQ ^a	0.05/0.10	0.30/0.60	—	—
DQ ^b	0.05/0.08	0.30/0.50	—	—
DQSK ^c -LC ^d	0.03/0.06	0.25/0.40	0.03/0.06	—
DQSK-ELC ^e	<0.01	0.15/0.25	0.03/0.06	—
DQSK-FS ^f	<0.01	0.15/0.25	0.03/0.06	Ti, Nb
High Strength	Varies	Varies	Yes/No	— ^g

Note: All grades contain trace amounts of P, S, Cu, Mn, and N.
 (a) CQ = Commercial quality.
 (b) DQ = Drawing quality.
 (c) DQSK = Drawing quality, special killed.
 (d) DQSK - LC = DQSK-Low carbon.
 (e) DQSK - ELC = DQSK-Extra low carbon.
 (f) DQSK - FS = DQSK-Fully stabilized (interstitial-free).
 (g) May contain P, V, Nb, Ti, Si.

Table 4—Prospective Surface Constituents on Carbon Steel Sheets

- Rust preventive oils:
 - Paraffinic and naphthenic petroleum oils
 - Rust inhibitors (e.g., arylalkyl sulfonates)
 - Oxidation inhibitors [e.g., methylenebis(2,6-di-tert-butylphenol)]
 - Oxidation by-products of aging (acids, ketones, alcohols, and varnish-like films)
- Oxides, hydrates, and salts
- Metal fines and extraneous residues from processing (annealing, temper-rolling, etc.)
- Surface carbon

which ultimately require treatment and painting for a high-quality finish. However, the presence of such oils on the steel surfaces must be considered by the processor because they must be removed effectively to properly treat and paint the sheet. The rust preventive oils contain inhibitors and anti-oxidants as components of their formulation which may be difficult to handle in some cleaning operations, especially after periods of extensive storage and aging. Therefore, it is important to recognize that one is dealing with an inhibited-oil coated surface when processing steel sheets. Although the oils used on carbon steel sheets are composed of very inert mineral oils and additives, when they are dispersed as thin films on steel they can react over time under certain conditions. Such conditions include high storage temperatures and high humidity, to develop acidic by-products which can cause corrosion stains and develop polymeric, varnish-like constituents which are very difficult to remove from the steel surfaces by alkaline cleaning techniques.

The corrosion stains which develop on oiled sheets may be of two types. One type is an "oil stain," which is due to darkening of the oil from the effects of the oxidation reactions of the oil occurring on the steel's surface. These reactions are strongly influenced by elevated temperature and humidity factors. The other type is a rust stain caused by corrosion of the steel surface beneath the oil, usually due to the presence of condensed moisture. One or both of these conditions may be involved on a typically stained carbon steel sheet. Whether or not the sheet is cleanable will depend on how far the oxidation and corrosion reactions have advanced before the finishing process is attempted. Superficial stains can usually be cleaned and the sheet treated and painted satisfactorily, but if the sheet has become appreciably etched by the corrosion action it cannot be restored to its original surface quality.

In addition to the concerns about the effects of oiled surfaces on treatment and painting or plating, there are questions about other surface constituents or contaminants on the steel which deserve consideration (see Table 5). As previously noted, rolled metal surfaces, including those of steel, consist of a composite of oxides, hydrates, fines, salts, and various other compounds associated with the prior processing of the metal. Carbon steel surfaces may also carry traces of carbon deposits known as "surface carbon" to distinguish them from the carbon dissolved in the steel as part of its composition. The oxides and hydrates on the steel surface are chemically bound to

it and are always present as part of its natural state. Thus, the latter are not contaminants but an integral part of the surface that must be treated and painted. On the other hand, the metallic fines, salts, residual oils, surface carbon, etc. are contaminants because they can and do adversely alter the response of the surfaces to the cleaning, treating, and painting processes imposed on the sheets on which they reside. Yet even these contaminants can be tolerated if their concentration is low enough to preclude any serious interference with treating and painting objectives of the finishing line. By way of example, surface carbon on cold-rolled sheet at concentrations of 10 mg/m² (1 mg/ft²) is an objectionable deterrent to a good phosphate treatment but at 1 mg/m² it is virtually innocuous to the process. Conversely, oxidized oil residues and some salts cannot be tolerated even at very low levels of concentration because they are seriously incompatible with the treatment and painting processes at any level.

Effective alkaline cleaning methods will remove most contaminants from carbon steel sheets or reduce them to tolerable levels permitting subsequently effective treatment and painting. Certainly, the alkaline cleaning operations commonly employed by most equipment, appliance, and automotive component manufacturers are adequate for cleaning carbon steel sheets in the condition in which they are normally supplied to these users. In those few instances when carbon steel sheets cannot be adequately cleaned by the conventional alkaline means and yet the cleaning baths are operating at their proper cleaner concentrations, temperatures, spray pressures or flow rates, etc., then the problem may be with the sheet surface condition. The most common occurrences which interfere with cleanability of carbon steel sheets are excess surface carbon, oxidized or otherwise denatured oils and extraneous contaminants, such as gear lubes, which may be insensitive to alkaline detergency. Unfortunately, these latter constituents generally cannot be removed from the steel surfaces by anything but acid pickling, aggressive acid cleaning agents, or electrolytic cleaning processes. For example, surface carbon deposits cannot be effectively removed by alkaline detergents even with aggressive brushing. At present, there are very few steel painting facilities equipped for electrolytic or acid cleaning operations.

Although, on the whole, they are very similar to the conventional carbon sheets in cleanability, the HSLA sheets may be somewhat more troublesome to clean on occasion because these sheets can develop surface oxides and smuts which are more intractable to the cleaning process. Silicon-alloyed grades may carry oxides which

Table 5—Qualitative Effects of Carbon Steel Surface Contaminants on Paintability Performance

Surface Contaminant	Typical Paintability Performance of Sheet	
	Good	Poor
Iron fines, mg/ft ²	<5	>10
Salts, as chlorides, mg/ft ²	0.1-0.2	>0.5
Salts, as sulfates, mg/ft ²	<0.2	>0.5
Surface carbon, mg/ft ²	0.1-0.4	>1.0
(mg/m ²)	(1-4)	(10)

tenaciously retain oils and they also tend to form more surface carbon residues during the box annealing processing of these sheets. High manganese-alloyed and phosphorus-alloyed grades also are slightly more sensitive to cleaning variables and cleaning process inefficiencies than are the carbon steel sheet grades because of the increased accumulation of manganese- and phosphorus-containing species on these alloyed-steel surfaces.

As is generally known, the treatments usually applied to hot- and cold-rolled sheets and their HSLA counterparts in preparation for painting are either iron phosphates or zinc phosphates. However, those processors treating sheets in the flat by roll coating may also use certain chromates on carbon steel surfaces prior to painting (see Table 6). The iron phosphate treatment coatings are more properly called iron phosphate-oxide coatings because they consist of mixtures of iron phosphate and iron oxides developed on the steel surface by the action of acidified alkali metal or ammonium phosphate solutions. In any case, whether the steel is treatment-coated with iron phosphate-oxide or zinc phosphate, the need for developing the best quality of treatment coating attainable in a given finishing operation cannot be overemphasized. A phosphate treatment is expected to provide improved corrosion resistance and paint adherence to the painted article and its quality is judged on how well it meets these requirements. Good quality phosphate coatings characteristically have low porosity, high density, small and uniform crystal size, and no appreciable loose surface powder. Typically, about 90% of the paint adherence and corrosion failures observed on painted steel sheet can be directly ascribed to poor quality phosphate coatings beneath the paint and about 75% of these failures are due to either ineffective cleaning of the steel prior to treatment or poor control of the phosphating bath medium during treatment.

As previously indicated, the poor cleanliness can be steel-related or cleaner-bath related, however, it is virtually impossible to assign the responsibility for the problem to either cause unless it is done at the actual time of cleaning, treatment, and painting. Even poorly cleaned and untreated steel will accept and bond well to paint until the painted surface is exposed to moisture, whereupon the paint will usually soon lose its adherence and the steel will rust. Consequently, in the usual course of events, a failure due to a poor phosphate treatment condition on a painted cold-rolled steel part will not appear until long after the part has been finished and its cause can be identified. The only option open to the treatment and painting processor is to closely monitor these processes to minimize the risks of failure and to detect signs of deviations from standards as early as possible.

Coated Sheets

To avoid any confusion over nomenclature, it will be useful to review briefly a description of the various products that are classified as coated sheets. Coated sheets, in steel industry parlance, is generally the term applied to those sheets bearing a nonferrous coating over the steel base, although the coated tin-mill products are an exception to this generalization. Included under this generic designation are galvanized steel sheets (zinc-coated steel

Table 6—Typical Pretreatments for Steel and Coated Steel Sheets

Treatments for Carbon Steel Surfaces

- Iron phosphate-oxides
- Zinc phosphates
- Chromates, non-rinse type

Treatment for Coated Steel Sheet Surfaces

- Zinc phosphates
 - Complex oxides
 - Chromates
 - Chromate-phosphates
-

sheets), terne-coated sheets, aluminum-coated sheets, zinc-iron, zinc-nickel and zinc-aluminum coated sheets, chromium- and chromium oxide-coated sheets, and sheets bearing a variety of organic coatings and paints. There are also coated sheet products which consist of combinations of both the metallic and organic coatings, such as prepainted galvanized sheets and organic-coated terne-coated steel sheets. The principal purpose of coatings on steel surfaces is, as noted previously, to improve the corrosion resistance of the steel product and/or to provide it with a decorative finish or an altered appearance.

The coated sheet products are further differentiated by the specific means used to coat them. Thus, where the coatings are applied by immersion of the steel sheet in molten-metal baths, they are referred to as hot-dipped coatings. Where the coatings are electrochemically deposited on the steel surfaces they are designated as electrolytic coatings. Because of the specific nature or chemistry of some coatings, they can be applied by both hot-dipped and electrolytic methods, but some can only be applied by the one or the other of the methods. Zinc, for example, is readily coated onto steel by hot-dipping or by electrolytic plating. Aluminum, however, is only readily coated by hot-dipping means because of the explosion hazards which accompany the electrodeposition of aluminum. Chromium and chromium oxide coatings are only applied in regular practice by electrolytic deposition.

The coated sheets are comprised of a cold-rolled, or in some cases, hot-rolled steel sheet base and a superimposed coating material of substantially different properties. While in some instances the composite product, that is, the coated sheet, will retain most if not all the characteristics of the base steel, it is also possible for the coated sheet to become altered in mechanical properties in comparison to those of its parent sheet because of the processing to which it is subjected in the coating operations. The importance of this circumstance must be recognized to avoid misapplication of the coated sheet product where it is substituted for an uncoated steel sheet to gain the advantages offered by the coated product, although the increased availability of fully-stabilized steels (interstitial-free steels) in recent years has decreased this problem significantly. In contrast, the electrolytic galvanizing of a steel sheet has a minimal effect on the mechanical properties of the sheet and it will retain the values of those properties it had prior to its plating.

The coated sheets also retain most of the dimensional attributes of the cold-rolled or other parent sheet. Thus,

the dimensional tolerances that apply to the base sheet are generally applicable to the coated product as well. Shape and flatness properties, however, may not carry over to the coated sheet because these can be affected by the processing equipment and handling operations accompanying the coating process.

ZINC-COATED (GALVANIZED) SHEETS: Hot-dipped, zinc-coated (HDG) sheets are furnished in two basic forms, free zinc-coated or alloyed zinc-coated. The alloyed zinc-coated sheets alluded to in the following include only iron-zinc alloys. Alloys of zinc with aluminum will be discussed later. The HDG free zinc-coated sheets may be obtained as regular spangled, regular minimum spangled, extra-smooth (temper-rolled), or powdered-zinc treated (PZT) galvanized sheets in the various coating weight designations G 01, G 60, G 90, etc. The coatings on alloyed zinc-coated sheets formed from hot-dipped zinc coatings, the so-called galvanized sheets, contain from about 8-12% iron and are available in the characteristic matte texture of the alloyed surface in coating weight designations of A 01, A 40, and A 60. The numerical values 60, 90, etc. refer to the respective numerical equivalent coating weights expressed in oz/ft² total coating on both sides of the sheet.

Most electrolytic zinc-coated (EG) sheets and electrolytic zinc-alloy-coated sheets are furnished to the trade in the as-plated, matte-finish surface condition and their coating weight designations are expressed in metric units as g/m² per side. Occasionally, the EG sheets may be lightly temper-rolled where a specific surface roughness finish is desirable or to obliterate minor surface anomalies and restore uniformity of appearance.

HDG zinc- and alloyed zinc-coated sheets may be supplied in the nonchemically treated (NCT) or chemically treated (CT) condition. The chemical treatment is intended to passivate the zinc surfaces to retard the white corrosion staining to which zinc is susceptible when stored or transported under humid conditions. Generally, the NCT sheets are furnished to users intending to treat and paint the parts produced from them because the passivation treatments applied to the zinc surfaces interfere with their paintability. Both the NCT and CT sheets are usually lightly oiled with rust preventive oils to provide some resistance to transit abrasion along with some modest corrosion protection. The EG zinc- and alloyed zinc-coated sheets, in contrast to the case for HDG sheets, are usually furnished in the NCT condition and lightly oiled because they are almost invariably used in applications where they will be painted.

The processes for cleaning and treatment of zinc- and alloyed zinc-coated sheets in preparation for painting do not differ greatly from those used with carbon sheet products. In fact, most treatment facilities can handle carbon and coated sheet parts concurrently with the proper choice of treatment reagents. The coated sheets are readily cleanable with alkaline cleaning agents provided the oils on them have not become oxidized or aged to an intractable state. Phosphate-containing cleaners may cause a problem in some cases if the zinc-coated sheet is overly reactive to the cleaning agent, as is sometimes observed with EG sheets. The phosphate cleaner can actually cause zinc phosphate nuclei to develop on the

zinc surfaces, which produce phosphate protrusions in the zinc phosphate treatment coatings deposited during subsequent phosphate treatment.

After cleaning, the zinc-coated sheets may be processed with phosphate, chromate, or alkaline complex-oxide treatment media to develop the corresponding paint base coatings. The phosphate coating media are the only ones suitable for treatment systems simultaneously coating both carbon steel and zinc-coated parts. In contrast, the chromate and complex oxide media do not work for carbon sheet treatment. The zinc phosphates are preferred for zinc-coated sheet, however, iron phosphate-oxides appear better suited for use on the zinc-iron alloyed sheets. NCT zinc-coated sheets are required for use with these painting pretreatments except for a special case involving the chromates. With the proper choice of chromate passivation treatment and chromate paint pretreatment, a CT galvanized sheet may be used as a base for painting with excellent results. A passivated galvanized sheet, coupled with a chromate paint pretreatment as the basis of a paint finishing system, is referred to as an integrated paint pretreatment system. The integrated pretreatment system has been used successfully on hundreds of thousands of tons of prepainted galvanized and zinc-aluminum alloy coated sheets.

ZINC-ALUMINUM ALLOY-COATED SHEETS: Zinc-aluminum alloy-coated sheets constitute a special case because the principal representative of this type of sheet is Galvalume™ sheet, where zinc is the minor component of the alloy coating in contrast to the situation with the zinc-alloy-coated sheets considered previously. The Galvalume coating consists of 55% aluminum, 43.4% zinc, and 1.6% silicon by weight, or about 75% aluminum, 22.5% zinc, and 2.5% silicon by volume. Obviously, the Galvalume coating more nearly constitutes an aluminum surface than a zinc surface and its response to cleaning and treatment reflects this fact. Currently, most Galvalume sheet is used in the building products market and, where it is treated and painted, the processing is done on a continuous-coil painting line. Cleaning is done by using conventional alkaline cleaning media and spray, or immersion processes as with the zinc- and zinc-alloy-coated sheets. However, the pretreatments for painting are preferably chromates rather than the phosphates or complex oxides employed with the zinc-coated sheets. The integrated paint pretreatment system also has worked well for producing prepainted Galvalume sheet and this technique, with some modifications to accommodate various proprietary chromates, is widely used for this purpose.

Galfan™ sheet is the other representative of the commercially available zinc-aluminum alloy-coated sheet family, but unlike Galvalume, its coating is predominantly a zinc-containing alloy having only 5% aluminum. Galfan, a development of the International Lead Zinc Research Organization (ILZRO), is offered to the trade as a more ductile coating alternative to Galvalume, especially in the form of a prepainted sheet. Because aluminum-containing zinc coatings of even relatively low concentrations of aluminum tend to form substantial concentrations of aluminum oxides at their surfaces, they are best treated with the chromate-type paint pretreatments and Galfan

sheet is no exception. It responds very well to the same cleaning and treatment processing employed with Galvalume sheet.

ALUMINUM-COATED SHEETS: Aluminum-coated sheets are currently used primarily for roofing sheets, automotive muffler and exhaust systems, heat-resistant appliance and furnace parts, and industrial ovens and dryers. The aluminum coating serves primarily as a barrier to corrosive attack rather than as a sacrificial protective coating for steel, as is the case with zinc. The coating composition may be essentially all aluminum or contain up to 10% silicon as an alloying element. Although most aluminum-coated sheets are used unpainted, the sheet is readily paintable, using the pretreatments suitable for aluminum sheet, preferably the chromates, and conventional painting practices.

Painted-sheet durability is very good and the undercutting-corrosion rate at cut edges and damaged sites where steel is exposed is slower than that observed with painted zinc-coated sheet. The slower corrosion rate of the aluminum-coated sheets is due to the lower solubility of the aluminum corrosion products than those of zinc at these corrosion sites.

Because the demand for aluminum-coated sheet is predicated primarily on its excellent suitability for heat resistant applications and these seldom involve painted parts, paintability considerations for this product have been of little concern to the majority of its users.

TERNE-COATED STEEL SHEETS (LONG TERNE SHEETS): Terne-coated sheets are produced from annealed and temper-rolled cold-rolled sheets which are hot-dip coated with a lead-tin alloy composed of approximately 92% lead and 8% tin. There are two variations of terne-coated sheet products distinguished by the type of base upon which the terne coating is deposited. The two variations are termed regular long terne-coated sheet and nickel-terne-coated sheet. Regular long terne-coated sheet is produced by hot-dip terne coating a clean, oxide-free steel sheet base. The nickel-terne-coated sheet is produced by first electrolytically depositing a very thin nickel (flash) coating on the steel base before it is subsequently hot-dip coated with the terne coating. The nickel flash coating in the latter product is intended to improve the continuity of the terne coating applied over it and, thus, improve the corrosion resistance of the terne-coated sheet overall.

Terne-coated sheet is noted for its good drawability, corrosion resistance, solderability, and paintability. The traditional uses for this coated sheet have been chassis, capacitor containers, and other parts for televisions, radios, recorders, etc., fuel tanks, caskets, heater and furnace parts, air filters, oil pans, and valve covers. Terne-coated sheets are available with terne coatings in designations of LT 01, LT 25, LT 35, LT 40, etc., where again, the coating weight is expressed in oz/ft² of coating weight on both sides. The terne-coated sheets may be CT when furnished for fuel tanks or NCT for most other applications.

When painting is required on NCT terne-coated sheet parts, the only preparation required is to provide a clean, grease- and oil-free surface. Paint pretreatment is not

required, nor is it feasible because of the inertness of the lead alloy to reaction with known phosphate and chromate prepaint treating media. However, the recent advent of prepainted fuel tank sheets has encouraged some research toward enhancement of the adherence of paints to terne with pretreatments. In a current commercial practice, prepainted terne sheets intended for fabrication into fuel tanks are being produced by coil-coating operations which prepare the terne surfaces by alkaline cleaning and abrasive brushing prior to the roll-coat application of a zinc-rich and an aluminum-pigmented epoxy primer to opposite sides of the sheets. This type of rather drastic processing is necessary here to maximize the primer adherence for the deep-drawn fuel tanks, but is not ordinarily required for less demanding painted terne applications.

TIN-FREE STEEL SHEET AND CHROMIUM/CHROMIUM OXIDE-COATED GALVANIZED SHEETS: Tin-free steel (TFS) sheet is a chrome/chrome oxide (Cr/CrO_x)-coated cold-rolled steel sheet whose coating is somewhat similar to that on tin-mill TFS. The TFS sheet, like its tin-mill counterpart, has a great affinity for bonding to organic coatings and paints. The Cr/CrO_x coating on the steel is deposited electrolytically and has a nominal coating weight on each side of 5 mg/ft² composed of about 3 mg/ft² of metallic chromium and 2 mg/ft² of mixed chromium oxides. The Cr/CrO_x coatings are very inert and somewhat hard, brittle, and abrasive as compared to other nonferrous metallic coatings.

When painted, the TFS sheet shows excellent resistance to corrosion and exhibits excellent paint adherence. However, when the TFS sheet is drawn or formed, the Cr/CrO_x coating tends to spall from the steel and the steel is no longer protected in these damaged areas. To restore the formed TFS sheet to a semblance of its original corrosion-resistant state, the formed article can be treated with a zinc phosphating medium which will develop a zinc phosphate coating in those areas where the TFS coating has been damaged and bare steel has been exposed. When the phosphate-repaired TFS sheet is painted and tested thereafter, there is little or no difference in corrosion resistance in the adjacent TFS-coated and phosphate-treated areas.

In the salt-spray test, painted TFS was observed to be equal or superior to painted iron phosphate-oxide-treated cold-rolled sheets in both corrosion resistance and adhesion. Painted TFS sheet tends to resist undercutting of the paint at sheet edges and at scratches better than painted iron phosphate-oxide-treated cold-rolled sheet. TFS sheet is a prospective candidate for appliance, office furniture, and fixtures where high humidity resistance is required.

Cr/CrO_x coatings on EG sheet have been investigated extensively in Europe by Centro Sperimentale Metallurgica (CSM). The coated sheet is called Zincrox™ and the Cr/CrO_x coating may be present on the zinc sheet at levels between about 1 g/m² (100 mg/ft²) and 0.5 g/m² (50 mg/ft²). At the minimum level of 0.5 g/m² (50 mg/ft²), the coating is about 10× heavier than that used on TFS cold-rolled sheet as noted previously. However, the CSM coating contains proportionally less chrome oxide than the TFS coating on cold-rolled sheet, about 10/1, Cr/CrO_x, whereas the coating on cold-rolled sheet is preferably about 3/2, Cr/CrO_x on sheet product. In any case,

the benefits of the Cr/CrO_x coating over EG sheet appear to be improved resistance to paint undercutting at sites of chipping and resistance to scab corrosion.

TIN-MILL PRODUCTS: BLACKPLATE, TINPLATE, AND TFS: Tin-mill products include primarily three materials: blackplate, tinplate, and TFS. Blackplate is simply a very thin cold-rolled steel ranging between 0.006 and 0.015 in. in thickness provided to the trade in a variety of temper grades and without any tin coating. Blackplate is furnished as a nonoiled (dry) product or with a thin layer of a polybasic ester lubricant such as butyl stearate (BSO) or acetyl tributyl citrate (ATBC). Tinplate is an electrolytically-applied tin-coated thin sheet between 0.006 and 0.014 in. thick available in a range of tin coating weights from 0.1 to 1.35 lb/bb of sheet, where bb refers to a base box of tinplate which is an area of about 218 sq ft of tinplate.

Tinplate is usually supplied with one or the other of two tin oxide-stabilizing treatments on its surface. The treatments are based on sodium dichromate solutions which are applied to the tinplate surface as a dip or electrolytically. Where the solution is applied only as a dip treatment, it is referred to as SDCD treatment and the resulting chromate film usually contains about 90-120 micrograms of Cr/ft² of surface. Where the treatment is electrolytically applied, it is termed a CDC treatment and the resulting chromate film generally has a chromium level of about 300-500 micrograms/ft². Tinplates are usually furnished very lightly oiled with ATBC or dioctyl sebacate (DOS) esters and the oil levels are around 0.1 to 0.2 g/bb.

TFS as a tin-mill product is very similar to the TFS sheet product described earlier. Tin-mill TFS is essentially blackplate carrying a Cr/CrO_x coating consisting of 5 mg/ft² of metallic chromium and about 1 mg/ft² of chromium oxides. TFS is usually supplied very lightly oiled with BSO.

The tin-mill products are unique among steel flat-rolled materials in that they are generally lacquered and decorated in the as-delivered condition without further preparation. This factor makes it imperative that the steel product and the coatings to be applied are fully compatible with one another to assure the user that they will meet his needs. For this reason, the tinplate producers, coating suppliers, and processors tend to cooperate closely in their efforts to satisfy the technology requirements associated with tin-mill products and the lacquers and coatings applied to them.

The major usage for tin-mill products is in container and packaging applications, and especially food containers. Tinplate has the unusual electrochemical characteristic that it becomes anodic to steel in the anaerobic environment which occurs within packed food cans. Under other conditions, because tin is more noble than iron in the electromotive series, the steel is anodic when coupled to tin and will corrode accordingly.

PREPAINTED CARBON STEEL AND COATED STEEL SHEETS: Prepainted sheets, or prefinished painted sheets, are the terms applied to steel sheets treated and painted in coil form on a continuous coil painting line. These products have become increasingly popular in recent years as steel

users strive to reduce their in-house painting operations to counter painting equipment obsolescence or environmental regulations, or to add manufacturing capacity without investing in additional painting facilities. The use of partially- or fully-finished painted sheets usually requires some changes in fabrication practices or modifications in the processing and forming equipment to accommodate the use of prepainted sheets in lieu of bare steel sheet products.

A prefinished sheet must be handled more carefully than an unpainted one to avoid damage to the paint film and compromising its appearance. Coil handling, blanking, pick-up and transfer, forming, bending, and assembly operations all must be done with an eye to the prevention of surface contacts which may mar, abrade, or scratch the paint. With proper attention, this is readily done even for such highly visible and finish-sensitive items as the large kitchen appliances.

The main deterrents to the adoption of prepainted sheets to manufacture prefinished parts are their incompatibility with joining and welding operations needed for assembly and the current limitation of paint film thickness to about one mil for most coil prepainted products. Unlike the sheets carrying paint films containing conductive metallic pigments, the conventional paint films are good insulators that interfere with the welding of parts during assembly and the paint films are generally damaged by the welding operations. With the exception of the coating of vinyl plastisols, all existing domestic coil painting lines can apply only a maximum of about 1-1.2 mils of dry paint per line pass. Any painted parts which must have thicker paint films than this usually cannot be made economically by coil-painting operations.

Prepainted sheets are available with virtually any of the carbon steel or coated-steel bases noted previously and may be painted with almost any type of thermoplastic or thermosetting paint. To maximize the adherence of the paint system and the corrosion resistance of the sheet, the steel sheets are appropriately pretreated with phosphates, chromates, etc., and then preferably painted with a combination of an inhibitive primer and a compatible topcoat for fully finished products. For the case of preprimed sheets intended for later finishing with color topcoats or other special-purpose coatings, the pretreated sheet may be primed with virtually any coating which can be uncoiled without sticking or otherwise adversely affecting the coil integrity (e.g., causing coil telescoping) after delivery from the coil coating line.

SUMMARY

Although a wide range of topics has been covered on a substantial number of steel sheet products with significantly different properties, the salient points of the preceding discussion were the following:

(1) The successful performance of organic coatings on steel surfaces can be assured by taking into account the inherent characteristics of these surfaces and then properly preparing and coating them accordingly.

(2) The paint pretreatment practices for hot-rolled steel, cold-rolled steel, and alloyed steel sheets are very similar and the essential element in the pretreatment pro-

cess is to obtain a well-cleaned sheet, free of oil and surface carbon residues to preclude interferences with the development of a good quality phosphate treatment.

(3) Among the coated-steel sheets, the zinc- and zinc-alloy-coated sheets are very susceptible to wet-storage staining and are therefore furnished both as passivated (chemically treated) or non-passivated (non-chemically treated) products which respond differently to cleaning and pretreatment. Non-passivated sheets respond normally to cleaning and treatment with phosphates, chromates, and complex oxides. However, passivated sheets must be specially treated with chromates to prepare them for painting.

(4) The zinc-aluminum-alloy sheets are a special case of the zinc-alloy coated products to the extent that chromate pretreatments are preferred for painting and the aluminum-coated sheets are likewise best pretreated with chromate media.

(5) Terne-coated steel sheet is very paintable by preparation with alkaline cleaning only and the terne surface is inert to all the currently available treating media for other sheet products.











(6) Tin-free steel sheet (Cr/CrO_x-coated cold-rolled steel) appears to be an unexploited, good prospect for painted parts resistant to high humidity exposures.

(7) Coil-coated prepainted sheets are gaining acceptance as materials of manufacture for parts that can be adapted to their use, such as in instances where a suitable substitute for joining by welding is feasible.

(8) Unlike steel sheets, tin-mill products are usually enamelled or lacquered without prior preparative treatment and, thus, require special attention to selection of coatings compatible with the surfaces to be finished to assure their suitability for coating.

The Collectible Intelligence.

The NEW Federation Series on Coatings Technology

<p>Radiation Cured Coatings J.R. Costanza, A.P. Silveri and J. Vona</p> 	<p>Coil Coatings Joseph E. Gaske</p> 	<p>Corrosion Protection by Coatings Zeno W. Wicks, Jr.</p> 	<p>Mechanical Properties of Coatings Loren W. Hill</p> 
<p>Automotive Coatings Bruce N. McBane</p> 	<p>Coatings Film Defects Percy E. Pierce and Clifford K. Schoff</p> 	<p>Application of Paint and Coatings Sidney B. Levinson</p> 	<p>Organic Pigments Peter A. Lewis</p> 
<p>Inorganic Primer Pigments Alan Smith</p> 	<p>Marine Coatings Henry R. Bleile and Stephen D. Rodgers</p> 	<p>Sealants and Caulks Joseph W. Prane</p> 	<p>Aerospace and Aircraft Coatings A.K. Chattopadhyay and Mark R. Zentner</p> 

COMPLETE LISTING OF TITLES AVAILABLE

Sealants and Caulks

J. W. Prane

Aerospace and Aircraft Coatings

A.K. Chattopadhyay & M.R. Zentner

Film Formation

Z.W. Wicks, Jr.

Intro. to Polymers and Resins

J.W. Prane

Solvents

W.H. Ellis

Coatings Film Defects

P.E. Pierce & C.K. Schoff

Application of Paint and Ctgs.

S.B. Levinson

Organic Pigments

P.A. Lewis

Inorganic Primer Pigments

A. Smith

Marine Coatings

H.R. Bleile & S.D. Rodgers

Radiation Cured Coatings

J.R. Costanza, A.P. Silveri & J. Vona

Coil Coatings

J.E. Gaske

Corrosion Protection by Ctgs.

Z.W. Wicks, Jr.

Mechanical Properties of Ctgs.

L.W. Hill

Automotive Coatings

B.N. McBane

Introduction to Ctgs. Technology

A.H. Brandau

Federation of Societies for Coatings Technology

492 Norristown Rd., Blue Bell, PA 19422-2350

Phone: (215) 940-0777/FAX: (215) 940-0292

\$5.00 EACH

Make all checks payable
in U.S. Funds

Also available from:

in the U.K., Birmingham Paint, Varnish and Lacquer Club, Raymond B. Tennant, Carrs Paints Ltd., Westminster Works, Alvechurch Rd., Birmingham B31 3PG, England (British Pounds Sterling)

in Mexico, Miss Elia Gallegos, Mexico Society, Gabriel Mancera 309 Col. Del Valle, 03100 Mexico, D.F., Mexico

FSCT PUBLICATIONS ORDER FORM

Quantity	Price	Total
----------	-------	-------

Journal of Coatings Technology:

	U.S. and Canada	Europe (Air Mail)	Other Countries
1 Yr.	\$30	\$60	\$45
2 Yrs.	57	117	87
3 Yrs.	82	172	127

New Federation Series on Coatings Technology

(\$5.00 ea.)

- "Film Formation"—Z.W. Wicks, Jr.
- "Radiation Cured Coatings"—J.R. Costanza, A.P. Silveri, and J.A. Vona
- "Introduction to Polymers and Resins"—J. Prane
- "Solvents"—W.H. Ellis
- "Coil Coatings"—J.E. Gaske
- "Corrosion Protection by Coatings"—Z.W. Wicks, Jr.
- "Mechanical Properties of Coatings"—L.W. Hill
- "Automotive Coatings"—B.N. McBane
- "Coating Film Defects"—P.E. Pierce and C.K. Schoff
- "Application of Paints and Coatings"—S.B. Levinson
- "Organic Pigments"—P.A. Lewis
- "Inorganic Primer Pigments"—A. Smith
- "Marine Coatings"—H.R. Belle and S. Rodgers
- "Sealants and Caulks"—J. Prane
- "Aerospace and Aircraft Coatings"—A.K. Chattopadhyay and M.R. Zentner

Technical Volumes

- Paint/Coatings Dictionary (Mbr. -\$30; Non-Mbr. -\$50)
- Infrared Spectroscopy Atlas (1980 Edition) (Mbr. -\$75; Non-Mbr. -\$100)
- Glossary of Color Terms (\$6.00)

Audio/Visual Presentations

(Slide/tape except where noted)

- Causes of Discoloration in Paint Films (\$40)
- The Setaflash Tester (\$100)
- High Speed Dispersion (\$65)
- Introduction to Resin Operation (\$65)
- A Batch Operated Mini-Media Mill (\$60)
- Operation of a Vertical Sand Mill (\$75)
- Laboratory Test Procedures (VHS format) (\$50)
- Federation Training Series on Test Methods (\$70)

Pictorial Standards of Coatings Defects

(\$100)

- Complete Manual
 - Individual Standards (\$3 ea., plus \$3 per photo as noted)
- | | | |
|---|---|---------------------------------------|
| <input type="checkbox"/> Adhesion (1) | <input type="checkbox"/> Blistering (4) | <input type="checkbox"/> Chalking (1) |
| <input type="checkbox"/> Checking (1) | <input type="checkbox"/> Cracking (1) | <input type="checkbox"/> Erosion (1) |
| <input type="checkbox"/> Filiform Corrosion (3) | <input type="checkbox"/> Flaking (2) | <input type="checkbox"/> Mildew (3) |
| <input type="checkbox"/> Print (1) | <input type="checkbox"/> Roller Spatter (5) | <input type="checkbox"/> Rust (4) |
| <input type="checkbox"/> Traffic Paint Abrasion (2) | <input type="checkbox"/> Traffic Paint Chipping (2) | |
- Record Sheet (pad of 100 sheets) (\$3.50)

Subtotal.

Pa. Residents please add 6% Sales Tax.

Total.

Available in the U.K. from: Birmingham Paint, Varnish and Lacquer Club, c/o Ray Tennant, Carrs Paints Ltd. Westminster Works, Alvechurch Rd., Birmingham B31 3PG, England

Available in Mexico from: Miss Elia Gallegos, Mexico Society, Gabriel Mancera 309 Col. DEL VALLE, 03100 Mexico D.F.

ALL INFORMATION BELOW MUST BE COMPLETED

YOUR COMPANY:

Check the **one** block which applies most specifically to the company or organization with which you are affiliated.

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

(please specify)

YOUR POSITION:

Check the **one** block which best describes your position in your company or organization.

- 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
- J Other _____

(please specify)

Signed _____ Date _____

Name _____

Title _____

Company _____

Address _____

City & State _____

Country _____ Mail Code _____

Make checks payable to: Federation of Societies for Coatings Technology
Postage and handling charges will be added to all orders requiring billing.

- FSCT Member Non-Member Please send membership information

All checks must be payable on a U.S. Bank

Federation of Societies for Coatings Technology • 492 Norristown Rd. • Blue Bell, PA 19422 • 215/940-0777

Society Meetings

BALTIMORE JAN.

"Thermal Sag Control"

The meeting featured a visit from Federation officers President Kurt F. Weitz, Secretary/Treasurer Colin D. Penny, and Executive Vice-President Robert F. Ziegler.

Messrs. Weitz and Penny each spoke briefly about the numerous activities of the Federation. Mr. Ziegler gave a slide presentation on the various stages of construction and the completed new Federation headquarters building in Blue Bell, PA.

Also, they presented 1990 Host Committee Chairman Richard C. Chodnicki, of Van Horn Metz & Company, with a gift in appreciation of his efforts in helping make the 1990 Annual Meeting and Paint Show in Washington, D.C. a success. Gifts also were presented to the Host Committee Subcommittee Chairmen.

Certificates of Merit were presented to Technical Committee Chairman Mary Somerville, of Bruning Paint Company, Mary Lou Spurrier and Charles Allen, of SCM Chemicals, Inc., and Jack Koberstine, of Aqualon Company, for their efforts and work on the Technical Committee paper which was awarded First Prize in the Society Speaker Awards competition at the 1990 Annual Meeting.

A Merit Citation was presented to Immediate Past-President Donald Hilliard, of Unocal Chemicals Division, for his four years of service as a Society officer.

The traditional Hüls Gavel was given to President Gary Morgereth, of McCormick Paint Works Company.

A 25-Year Pin was presented to Calvin C. Tatman, of SCM Chemicals, Inc., for his membership in the Society for a quarter-of-a-century.

Frank H. Gerhardt, of Bruning Paint Company, the winner of the 1990 Herman H. Shuger Memorial Award of the Baltimore Coatings Industry Awards Council, was given a collage of photos taken during the Shuger Award dinner.

The meeting's technical speaker was New York Society member Alan Smith, of Rheox, Inc. Dr. Smith discussed "THERMAL SAG CONTROL IN HIGH SOLIDS BAKING ENAMELS."

The speaker opened his talk by defining various key words that are associated with his work, including rheology, shear, stress, strain, modulus, and viscosity. He proceeded to explain the test procedures and some of

the equipment used in his study, including the Bohlin VOR Rheometer.

Dr. Smith stated that sagging occurs in high solids baking enamels at elevated temperatures during the curing cycle. This sagging is due to a reduction in viscosity of the film. He said there are several means by which to solve the sagging problem, including adjusting the molecular weight of the resin, adding functional groups to the resin, or adding chemical additives.

Three different additives were discussed, a polymer, an organic salt, and a fumed silica. Dr. Smith stated that seven different criteria need to be met to have an effective sag resistant high solids coating. He said the criteria or conditions may be achieved quicker and easier with the addition of a rheological additive.

Q. Can a person predict the tendency to sag based on the viscosity of a coating?

A. No, viscosity by itself is insufficient to characterize the phenomenon of sagging.

JIM SMITH, Secretary

CDIC JAN.

"Alginates and Biogums"

The educational speaker was Bob Hellebush, of South Port Advisors, Inc. Mr. Hellebush gave a talk on "INVESTMENTS AND TAX STRATEGIES FOR THE 90s."

Henri Monty, of Kelco Division of Merck & Company, Inc., presented the technical talk. Mr. Monty discussed "PROPERTIES AND COATING APPLICATIONS OF ALGINATES AND BIOGUMS."

The speaker explained that alginates are polysaccharides extracted from sea weed, and xanthan gum is a microbial polysaccharide produced by fermentations. Both algin and biogums are natural polymers that have been used extensively to maintain homogeneity of emulsions, suspensions, and foams in a wide variety of industrial applications.

Mr. Monty stated that the value of algin and xanthan gum in coatings relates to their ability to control the flow behavior of aqueous systems under various chemical and physical conditions. He said a basic understanding of rheology is important when it comes to appreciating the application and performance of algin and xanthan gum.

The speaker classified rheological behavior as being Newtonian or non-Newtonian. He said algin and xanthan gum

are non-Newtonian because their viscosities vary with shear rate (this behavior is known as pseudoplastic).

Xanthan gum products, according to Mr. Monty, are used in surface coating applications because of their ability to suspend aggregate and pigment, ease of application to substrates, high build without sagging, and retention of textured effects.

The speaker said the xanthan gum products exhibit a unique combination of solution properties: a high degree of pseudoplasticity; compatibility with many acids and bases; and stability in the pH range from 2 to 12.

Mr. Monty stated that algin is less pseudoplastic than xanthan gum. Also, they respond to changes in ionic strength, shear, and salt differently than xanthan. However, they have film forming properties and are widely used in coating applications in the paper and textile industries.

Q. How good is the package stability of the system?

A. The dry stability of the gum is good. Once the gum is hydrated, it is susceptible to bacteria. You need to add biocide, otherwise it degrades within 24 hours.

Q. What kind of incorporation technique do you use?

A. Generally, it is easier to hydrate the gum before adding other ingredients in the formula, otherwise, it takes vigorous agitation to bring the gum into solution.

ALIPIO R. RUBIN, JR., Secretary

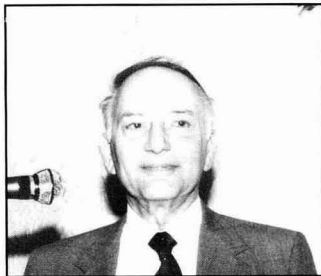
CHICAGO FEB.

"High Solids Coatings"

New York Society member Marvin J. Schnell, of Troy Chemical Corporation, was the meeting's technical speaker. Mr. Schnell's topic was "FLOW AGENTS FOR HIGH SOLIDS COATINGS."

The speaker began his talk stating that VOC regulations have prompted reformulation of solvent-based systems to higher solids types. These new types represent new challenges for the research and development chemist. The major problems are the need to eliminate poor flow and leveling.

Mr. Schnell reviewed the theory of flow/leveling, emphasizing surface tension effects associated with commercially available flow control additives in four basic high solids types of coatings: air drying alkyds, baking alkyds, baking polyesters, and baking acrylics.



CHICAGO SPEAKER—Marvin Schnall, of Troy Chemical Corp., addresses the Chicago Society February meeting on "Flow Agents for High Solids Coatings"

A discussion of the experimental results followed. The results demonstrated the effects of surface tension on the systems from flow control additives of known surface tensions. The effect on the surface wetting, and flow and leveling for each of the four categories of coatings was explained.

The speaker examined the methods which allow coatings chemists to test the surface tension of coatings they have formulated. Also, a method to recheck the surface tension after modifying with a flow control additive was discussed. According to Mr. Schnall, this rechecking allows for the documentation of the surface tension, and for determining the necessary amount of additive to achieve the best combination of flow, leveling, and wetting.

CLIFFORD O. SCHWAHN,
Publicity

CLEVELANDNOV.

"Third Environmental Decade"

Congratulations were offered to Vice President Ben J. Carozzo, of Tremco Corporation, and Technical Committee Chairman Freidun Anwari, of Coatings Research Group, Inc., for their winning First and Second Prize, respectively, in the A.F. Voss/*American Paint and Coatings Journal* Awards competition at the 1990 Annual Meeting, in Washington, D.C.

Mr. Anwari also was congratulated for winning the Second Prize in the Society Speakers Awards competition in Washington, D.C.

By-Laws Committee Chairman Charles K. Beck, retired, moved that two Resolutions be accepted:

Resolution I—"Scrolls of Honor"—whereas it is deemed desirable to honor certain deceased members who have made outstanding contributions to the Cleveland Society and its related industry, they are to be memorialized on a Scroll of Honor;

Resolution II—"Employment Assistance"—voting members in good standing

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Snyder's Willow Grove Restaurant, Linthicum, MD). JIM SMITH, Eastech Chemicals, 5700 Tacony St., Philadelphia, PA 19135.

BIRMINGHAM (First Thursday—Strathallan Hotel, Birmingham, England). D.C. MORRIS, PPG Industries (UK) Ltd., P.O. Box 359, Birmingham, B16 0AD, England.

CDIC (Second Monday)—Location alternates between Columbus, Cincinnati and Dayton). ALPIRO R. RUBIN, JR., Hilton-Davis Chemical Co., 2235 Langdon Farm Rd., Cincinnati, OH 45237.

CHICAGO (First Monday)—alternates between Sharko's Restaurant, Villa Park, IL, and Como Inn, Chicago, IL). WILLIAM FOTIS, Valspar Corp., 1191 S. Wheeling Rd., Wheeling, IL 60090.

CLEVELAND (Third Tuesday—Brown Derby, Independence, OH in Sept., Oct., Nov., Feb., March, April; Jan. meeting, Landerhaven, Mayfield Heights). ROY GLOVER, Mahoning Paint Corp., 653 Jones St., P.O. Box 1282, Youngstown, OH 44501.

DALLAS (Thursday following second Wednesday—The Harvey Hotel, Dallas, TX). MIKE EVANS, J.M. Huber Corp., 803 Pleasant Valley, Richardson, TX 75080.

DETROIT (Second Tuesday)—meeting sites vary). SCOTT WESTERBEEK, DuPont Co., 945 Stephenson Hwy., Troy, MI 48007.

GOLDEN GATE (Monday before third Wednesday)—alternates between Francisco's in Oakland, CA, and Holiday Inn in S. San Francisco). LARRY G. SAYRE, O'Brien Corp., 450 E. Grand Ave., S. San Francisco, CA 94080.

HOUSTON (Second Wednesday—Sonny Look's Sirlion Inn, Houston, TX). TERRY F. COGAN, Raw Materials Corp., P.O. Box 690285, Houston, TX 77269.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). CRAIG HUGHES, Farmland Industries, Inc., P.O. Box 7305, N. Kansas City, MO 64116.

LOS ANGELES (Second Wednesday—Steven's Steakhouse, Commerce, CA). V.C. BUD JENKINS, Ellis Paint Co., 3150 E. Pico Blvd., Los Angeles, CA 90023.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). TIMOTHY FORTNEY, American Dispersion, Inc., P.O. Box 34033, Louisville, KY 40232.

MEXICO (Fourth Thursday—meeting sites vary). ANTONIO JUAREZ, Amercoat Mexicana, via Gustavo Baz 3999, 54030 Tlalnepantla, edo de Mexico.

MONTREAL (First Wednesday—Bill Wong's Restaurant, Montreal). ROBERTO CUBRAL, L.V. Lomas Chemical Co., 1660 Hynus, Dorval, Que., H9P 2N6, Canada.

NEW ENGLAND (Third Thursday—Sheraton Lexington Hotel, Lexington, MA). JOHN LUKENS, D.N. Lukens, Inc., 15 Old Flanders Rd., Westboro, MA 01581.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). MICHAEL FRANTZ, Daniel Products Co., 400 Claremont Ave., Jersey City, NJ 07304.

NORTHWESTERN (First Tuesday after first Monday—Jax Cafe, Minneapolis, MN). JOSEPH WIRTH, Consolidated Container Corp., 735 N. Third St., Minneapolis, MN 55401.

PACIFIC NORTHWEST (PORTLAND SECTION—Third Tuesday; SEATTLE SECTION—Third Wednesday; BRITISH COLUMBIA SECTION—Third Thursday). JOHN BARTLETT, Pacific Bartlett Co., 11813 S.E. 257th St., Kent, WA 98031.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, GSB Bldg., Bala Cynwyd, PA). WILLIAM J. FABINY, Sermaguard Coatings, 155 S. Limerick Rd., Limerick, PA 19468.

PIEDMONT (Third Wednesday—Ramada Inn Airport, Greensboro, NC). ANNETTE SAUNDERS, Akzo-Reliance, P.O. Box 2124, High Point, NC 27261.

PITTSBURGH (Second Monday—Montemurro's Restaurant, Sharpsburg, PA). JEFFREY STURM, Kop-Coat, Inc., 3020 William Pitt Way, Pittsburgh, PA 15238.

ROCKY MOUNTAIN (Monday following first Wednesday—Zangs Brewery, Denver, CO). ED MCCARTHY, Cyprus Minerals, 8995 E. Nichols, Englewood, CO 80112.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant, St. Louis, MO). DENNIS CAHILL, Archway Sales, Inc., 4321 Chouteau Ave., St. Louis, MO 63110.

SOUTHERN (GULF COAST SECTION—third Thursday; CENTRAL FLORIDA SECTION—third Thursday after first Monday; ATLANTA SECTION—third Thursday; MEMPHIS SECTION—bi-monthly on second Tuesday; and MIAMI SECTION—Tuesday prior to Central Florida Section). BILLY M. LEE, Kemira, Inc., P.O. Box 368, Savannah, GA 31402.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). MIKE HAZEN, L.V. Lomas Ltd., 99 Summerlea Rd., Brampton, Ont., L6T 4V2, Canada.

WESTERN NEW YORK (Third Tuesday—meeting sites vary). MARKO MARKOFF, 182 Farmingdale Rd., Cheektowaga, NY 14225.

who are unemployed may advertise their availability without charge in the monthly meeting notice.

Both resolutions were passed by the membership in attendance at the meeting.

Robert Cunningham, Federal Affairs—Senior Counsel for the National Paint & Coatings Association, was the meeting's speaker. Mr. Cunningham's topic was "THE THIRD ENVIRONMENTAL DECADE—INDUSTRY STILL PLAYING CATCH-UP."

Mr. Cunningham spoke about the environmental problems and burdens being placed on industry. He stated that while these problems and burdens grow geometrically, available dollars and personnel are increasingly hard to come by.

According to the speaker, the national goals of the 1970s were simple: clean up the air and water ways, literally, by getting the lumps out so that untreated sewage could not be discharged and the air could be free of the dirt. He said that Congress has acted with little comprehension of whether its goals were achievable, and when or where and at what costs. As a consequence, the EPA and industry were forced to feel their way.

The speaker said that by the 1980s the environmental focus had shifted. Now its concern was to "worry more and more about less and less."

Mr. Cunningham explained that at the end of the first environmental decade, the Reagan Revolution was misconceived as the "grass roots" call for less governmental control of the environment.

In the second environmental decade, according to the speaker, Congress made it clear that it was unwilling to engage in meaningful debate on what national environmental priorities should be, or on how to accomplish them, or on whether certain environmental goals were worth pursuing. By the end of the second environmental decade, industry's fundamental goal was that environmental law and regulation should be "cost effective" and become falsely perceived as a "corporate desire to do nothing."

Mr. Cunningham stated that the extremist environmental goals of the 1980s are in the 1990s main stream. Present concerns are the air emissions permitting program, the cornerstone of the Clean Air Act of the 1990s. The goal is to make the individual facility pollution control obligation more enforceable, by centralizing all emissions and other air quality requirements in a single document. The permit programs also aim at strengthening the government financed resources for air pollution control enforcement through a permit "fee" system.

Mr. Cunningham explained the Clean Air Act Amendments, noting that it is unlawful for any person to operate certain specified sources (any stack or a similar device that an industrial facility can have) of air pollutants without a permit, or violate

any requirements of an issued permit. Sources required to obtain permits are: major sources; sources which emit 100 tons or more per year; any source subject to the new Air Toxic Regulation (U.S. EPA designated categories of industrial sources that omit 10 tons or more per year of a singular toxic or 25 tons per year of any combination of air toxins); sources subject to acid deposition control; any source required to have a permit for construction and operation and unattainment or prevention of significant deterioration area; and, if subject to new source performance standards.

The speaker said that small businesses can obtain a substitute permit under new laws (Small Business Permit Program). Benefits of the permit are: availability; less costly pollution prevention methods; and reduced permit fees. Eligibility is limited to sources that meet the following criteria: source is owned by an individual that employs less than 100 individuals; source emits less than 50 tons per year of any regulated pollutants; source emits less than 75 tons per year of all regulated pollutants; and source is not considered a major source. A source also may qualify for the small business program if it does not emit 100 tons per year of all regulated pollutants.

Mr. Cunningham said that a draft of a new three-year technical study of the New Clean Air Act, regarding consumer commercial products, is due for release in April 1992. Also, a national rule for selection of the classes for the categories of consumer commercial products will then be developed based on this study.

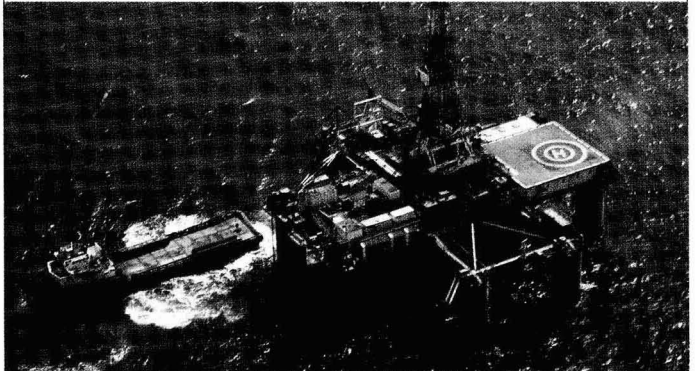
The speaker discussed the initial work done on architectural and industrial coatings. Work is focused on collecting available technical data on coatings and lower VOC substitutes. The consumer commercial product categories will be addressed by national rule in July 1992. The final guidelines will be issued in September 1993.

In conclusion, Mr. Cunningham believes that the 1990s will be substantially different from the last 20 years. Scientific and political knowledge will be brought together. Local environmental concerns will lead to the transnationalism of the environmental movement.

Q. What evidence do you have of the pendulum swinging in the other direction?

A. Historically, the data analysis shows this. Also, because we are through the McCarthy era. I do not think there is enough

Cast off corrosion with SACI high-solids.



Do you need maintenance coatings that perform well in highly-corrosive environments?

Then SACI® 8000 Series concentrates should be a major component of your coatings system.

Based partly on modified sulfonate chemistry, these high-solids products have a high affinity to metals, so they require minimal surface preparation and resist undercutting.

Like typical paint systems, these SACI-based coatings are easy to pigment and they dry to hard films.

Because they're high-solids, they offer low VOC.

Call our Sonneborn Division at 212-605-3922. Or write to us at 520 Madison Ave., New York, NY 10022.

Witco

CAL POLY FOUNDATION—Participants in the Cal Poly Foundation presentation ceremony, at the Los Angeles Society January meeting, include (l-r): James Calkin, Parker Pace, Gil Mislav, Marv Wager, Etta Cromwell, John Prinz, Kim Kittredge, Pat Marantette, and Kay Kittredge



energy to continue in that direction. Historically, we "swing" and Capitol Hill legislators are starting to listen to business more. The legislators are becoming aware that the shift in actions/legislations, previously taken, is having an environmental reverse effect. There is more listening and less fighting on the side of government versus business.

Q. At extremely low percentage levels of "now" toxins, back in the 1960s and 1970s many larger companies were compliant as to the legal content in their paints. Yet, it appears today that these same companies are being sued for that product and possible damages brought about by its use. Are these companies legally responsible from 20 years ago?

A. Yes, the defense says that companies were aware of the possible damages and their side effects.

ROY GLOVER, *Secretary*

KANSAS CITYJAN.

"Polyethylene Additives"

The meeting's speaker was Eric H. Erenrich, of Allied-Signal, Inc., a member of the New York Society. His presentation was entitled "POLYETHYLENE ADDITIVES FOR THE INK AND COATINGS INDUSTRIES."

Dr. Erenrich began his presentation by discussing waxes. He explained the physical properties of waxes and presented a slide show to demonstrate some of the testing equipment used to measure the properties. The molecular variables of waxes also were reviewed.

The speaker switched the focus of his talk to polyethylene waxes. He said polyethylene waxes can be characterized by the following product types: homopolymers; oxidized homopolymers; copolymers, including ethylene-acrylic acid and ethylene-vinyl acetate; and micronized.

Dr. Erenrich stated that the characteristics of polyethylene waxes used in the ink industry include: improvement of rub, slip, and scratch resistance; modification of sicc; and control of block resistance. Furthermore, he said the coatings industry can utilize polyethylene waxes for both similar and different applications, such as mar/abrasion

resistance, slip, blocking resistance, gloss control, and rheology in solvent-based systems.

The speaker demonstrated that the particle size of polyethylenes can be a key point in determining their effectiveness in some of the previously listed applications. Different processes used in dispersing the polyethylenes will result in various particle sizes: grinding—12 microns; shock cooling—2 microns; emulsification—0.07 microns; and micronization—10 microns.

According Dr. Erenrich, particle size is not the only characteristic to consider when contemplating the application of polyethylene waxes in both the ink and coatings industries.

In conclusion, the speaker stressed that when evaluating a polyethylene additive, it is important to consider the entire system and the various characteristics of each additive.

Q. Would the heat generated in the dispersion stage of an ink or coating cause a polyethylene additive to reach its melting point and, in turn, "seed out" upon cooling down?

A. Typically, the polyethylene additives are predispersed and would not be added during the grinding process. Furthermore, softening or melting points are usually above 70°C. Because this temperature is higher than most dispersion processes achieve, the risk of such seeding is negated.

CRAIG HUGHES, *Secretary*

KANSAS CITYFEB.

"Environmental Monitoring"

The meeting's speaker was Robert Sholar, of Terracon Environmental, Inc. Mr. Sholar's topic was "BASELINE ENVIRONMENTAL MONITORING: WHEN, WHY, AND HOW?"

The speaker's talk was based on an incident which occurred on a farm approximately 20 miles outside of Louisville, KY, in the 1970s. According to Mr. Sholar, the farm was a dumping ground for 17,000 visible drums of chemical waste. The farm, labeled the "Valley of Drums," was one of three high profile sites during the 1975-78

era which were used eventually to create Superfund in Congress.

Roughly 80% of the waste in the Valley of Drums could have been generated by coatings manufacturers or the end-users of coatings, stated the speaker. Kentucky had strict laws for the disposal of solid waste, but regulations regarding liquid waste were essentially non-existent. Mr. Sholar noted that because of the lack of rules regarding liquid waste, no one could be held responsible for the waste at the Valley of Drums.

The speaker said the a run-off of the liquid waste build-up eventually migrated to a nearby creek and, ultimately, to the Ohio River. Mr. Sholar noted that the Resource Conservation and Recovery Act (RCRA), passed in 1976, had no money available for clean-up of the site because its regulations had not been promulgated. However, funding was available in the Clean Water Act for spills in navigable water and their tributaries. In what the speaker classified as a gusty move, a Coast Guard captain and an EPA official classified the Valley of Drums as a tributary to navigable waters, thereby releasing the necessary funds to begin a clean-up of the site.

Mr. Sholar addressed the value and reasons for baseline environmental monitoring at a plant site, especially if the plant is not under the scrutiny of a regulatory agency. He detailed some of the problems environmental monitoring could help to avoid or alleviate.

The speaker said the thrust of RCRA is to help manage waste, encompass the generation of waste and its disposal, and all the pathways between these points. Mr. Sholar stated that the complexity of the various pathways increases the liability for a waste generator. Because RCRA establishes civil and criminal penalties for the willful or knowing mishandling of waste materials, an environmental audit can identify some of the circuitous pathways and, thereby, reduce the chances for such penalties.

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) can prove costly to a waste generator, stated Mr. Sholar. Under CERCLA regulations, a third party can seek compensation from the originator of waste even though the originator is not directly

involved in a wrongful act. Any company which stores chemicals or hazardous wastes has the potential of these chemicals moving off their property to other property. The speaker said an environmental audit can identify the potential for such problems.

Mr. Sholar outlined the three steps that were used to clean up the Valley of Drums site. The first step dealt with attempting to get the initial threat under control by dealing with the nearby creek. The second step involved the staging and sampling of the drums. The final step included the disposal and/or treatment of the contaminated soil and buried drums.

In conclusion, Mr. Sholar said that despite the site being a national priority list Superfund site, it does not pose a serious threat to the environment.

Q. What is the cost of determining if vacant land is EPA-clean?

A. In an industrial area, it would be approximately \$1,500 per acre if no problems were encountered.

Q. What if the land is in an industrial area?

A. Costs would vary, but, if there are businesses on two sides of the property which could contaminate the soil, it moves the audit from a Phase I non-intrusive audit to a Phase II intrusive audit. This adds another \$3,000, but costs could run as high as \$50,000.

CRAIG HUGHES, *Secretary*

LOS ANGELES JAN.

"Peroxide Cured Resins"

Environmental Affairs Committee Chairman Dave Muggee, of E.T. Horn Company, talked about the new Clean Air Act. He said under the Act, production (and import) of methyl chloroform (1, 1, 1-trichloroethane) will be phased out according to a set schedule, with allowable production based on a percentage of 1989 production. The following timetable has been set: 1991—100% (freeze); 1992—100%; 1993—90%; 1994—85%; 1995—70%; 1996—50%; 1997—50%; 1998—50%; 1999—50%; 2000—20%; 2001—20%; and 2002—essential uses only.

Mr. Muggee talked about the proposal from the California Department of Health Services to require "empty" hazardous materials containers to be classified as hazardous waste, thus extending state hazardous waste requirements to drum reconditioners. According to Mr. Muggee, if and when this is passed, drum companies will have to fill out a hazardous waste manifest for each shipment of empty drums to be reconditioned.

Marv Wager, of Standard Brands Paint, Chairman of the Cal Poly Foundation, ac-

cepted donations for the Cal Poly San Luis Obispo coatings course.

Immediate Past-President Parker Pace, of Behr Process Corporation, presented a check in the name of the late Society Past-President Earl Smith. Mr. Smith spent considerable time and effort on the Cal Poly project.

Rick Beck, of Standard Brands Paint, and Rick Burl, of Major Paint Company, presented a check in the memory of the late Robert M. Abrams. Mr. Abrams was very instrumental in bringing about the completion of the Cal Poly project.

Gil Mislung, of Dunn-Edwards Corporation, presented a check to the Cal Poly Fund in hopes of the project continuing to benefit the coatings industry.

John G. Prinz, of Sinclair Paint Company, and Eta Cromwell, wife of the late Dermont G. "Duke" Cromwell, Society Past-President and Society Representative, presented a check in support of the Cal Poly Fund.

Patrick J. Marantette, of E.T. Horn Company, and Kay and Kim Kittredge, wife and daughter, respectively, of the late Dave Kittredge, presented a check to the Cal Poly Fund. Mr. Kittredge was the one primarily responsible for the concept of an established

college training program in coatings and polymer science on the West Coast.

Other companies who have contributed substantially to the Cal Poly Foundation include: Aroproz Corporation; American National Can; *American Paint and Coatings Journal* Company; Benjamin Moore & Company; Buchwalder, Neimer, Fields & Younger; Deft Corporation; Multichem Products; Transcontainer Corporation; Union Carbide; and U.S. Can Company.

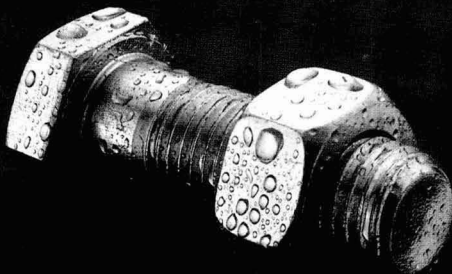
The meeting's speaker was Delano Eslinger, of Cook Composites & Polymers, Freeman Polymer Division. Dr. Eslinger discussed "PEROXIDE CURED RESINS/COOK COMPOSITES."

The speaker reviewed information concerning unsaturated oligomers specifically designed for cure in air using peroxide catalysts. These coatings are two-component systems with a long pot life and excellent cure response at force-dry temperatures.

According to Dr. Eslinger, the advantages of these peroxide curable coatings are that they are isocyanate and formaldehyde free, produce low toxicity, have low temperature cure, and possess low VOC.

The speaker emphasized the formulation parameters and guidelines, along with the

Say "Nuts!" to corrosion with SACI emulsions.



Do you need maximum corrosion protection where solvents or emissions are undesirable?

Then SACI® waterborne concentrates — the most effective water-based anti-corrosion products available — should be a major component of your coatings system.

They're ideal for applications ranging from temporary protection of metal stocks, such as nuts and bolts, to

permanent protection for rigorous automotive applications.

SACI emulsions can be formulated to yield oily, waxy, or hard, tack-free films.

Call our Sonneborn Division at 212-605-3922. Or write us at 520 Madison Ave., New York, NY 10022.

Witco

film performance properties of some selected coating systems. A discussion of the unique curing chemistry of these resins also was presented.

In conclusion, Mr. Eslinger stated that peroxide curable coatings can be applied over a variety of substrates and lend themselves to formulation versatility. Furthermore, the paint chemist only has to pay attention to the special chemistry that is going on and can use it to solve various formulation problems.

Q. Is there a surface tack that remains after the film has cured when using this technology?

A. Due to the alkyd-like chemistry at the surface, the solvent resistance of the surface is weaker than the subsurface part of the film. This is not a tack, only a slower curing portion of the film.

Q. What is happening when in a two-component system that bakes at 250°F in 10 minutes to a hardness on metal of H and rebaked at 250°F, comes off with your fingernail?

A. You are probably increasing the crosslink density so high that it is brittling and losing adhesion at that point.

V.C. BUD JENKINS, *Secretary*

LOUISVILLE JAN.

Past-Presidents' Night

The meeting was attended by 13 distinguished Past-Presidents of the Society. Each Past-President was introduced and received a round of applause.

Immediate Past-President Louis Holzkecht, of Devoe Marine Coatings Company, was presented with his Past-Presidents' Pin.

Environmental Affairs Committee Chairman Joyce St. Clair, of Kentucky Partners, announced that the symposium on "Hazardous Waste Minimization" will be



NEW EPOXY TECHNOLOGY—Marcel Gaschke (l) and Bob Collings (r) conducted an open forum session on "New Epoxy Technology" during the Pittsburgh Society's January meeting. Society Vice President and Program Committee Chairman Joseph Powell is between the guest speakers

held on April 17, at The Executive West Hotel.

By-Laws Committee Chairman Donald W. Collier, of Courtaulds Coatings, Inc., discussed the proposed amendment to the Society By-Laws. The new amendment would allow, with some limitations, Associate Members to serve as officers of the Society and minor terminology changes in the text. The amendment was accepted by a vote of members in attendance, and will be voted on again at the February Society meeting.

TIMOTHY FORTNEY, *Secretary*

NORTHWESTERN FEB.

"Interior Painting and Design"

Technical Committee Chairman Edward Ferlauto, of Valspar Corporation, gave an overview of the activities of the Technical Committee, including a status report on the acid rain "Real World Test" regarding coatings and corrosion in the environment.

The meeting's first speakers were Kathy Colvin and Patricia Stewart, of Hirschfield's Paint Mfg. Company. Their topic was "NEW TECHNIQUES IN INTERIOR PAINTING AND DESIGN."

The speakers discussed glazing as a way to coat a surface. Glazing, which requires a solution of two parts water, one part flowtrol, and one part latex paint, can be applied in numerous ways, including with sponges, rags, and paint brushes.

Stenciling also was reviewed. The speakers suggested using stenciling sparingly as an accent or to draw attention to a particular area.

The next speaker was Mike Haller, of Macbeth Division of Kollmorgen Instruments Corporation. Mr. Haller's talk focused on "THE INDUSTRIAL APPEARANCE REVOLUTION."

The speaker said appearance measuring instruments are used in color sensitive industries, including leather, food, pharmaceuticals, cosmetics, glass, ink, etc. The purpose of the instruments is to describe color accurately. Mr. Haller stated that appearance measuring instruments can be used to enhance the abilities of the human eye.

JOSEPH WIRTH, *Secretary*

PHILADELPHIA DEC.

"Calcium Carbonates"

The meeting's speaker was George S. Greene, of Pfizer, Inc., who spoke on "PRECIPITATED CALCIUM CARBONATES."

The speaker talked about the use of precipitated calcium carbonates (PCC) in the paper and plastics industry. He said PCC are used to replace acid sizing with alkaline sizing. The alkaline sizing, based on a spe-

cific crystal type of PCC, not only extended TiO₂ and bulked the fiber, but also provided favorable economics over the acid sizing. Dr. Greene said this is leading to an overall conversion to alkaline sizing in the pulp and paper industry over the next couple of years.

Dr. Greene stated that a variety of shapes and sizes of PCC crystals were possible. These ranged from spheres and cigar shaped crystals to a rosette shaped crystal. A slide demonstration presented the comparison of different crystal sizes and shapes.

According to the speaker, PCC's primary function in the paint and coatings industry about 15 years ago was anti-settling and improved brightness, not TiO₂ extension.

Dr. Greene explained that the PCC ability to extend the TiO₂ was not due to spacing of the TiO₂ particles in the conventional sense. Upon closer examination of the pigments, after removal of the solids from the liquid paint, it was observed that the rosette crystals of the PCC were trapping TiO₂ particles within the spiny structure of the crystal. Since the refractive index of PCC is very similar to the refractive indexes of binders, PCC are not considered as pigments, stated the speaker. Because of this classification and the structure of the rosette crystal, any pigment which will fit into the structure can be extended. Inorganic pigments, as well as organic pigments, can be extended and this can lead to improved color development.

Dr. Greene cautioned that order of addition is critical as opacity can be lost due to preferential absorption of other fillers, rather than of the color pigment. Another aspect of the trapping of small particles is lower effective resin demand, which results in higher gloss finishes. This characteristic, according to the speaker, has opened up development in the automotive finishes area.

In conclusion, Dr. Greene said that PCC were not a drop-in replacement for calcined clays despite maintenance of superior scrub resistance. He cautioned that dry hide will be reduced due to the change in resin demand. To compensate for this, standard practice is to remove excess binder, thus resulting in a cost savings. Dr. Greene stated the PCC are TiO₂ extenders which effectively lower resin demand and can result in cost savings of up to \$0.30/gallon.

Q. What is the hardness of PCC?

A. The hardness is 3.2-3.6 on Mohs scale, which is softer than, say, calcined clays.

WILLIAM J. FABINY, *Secretary*

PITTSBURGH JAN.

"Epoxy Technology"

The evening's technical session consisted of an open forum on "New Epoxy

TECHNOLOGY." CIBA-GEIGY Corporation's Marcel M. Gaschke, of the New York Society, and Bob Collings, were the speakers.

Dr. Gaschke began his talk with an emphasis on epoxy resins for protective coatings and their relation to VOC regulations. He explained the problems epoxy coatings manufacturers have had with VOC calculations using EPA Method 24. This method calls for ASTM D-2369 in determining the nonvolatiles and requires that both the epoxy portion and curing agent have a calculated VOC. The speaker pointed out that this is not fair in that certain volatile chemicals (i.e., benzyl alcohol, glycidyl ether, etc.) actually take part in the curing process and become part of the coating. As a result of this discrepancy, the EPA has now allowed a 1-24 hour induction period prior to analyzing the VOC. Dr. Gaschke stated that this shows that industry will get much further by showing a working cooperation with the agency.

Dr. Gaschke said that another new approach the EPA is looking at is performance of a coating. They believe that if a coating could have extended durability, this would mean that less recoating would be required; thus, resulting in less VOC escaping into the atmosphere. Dr. Gaschke stated that the EPA has told him that they are not so concerned with larger paint companies, but worry about the quality of coatings being made by smaller companies.

The speakers next topic was new developments and trends in epoxy technology. The first subject was a new flexible, high solids, low viscosity epoxy resin originally developed for the adhesive industry. The new resin was specifically designed to be extremely tough. When cured with proper amines, an epoxy coating of unusually good flexibility and toughness results. However, the chemical resistance does need to be improved.

Mr. Collings pointed out that in the area of aggregate floors, a new requirement of 30% elongation has been recently specified under ASTM C881-90. This new resin has shown much promise in meeting this specification.

Dr. Gaschke focused on the area of weatherable or exterior epoxy resins. He pointed out that polyurethanes make excellent exterior coatings. However, a perception of problems with isocyanates are prevalent in the marketplace. Therefore, it would be a good idea to make a weatherable epoxy.

Dr. Collings finished the meeting's presentation stating that the coatings industry needs to improve its products in the flooring and civil engineering markets in the following areas: fabrication and chip resistance, corrosion resistance, acid etch resistance, and transfer efficiency.

JEFFREY C. STURM, *Secretary*

ST. LOUISJAN.

Environmental Report

It was announced that David L. Wieties, of Resourceful Environment Ideas, Inc., and Gary L. Younce, of Akzo-Lanchem Corporation, are Co-Chairmen of the State Affairs Committee, a new joint venture of the Society and the St. Louis Paint and Coatings Association.

Five subcommittees were introduced as follows: Clean Air, Clean Water, OSHA, DOTS, and RCRA.

Frank Hackmann, of the law firm of Sonnenschein, Nath, and Rosenthal was the first speaker. The topic of his talk was the "CLEAN AIR ACT UPDATE."

The speaker used a slide presentation which illustrated the complexity of this legislation (Title 40 of the Code of Federal Regulations). He discussed the basic structure of the Act, the changes of the regulation from the 1977 laws to those of the 1990s, and automobile related standards. Also, ozone nonattainment was explained. Some of the costs, permit times, and air permits were detailed.

The second speaker was Bill Schuckman, President of the Metro Manufacturers Association.

Mr. Schuckman discussed 1987 as a starting point for emissions by using SARA Title III figures from each manufacturer's plant. He also reviewed the consequences of violations, auctions, or setting of unused emissions (banking) to other companies, rewards for turning in violators, the expenses to maintain and manage programs, the need to be very careful who you hire to direct the compliance, the need to find a person who can understand these rules, update MSDS, and determine potential liabilities.

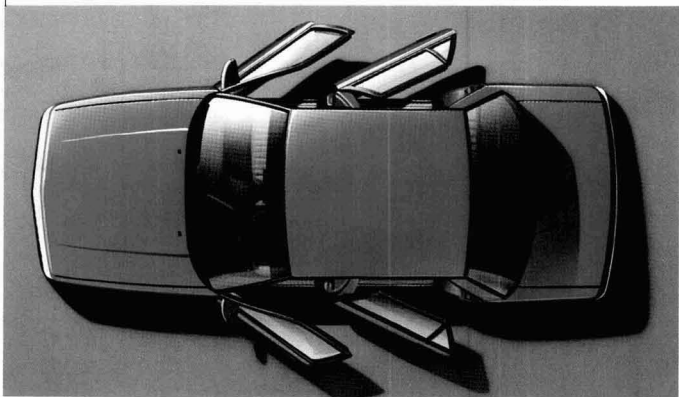
The meeting's final speaker was Arnold Montgomery, Commissioner for the City of St. Louis Pollution Control.

Mr. Montgomery stated that knowingly releasing hazardous emission into the air is a felony as opposed to being a misdemeanor, as in the past. He said the city of St. Louis inspects cars for emissions standards. In addition, reduced vapor pressure on gas pumps and special nozzles on the pumps are enforced.

In conclusion, Mr. Montgomery said that senior management needs to get involved in the compliance problem, because they will not be exempt from prosecution.

DENNIS CAHILL, *Secretary*

Slam the door on corrosion with SACI hot-melts.



Do you need excellent corrosion inhibitors in hot-melt form?

Then SACI® should be a major component of your coatings system.

Coating systems based on SACI have been proven effective in tough automotive applications such as doors and underbodies.

Their hot-melt form makes them easy to apply.

A variety of grades allows versatility in your formulation.

Solvent-free SACI concentrates are easy to work with and are non-toxic.

Call our Sonneborn Division at 212-605-3922. Or write us at 520 Madison Ave., New York, NY 10022.

Witco

Elections

BALTIMORE

Active

Chiazor, Charles M.—Duron Paints & Wallcoverings Inc., Beltsville, MD.
Greenland, James R.—Duron Paints & Wallcoverings Inc., Beltsville.
Nagaria, Ramniklal R.—Duron Paints & Wallcoverings Inc., Beltsville.
Robertson, Wesley E.—SCM Chemicals, Baltimore, MD.

Associate

Arnold, William F.—Duron Paints & Wallcoverings, Beltsville, MD.

BIRMINGHAM

Active

Perkins, Martin J.—Euramax Ltd., Industrial Estate Corby, Northants.

CHICAGO

Active

Alfano, Joanne B.—Ashland Chemicals, Willow Springs, IL.
Anderson, Brian T.—DeSoto, Des Plaines, IL.
Asplund, David L.—Northwest Coatings, Oak Creek, WI.
Beland, Michael A.—Halox Pigments, Hammond, IN.
Cygan, Ludwik S.—Morton International, Woodstock, IL.
Karnemaat, Richard J.—Interfibe Corp., Portage, MI.
Rayman, Thomas E.—Carbit Paint Co., Chicago, IL.
Superczynski, Wayne D.—Niles Chemical Paint, Niles, MI.
Tomasik, Daniel J.—Graham, Chicago.
Wasielewski, Wayne S.—Sun Chemical, Prospect Heights, IL.
Wouch, Gerald—R.R. Donnelley, Lisle, IL.
Yapp, William J.—Tioga International, Harvey, IL.

Associate

Bracken, David Jay Jr.—T.H. Hilson Co., Wheaton, IL.
Hilson-Reed, Lisa M.—T.H. Hilson Co., Wheaton.
Skrobot, Pete—Halox Pigments, Hammond, IN.
Tressel, Lloyd—3M Co., Hinsdale, IL.

Retired

Gogek, Jack L.—Glenview, IL.
Luzietti, Albert F.—A&C Enterprise, Westchester, IL.
Schultz, Benjamin—Chicago, IL.

CLEVELAND

Active

Barker, Michael J.—BF Goodrich, Brecksville, OH.

Cunningham, Glenn P.—Sherwin-Williams Co., Cleveland, OH.
Jayasuriya, Rohitha M.—Lord Corp., Erie, PA.
Kuzma, Leonard J.—Lord Corp., Erie.
Nayder, Dan A.—Mangill Chemical, Bedford, OH.
Sekerak, John R.—Mangill Chemical, Bedford.
Varn, Ronald D.—BF Goodrich, Brecksville.
Welker, Jacqui—Inter Colour Dimensions, Cleveland.
Wunch, Catherine P.—Engelhard Corp., Beachwood, OH.

Associate

Kotowski, David J.—Palmer Supplies Co., Cleveland, OH.

DETROIT

Active

Gosney, Edward H.—Morton International, Rochester Hills, MI.
Kabacinski, Ronald D.—United Paint & Chemical, Saline, MI.

Associate

Darehshori, Gholi F.—Peninsula Polymers, Grand Rapids, MI.
Harteis, Timothy J.—Tri Chem Inc., Hudson, OH.
Michell, Kristen M.—Dow Chemical Co., Southfield, MI.
Sabo, Edward—Etna Products Inc., Chagrin Falls, OH.

HOUSTON

Active

Castro-Juin, Edgar—Exxon Chemical, Baytown, TX.
Chellappa, Chel L.—Witco Corp., Houston, TX.
Cummings, Frederick L.—Dow Chemical USA, Freeport, TX.
Downs, Kim A.—Spartan Color, Houston.
Fitzgerald, Thomas W.—Monarch Paint Co., Houston.
Franke, Preston H.—Sentry Polymers, Freeport.
Gainer, A. Beryl—Southwestern Labs Inc., Katy, TX.
Hammersla, Bruce—Coronado Paint Co., Schertz, TX.
Hokanson, Jane A.—Dow Chemical USA, Freeport.
Hunter, James C.—El Paso, TX.
Kapadia, Jay M.—Coastline Ind. Coatings, Stafford, TX.
Larson, Thomas M.—Exxon Chemical, Baytown.
Mostafa, Yehia Ali—American Coating, Houston.
Navarrete, Dolly—Gulf States Asphalt, South Houston, TX.
Parikh, Ashwin V.—Witco Chemical Co., Houston.
Simpson, James U.—Plexmar, Inc., Houston.
Smith, Kurt—KTA-Tator Inc., Humble, TX.
Sullaway, Guy B.—International Paint, Houston.
Wing, Phil L.—Dow Chemical USA, Freeport.

Associate

Boyd, Charlcye K.—Raw Materials Corp., Houston, TX.
Carle, Harry O.—Schering Berlin Polymers, Dublin, OH.
Crozier, Dennis G.—Crozier Nelson Sales, Houston.
Gredler, Richard—Unocal Chemicals Div., Houston.
Ledbetter, Jennifer G.—Union Carbide, Houston.
McGuigan, John P.—Consultant, Houston.
Rezell, Joseph M.—Shell Chemical, Houston.
Risinger, Zay K. Jr.—Pacific Anchor Chemical, Houston.
Weaver, Gary D.—Hüls America Inc., Garland, TX.
Woodall, Billie E.—Raw Materials Corp., Houston.

Affiliate

Barbosa, Robert—Jones Blair TX-Resin, Dallas, TX.

LOS ANGELES

Active

Anderson, Howard—Arlon Inc., Santa Ana, CA.
Aquino, Tony—Van Aken International, Rancho Cucamonga, CA.
Brady, Randall J.—Deft Inc., Irvine, CA.
Cheng, Judy—Ameron, Brea, CA.
Curtin, A. Kimberly—Behr Process Corp., Santa Ana.
Grubbs, Charles L.—Akzo, Orange, CA.
Hacioglu, Ahmet Can—Devoe Coatings Co., Riverside, CA.
Jenkins, V.C. Bud—Paint Consultant, Riverside.
Rutherford, Mark A.—Day-Glo Color Corp., Cudahy, CA.
Turk, Hasan—Spraylat Corp., Los Angeles, CA.

Associate

Ansley, Steven W.—Romic Chemical, East Palo Alto, CA.
Doolittle, Jeanne R.—E.T. Horn Co., La Mirada, CA.
Mahoney, Tim—Manufacturing Business System, Pasadena, CA.

NEW ENGLAND

Active

Holland, Thomas J.—EM Industries, North Providence, RI.
Hughes, Joseph P.—Raffi and Swanson Inc., Wilmington, MA.
Lombard, Louis L.—Raffi and Swanson Inc., Wilmington.
Ledbury, Donald F.—Franklin Paint Co., Franklin, MA.
Sanborn, Norman G.—The Gillette Co., S. Boston, MA.
Shimkus, Edward J.—Omya Inc., Long Valley, NJ.
Warren, Ronald D.—ICI Resins US, Wilmington.

NEW YORK

Active

Faulkner, Gordon A.—Union Ink Co., Inc., Ridgefield, NJ.
Jablón, Michael—Allied-Signal, Morristown, NJ.
Robinson, Fred—Rhône-Poulenc, Cranbury, NJ.

Associate

Krizan, Jeffrey F.—Kemira, Inc., Bridgewater, NJ.
Lobdell, Paul H.—Unimin Specialty Minerals Inc., New Canaan, CT.
Moran, Thomas L.—B&P Environmental Resources, Oakland, NJ.

NORTHWESTERN

Active

Bui, Tien Van—Valspar Corp., Minneapolis.
Coad, Michael D.—Diamond Vogel Paints, Minneapolis, MN.
Hansen, Kevin M.—Valspar Corp., Minneapolis.
Hooper, Robert P.—Cargill Inc., Minneapolis.

Associate

Jansen, Theodor—Mobay Corp., Forest Lake, MN.
Johnson, Tim—Unocal Chemicals, St. Paul, MN.

Educator and Student

Bierwagen, Gordon P.—North Dakota State University, Fargo, ND.

PHILADELPHIA

Associate

Delaney, James M.—Ciba-Geigy Corp., Newport, DE.
Taliaferro, Andre J.—Alcoa, Berwyn, PA.
Woodcock, David S.—Rhône-Poulenc Inc., Flemington, NJ.

PITTSBURGH

Active

Eakin, Daniel A.—Watson-Standard Co., Pittsburgh, PA.
Hilliard J. Craig—Watson-Standard Co., New Kensington, PA.
Jones, Brad A.—PPG Industries, Springdale, PA.
Warren, Lee A.—Watson-Standard Co., Pittsburgh.

ST. LOUIS

Active

Furaus, Gerald—Carboline Co., St. Louis, MO.
White, James D.—Steelcote Manufacturing, St. Louis.
Zimmermann, Gary R.—Performance Polymers, St. Louis.

Associate

Kusky, Robert J.—Mozel Inc., St. Louis, MO.
Laurent, H. Jeff—F.R. Hall Co., St. Louis.
Tolle, Thomas—Burgess Pigment Co., Geneva, IL.

TORONTO

Active

Achaia, Mort B.—Hüls Canada Inc., Bramalea, Ont.
Carnwath, Colin N.—K-G Packaging Ltd., Concord, Ont.
Luszczek, Richard H.—Home Hardware Paint Div., Burford, Ont.
Rickard, Christopher G.—Mississauga, Ont.

Associate

Halpern, Lou E.—Grenhall Chemicals Ltd.,

Brampton, Ont.
Martin, Louis S.—Hüls Canada Ltd., Brampton.
Morris, Charles Massey—Whittaker Clark & Daniels Inc., Rexdale, Ont.
Newey, Michael W.—L.V. Lomas Ltd., Brampton.

WESTERN NEW YORK

Active

Beanan, Lawrence R.—Gold Bond Building Products, Buffalo, NY



New!

An Innovative Approach For Detecting Chloride Contamination



New!



BRESLE SAMPLER™



Bresle Kit



Bresle Sampler

A new, innovative approach to detecting soluble surface contamination after blast cleaning operations is being introduced to the United States and Canada by KTA-Tator, Inc. The Bresle Sampler™ and Bresle Kit provide a fast, simple field method of determining the presence of invisible contaminants including chlorides, sulfates, soluble iron salts, total moisture and total residual salt content.

Attach the Bresle Latex Sampler to the surface to be tested, inject the extraction fluid using a syringe, then remove and

analyze the liquid using standard laboratory techniques, chloride or ferrous ion test strips, or by using the Bresle Kit. The kit contains all of the necessary equipment to perform the extraction and to perform "Drop Titration" analysis for precise chloride detection, while in the field.

Call or write for further information on the Bresle Sampler™ and Bresle Kit. KTA-Tator, Inc. is the exclusive distributor of the Bresle line in the United States and Canada.

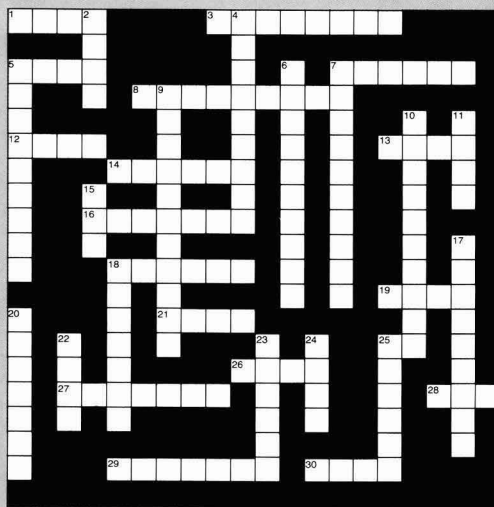
KTA-Tator, Inc. – Serving the Industry Worldwide
115 Technology Drive • Pittsburgh, PA 15275 • 412/788-1300
Gulf Coast Operations: 713/540-1177
Western Operations: 818/713-9172



**Professional Engineers • Chemical Engineers
Chemists • Coating Specialists**
Consulting • Project Management • Failure Analysis
Plant Surveys • Specifications • Inspection • Expert Witness
Instrument Sales • Physical Testing • Analytical Laboratory
Inspector Training • Accelerated Weathering • Test Panels

CrossLinks

by Earl Hill



Solution
to be
Published in
May Issue

No. 41

ACROSS

1. Woodwork or molding, e.g.
3. A wood that yields a semidrying oil, B_____
5. Critical _____ (Abr.)
7. Salts of this metal are used as fungicides
8. A type of glass bead
12. Sea algae yield this colloid
13. What are metal salts of fatty acids called?
14. Rubbery material like gutta-percha
16. Red (Syn.)
18. Hardness test, B_____L
19. To grind (verb)
21. Type of adhesion test
25. BG
26. Film condition caused by weathering
27. This type of protection keeps iron from deteriorating
28. What happens to wood?
29. Vegetable oil hydrocarbon which functions as an antioxidant
30. Under T_____E

DOWN

2. Leaf-like, usually transparent, silica mineral extender
4. What is a sealed, pressurized chemical reaction vessel?
5. A clear coating used in the application of gold leaf
6. Black pigment from England
7. Oil of lemongrass (Syn.)
9. To clump together
10. Fine filaments from a spraying process
11. _____ varnish
15. Dry _____
17. Rosin, for one
18. Mineral source of aluminum
20. What goes between?, B_____R
22. Sticky (Syn.)
23. You cover joints on exterior boards with thin strips of these
24. Outlet for release
25. A brown water color pigment

Thomas D. Faulkner has joined the staff of Atlas Electric Devices Company, Chicago, IL, as Product Manager for Flammability Instrumentation. Mr. Faulkner will be responsible for the marketing, sales, and development of the company's complete line of flammability test instruments worldwide.

The Solvents and Coatings Materials Division of Union Carbide Chemicals and Plastics Company Inc., Danbury, CT, has combined its UCAR Coatings Resins and Solvents and Intermediates Departments. **James F. Flynn** has been named Vice President and General Manager—Solvents, Resins, and Intermediates. Mr. Flynn previously served as Vice President and General Manager of the Solvents and Intermediates Department.

In addition, **Joseph R. Flesher** has been appointed Vice President and General Manager of the newly formed Unicarb System Department. He has been with Union Carbide for over 30 years, most recently serving as Vice President and General Manager of the UCAR Emulsion System Department.

John McGroarty has accepted the position of Manager of Marketing/Biocides for Hüls America Inc., Piscataway, NJ. He joined Hüls in 1979 as a Salesman. In 1982, Mr. McGroarty was promoted to Regional Sales Manager/Midwest Territory. Prior to joining the company, he was a Sales Representative for NL Industries.

In addition, **Craig W. Smith** has been named Marketing Representative/Catalog and Inside Sales for the company's Silanes and Silicones Group. In this position, he will also act as a Technical Consultant and assist in the development of product literature.

The following staff changes have been announced by Advanced Coating Technologies (ACT), Inc., Southfield, MI. **Ron Swinko** has been promoted to Vice President/Sales and Marketing with responsibility for both domestic and international sales. He is a member of the Detroit Society.

Joining the firm are **R. James Shaffer**, as Director of Marketing/Testing Services and **Laura E. Soreide**, as Senior Project Engineer. Mr. Shaffer previously held several technical positions at National Steel Corporation and Ms. Soreide was a Materials Engineer with Chrysler Corporation before joining ACT.



T.D. Faulkner



J.F. Flynn



T. Del Donno



W. Wood

Theodore Del Donno has been appointed to the position of Technical Sales Service Manager/Acrylic Polymer Technology Department of Rohm Tech Inc., Fitchburg, MA. He was most recently with Industrial Coatings Research at the Rohm and Haas Central Research Laboratories, where he led exploratory research, product development and technical service projects. Mr. Del Donno brings to this position 18 years of experience in laboratory research.

Air Products and Chemicals, Inc., Allentown, PA, recently announced the following executive appointments: **Ronald L. Barsema**—Vice President and General Manager/Engineering; **Leo J. Daley**—Vice President and Corporate Controller; **Thomas R. Hall**—Vice President and General Manager/Polymer Chemicals Division; and **David H. Kelly**—Vice President and Treasurer.

W. Dexter (Dex) Brown has accepted the position of General Manager/Commercial Development Department for Airco Gases, Murray Hill, NJ. Under his direction will be the development of new application technologies for use with a variety of markets including food, metalworking, plastics, and the environment. Mr. Brown will also be responsible for equipment development and construction, field engineering services, and noncryogenic commercial development.

Solvay Polymers, Inc., Houston, TX, has chosen **Gary Miertschin** to fill the newly-created position of Vice President of Marketing. In this capacity, he will be responsible for marketing, facilities and production planning, and customer service for HDPE and PP. Mr. Miertschin previously served as Director of Marketing.

United Gilsonite Laboratories (UGL), Scranton, PA, has appointed **Wayne Wood** to the position of Senior Chemist. In this position, he will be involved with product research and development. Mr. Wood joins UGL after serving as Technical Director with the Allentown (PA) Paint Manufacturing Company. He is a Past-President and a 29-year member of the Philadelphia Society.

Debora S. Reid has been promoted by ANGUS Chemical Company, Northbrook, IL, to the position of Technical Service Specialist/Biocides. In this capacity, she will be responsible for the development, implementation, and maintenance of a technical service program for the company's biocide customers.

In addition, the promotion of **Thomas L. Johnson** to Market Development Manager/Coatings has also been announced. He previously served as Technical Service Specialist.

Allen W. Grobin, Jr., standards project authority for metallic and inorganic coatings for IBM Corporation, Poughkeepsie, NY, has been elected to a three-year term on the American Society for Testing and Materials (ASTM), Philadelphia, PA, Board of Directors. His term of office began on January 1. Mr. Grobin currently serves as Vice Chairman of ASTM's Committee B-8 on Metallic and Inorganic Coatings and Vice Chairman of two subcommittees that represent new activities which he brought into B-8, thermal spray coatings and diffusion coatings. He was presented with Committee B-8's Certificate of Appreciation in 1979 and received the Society's Award of Merit in 1987.

Fortify every drop of your paint with HALOX Inhibitive Pigments



Find out how with the HALOX Reference Manual

Get detailed product information, performance data, applications, formulation guidelines, and more in your personal copy of this valuable reference. Examine the comprehensive selection of non-toxic HALOX pigments for corrosion inhibition and tannin stain blocking, compatible with a wide variety of water and solvent-borne coatings systems. And discover how the unique added values of HALOX SQP—Service, Quality, Performance—will fortify your industrial, professional, and consumer paints.

Advanced technology applied against corrosion



HALOX PIGMENTS

2340 165th Street, Hammond, IN 46320, (219) 845-4599
 Telex: 72-5481 HMD LEAD HM, Fax: (219) 845-7138
 A DIVISION OF HAMMOND LEAD PRODUCTS, INC.

The Macbeth Division of Kollmorgen Instruments Corporation, Newburgh, NY, has appointed **Wolfgang Weber** as Director of Sales for its European operation. He joins Macbeth from New Brunswick Scientific. In this new position, Mr. Weber will be based in Munich, Germany.

Also, **Dan Hendrickson** has been named a Sales Representative for the firm's line of color measurement products. His territory includes New Jersey, Delaware, and parts of Pennsylvania and New York. Mr. Hendrickson previously worked for Hunter Laboratories.

The election of **Dennis L. Dalton** as Vice President of Marketing/International has been announced by Buckman Laboratories International, Inc., Memphis, TN. He will be responsible for the Asia/Pacific region. Mr. Dalton was previously employed with Cosan/CasChem.

Sartomer Company, Exton, PA, has announced two marketing staff appointments. **Robert J. O'Toole** was named Sartomer's North American Product Sales Manager for the specialty chemicals produced by the company's affiliate, Cray Valley Products, Farmborough, England. He will concentrate on the North American marketing and customer support of Cray Valley's line of products, which includes resins and specialty additives for the paint and coatings industry, and micronized waxes for the inks industry.

Daniel Radell has been appointed Product Sales Manager for Specialty Acrylates. In this capacity, he will be responsible for marketing and sales support of the Sartomer's line of monomers, oligomers, and photoinitiators for radiation curing applications.

Accepting the position of Marketing Manager for Liquid Carbonic International Services Corporation, Chicago, IL, is **John Segura**. In this capacity, he will oversee the development of marketing programs for carbon dioxide and other industrial/medical gases. Mr. Segura will also provide marketing support for all of the company's international affiliates. He has been with the company since 1978.

Inland Leidy, Inc., Baltimore, MD, has announced that **Alan H. Deitch** has joined the company as Sales Representative. His territory will include the Baltimore-Washington corridor, as well as Delaware and Pennsylvania. Prior to accepting this position, Mr. Deitch served as Chemical Research Technician with W.R. Grace and Company, Davison Chemical.

The naming of **Roger P. Schwartz** as Vice President of Automotive Sales with the Plastics Division has been announced by Eagle-Picher Automotive Group, Grabill, IN. Based at the group's Inkster, MI, office, he will manage the division's domestic and international automotive sales function. Mr. Schwartz joined the Plastics Division in 1987 as Automotive Sales Manager.

The Specialty Chemicals Division of S.C. Johnson Wax, Racine, WI, has appointed **Debra K. Moran** as Industry Specialist in the Powder Coatings Technical Service Group. Ms. Moran joined S.C. Johnson from the Glidden Company where she served as a Project Leader for the development of new powder coatings.

Also, the Specialty Chemicals Division has named **Michael J. White** as District Accounts Manager for Kansas, Oklahoma, Missouri, south central Illinois, Iowa, Nebraska, and North and South Dakota. He will provide sales support for the Jconcryl® and Jonwax® lines in his territory.

Hitox Corporation of America, Corpus Christi, TX, has appointed **Jack H. Perkins** as Vice President of Sales and Marketing. He brings to this position over 22 years of experience in the coatings, plastics, and paper industries. Mr. Perkins has held sales, marketing, and management positions with Cook Paint and Varnish, SCM Chemicals, and J.M. Huber Corporation. He succeeds **Sara M. Robinson**, who recently resigned. Ms. Robinson is a member of the Houston Society.

Akzo Coatings Decorative Finishes, Troy, MI, has announced the following three promotions:

Phil Pettine has been appointed District Manager. In this position, he will coordinate all Sikkens woodfinish brand sales activity for the entire southeast district including Georgia, North and South Carolina, Florida, Tennessee, Alabama, and Mississippi.

The newly-created position of National Sales Manager has been filled by **Nick Bellizzi**. He will manage the expanding dealer network and coordinate the sales activities of Akzo's Sikkens products nationwide.

The naming of **Cor van der Voet** to Technical Director of Decorative Finishes completes the staff promotions. He has served as Technical Manager for Decorative Finishes in the U.S. since 1988 and presently manages the company's decorative production facility. Prior to that time, Mr. van der Voet worked in Holland for Akzo Coatings B.V.

The American Paint Journal Company, St. Louis, MO, has named **Chuck Reitter** its President and Chief Operating Officer. He previously served as Editor/Vice President. Mr. Reitter is now responsible for all marketing, editorial, accounting, circulation, production, and administrative functions. He will also oversee long-range planning for *American Paint & Coatings Journal* (APJ) and *American Painting Contractor*. Mr. Reitter currently serves as Assistant Treasurer of the St. Louis Society.

Also, **Joe Maty** has become Editor of the APJ. He previously served as Associate Editor and now assumes full responsibility for the editorial content of the magazine.

In addition, **A.F. Voss, Jr.**, former President, has been named Chairman. He will retain a major role in the Marketing Department and will continue to have a high profile at industry meetings and conventions.

The following appointments have been announced by Lonza Inc., Fair Lawn, NJ: **Al Holderith**—Manager/Customer Service, Performance Chemicals Group; **Nancy Morlino**—Manager/New Business Development, Functional Chemicals Group; **John Dobol**—Director of Marketing/Nutrition Products, Organic Chemicals Division; and **Phil Riley**—Account Manager, Organic Chemicals Group.

National Decorating Products Association (NDPA), St. Louis, MO, has named **Robert B. Petit** National Sales Manager in charge of advertising for *Decorating Retailer* magazine. He previously served as Executive Director of the Window Coverings Association of America and as Midwest Sales Representative.

In addition, **David Weiss** has been appointed Senior Market Research Analyst. In this capacity, he will conduct all support brand studies and publish the association's annual "Decorating Products Retail Sales Report."

Bernard J. Burke has been named President of Finnaren & Haley Paint, Conshohocken, PA. He has been with the company since 1967. Mr. Burke most recently served as Executive Vice President and General Manager.

Obituary

Robert M. Noble, Chairman and Managing Director of SCM Chemicals Limited, Bunbury, Western Australia, died February 23, 1991.

Mr. Noble joined the LaPorte Industries, Limited, titanium dioxide business in England in 1968. He rose through positions of increasing responsibility in the United Kingdom and Australia and became Group General Manager/Titanium Dioxide for LaPorte in 1982. Mr. Noble joined SCM Chemicals in 1984 by way of the acquisition of LaPorte's Titanium Dioxide business by SCM Chemicals. He returned to Australia in 1988 as Chairman and Managing Director of SCM.



Simply the Only Way...

... to Measure the Extensional Viscosity of Fluids

Now there is a tool to help you measure the extensional viscosity of simple and complex fluids, the Rheometrics Fluids Extensional Analyzer (RFX).

Extensional viscosity measurements are the key to solving high rate process problems in spray, coating, and injection applications — problems that cannot be solved using shear viscosity measurements.

Simply A Better Way

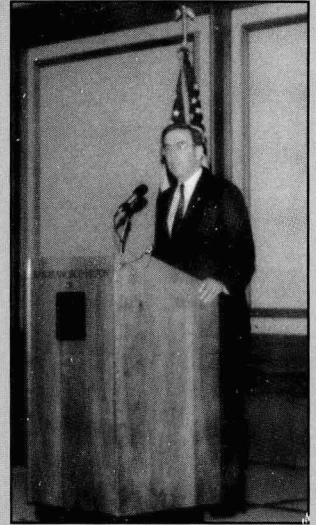
The RFX is the only instrument that can reliably measure extensional viscosity. It is compact, easy to operate, and low in cost.

Call us for more information or a free demonstration of this unique technology available exclusively from Rheometrics.

Rheometrics®

One Possumtown Road, Piscataway, NJ 08854

(908) 560-8550



"Coatings Science for the Nineties" Theme Explored At Successful Western Coatings Societies Symposium

On February 18-20, the city of San Francisco hosted the Western Coatings Societies' 20th Biennial Symposium and Show. Held at the San Francisco Hilton Hotel, the WCSSS attracted 1741 registrants, setting a record for the event held in that city. In addition, 100 exhibits devoted to a variety of raw materials, production equipment, testing devices, and services to the coatings industry were displayed in nearly 16,000 sq ft of exhibit space.

Highlights of the events included the Keynote Address on February 18 by Jerome Crowley, Jr., of The O'Brien Corporation. Mr. Crowley currently serves as President of the National Paint and Coatings Association. On Tuesday, February 19, attendees at the Industry Luncheon were addressed by Reverend Cecil Williams, a national leader in the fight against the abuse of crack cocaine and the empowerment of the African-American family. Reverend Williams is recognized as one of the most respected public figures in San Francisco.

Keyed to the theme of "Coatings Science for the Nineties," the technical program offered varied presentations that often attracted standing-room-only audiences.

Technical Program

Divided into four special sessions, "Chemophobia, Ecohysteria, and How to Fight Them," "Computer Aids for the Coatings Chemist," "Coatings Chemistry and the Law," and "Regulation, Law and Industry Response," the technical presentations included the following:

"Waterborne Nitrocellulose Lacquers for Wood Coatings with Lower VOC"—C.M. Winchester, Aqualon Company

"Improved Rheological Characteristics of Water-Reducible Formulations with Hydrophobic Fumed Silicas"—M. Nargiello and D. Chasse, Degussa Corporation

"Formulating Exterior Latex House Paints with Kaolin Clays"—T. Broome, J.M. Huber Corporation

"Bay Area Air Quality Management District"—M. Feldstein

"PARLE, Advocating Responsible Legislation for the Environment"—N. Kisner, Triangle Coatings, Inc.

"EL RAP: Who We Are and What We Do"—R. Wendoll, Dunn-Edwards Corporation

"The Chemical Industry Council of California, Advocacy in the 90s"—P.A. Kronenberg, CICC

"California Paint Council"—M. Allen, The Garrett Allen Konovaloff Group

"LITHOPONE: Back to the Future—A Modernized White Pigment"—M. Issel, Sino-American Mineral & Metal

"Improved Procedures for Short-Term Evaluation of Protective Coatings for Steel"—B. Appleman, Steel Structures Painting Council

"Polymers and Coatings Program at Cal Poly State University"—M.T. Wills, D. Jones, T. Westover, Cal Poly San Luis Obispo

"High Solids Polyorganosiloxane Polymers for High Temperature Applications"—W.A. Finzel, Dow Coming

"Identification of Pigments with Modern Instrumentation in a Paint Lab"—R. Kumar, Hoechst Celanese

"Flow Agents for High Solids Coatings"—M.J. Schnell, Troy Chemical

"Automating Paint Manufacturing Processes with PC's"—C. Hudson, Pacific Micro Engineering

"On-Line Information Retrieval—Answering Scientific and Business Questions from the Convenience of Your Office or Lab"—J.L. Grant, Dialog Information Systems, Inc.

"Statistical Quality Control in Coatings Production"—J. Cawley, NW Analytical

"Quality Improvement Through Employee Involvement"—K. Mercer, The Glidden Company

"Quantifying Facts and Phobia"—A. Banov, *American Paint and Coatings Journal*

"Ecohysteria and Chemophobia Monsters"—R.D. Athey, Athey Technologies

"The Rhetoric of Technical Communications"—A.J. Shaw, Shaw Consulting

"Effective Communications with the News Media"—D. Green, David Green and Associates

"Rheology Modifiers: Modeling Their Performance in High Gloss Paints"—T.L. Maver, Rohm and Haas

"Rheological and Applied Properties of Latex Paint Thickened with Conventional

and Hydrophobically-Modified Hydroxyethylcellulose"—G.W. Vanderslice, Aqualon

"Spray Polyurea—100% Solids High Performance Elastomer Systems"—D. Primeaux, Texaco

"What the Latex Paint Formulator Should Know about Polymer Emulsions"—R.R. Brown, Unocal

"U.S. Patent Protection for Coatings"—R.S. Berman, Spensley, Horn, Jubas & Lubitz

"Patents and Trademarks—A Japanese Perspective"—K. Yamasaki, Spensley, Horn, Jubas & Lubitz

"Trademarks for the Coatings Industry"—R.H. Zaitlen, Spensley, Horn, Jubas & Lubitz

"Two-Component Isopolyester Urethane Coatings for Plastics"—E.A. Simpson, Amoco

"Utilization of Hydroxy Terminated Polybutadiene in Air Dry Rust Inhibitive Primers"—J.J. Salitros, Atochem

"Controlling Biological Contamination in Coatings Manufacturing Processes"—H. Macheem, Troy Chemical.

Committee Chairmen

Serving as General Chairman for the event was Patricia Shaw of Davlin Paint Company. Co-Chairman was Gordon Pioch, of Eureka Chemical Company. Tom Dowd, of Dowd & Guild, served as Exhibits Chairman. Additional support was provided by Ted Favata, of Cal Coast Chemicals, Inc.—Treasurer; Dr. Robert Athey, of Athey Technologies—Technical Program Chairman; Patricia Stull, of Pacific Coast Chemicals—Publicity Chairman; Allen Bernes, of E.T. Horn Co.—Registration/Housing Chairman; Leon Persson, of Harcros Chemicals—Advisor; Tina Onderbeke, of Dowd & Guild—Exhibits; Debra Callen, of E.T. Horn & Co.—Registration; Sandra Dickinson, of Harcros Chemicals—Los Angeles Representative; Evelyn Adler—Spousal Program Chairman; and Barry Adler—Entertainment Chairman.

1993 Event Scheduled

Plans are currently underway for the 21st Biennial Symposium and Show. Scheduled for March 23-25, 1993, the event will be held at the Disneyland Hotel and Convention Center, in Anaheim, CA.

Final Program Set for Gordon Research Conference Slated For July 29-August 2, in New London, NH

The Gordon Research Conference on the Chemistry and Physics of Coatings and Films is scheduled for July 29-August 2, at Colby-Sawyer College, in New London, NH. This international event, which draws together the leading coatings and films scientists from around the world on a biennial basis, creates a forum for the discussion, on an "off the record" basis, of the cutting edge topics in the science and technology of coatings and films.

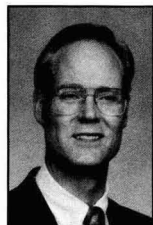
The final program has been set for the conference, and is as follows:

"UV Radiation Curing of Organic Coatings: Kinetic Analysis of Ultrafast Reaction"—Christian Decker, of Laboratoire de Photochimie Générale, Ecole Nationale Supérieure de Chimie de Mulhouse

"Radiation Sensitive Polymer Coatings for Microelectronic Device Applications"—Elsa Reichmanis, of AT&T Bell Laboratories

"Theoretical Modeling of Polymer-Surface Interactions"—J.W. Holubka, of Ford Motor Co.

"Mechanisms and Models of the Degradation of Protective Coatings on Steel Exposed to Electrolytes"—Tinh Nguyen, of U.S. Department of Commerce, National Institute of Standards and Technology



Chairman G. Pilcher

"Super Strong Polymers: Films and Coatings"—Flonnie Dowell, of Los Alamos National Laboratory

"Plasticized PVC Sheets with Low Matter Transfer: Modeling of the Process"—J.M. Vergnaud, of Laboratoire de Chimie des Matériaux et Chimie Industrielle, Université Saint-Etienne

"Films in Space"—Vincent D. McGinniss, of Battelle, Columbus Laboratories

"Photochemistry and High-Resolution Patterning of Self-Assembling Films"—Jeffery M. Calvert, of U.S. Department of the Navy, Naval Research Laboratory

"Corrosion Response of Organic Coatings to Strain"—James H. Bryson, of Inland Steel Co.

"Metal/Polymer Interfacial Films of the Pyroaurite Type Beneath Coatings"—Peter J.

Moreland, of ICI Resins and Andrew N. MacInnes, of Department of Chemistry, Harvard University

"Fractal Analysis of Engineering Surface Topographies"—Christopher A. Brown, of Mechanical Engineering Department, Worcester Polytechnic Institute

"Fractal Analysis Applied to Pigments in Coatings"—Brian H. Kaye, of Department of Physics and Astronomy, Laurentian University

"Rheology of Waterborne Dispersion as Affected by Associative Thickeners"—A.J. Reuvers, of Akzo International Research by "Conductive Latices"—Mahmoud Aldissi, of Champlain Cable Corp.

"Investigations into Magnetic, Monodispersed Particles, and Miniemulsion Polymerization"—John Ugelstad, of The Norwegian Institute of Technology, University of Trondheim

"Random Clustering of Dispersed Systems"—F. L. Floyd and R. M. Holsworth, of The Glidden Co.

"Structure Property Considerations in Solution Diffusion Membrane and Barrier Applications"—W.J. Koros, of Department of Chemical Engineering, The University of Texas at Austin

"Long Duration Exposure Facility (LDEF) Exposure of Selected Coatings and Films"—Philip R. Young, of NASA, Langley Research Center

For more details, contact Conference Chairman George R. Pilcher, Akzo Coatings, Inc., 1313 Windsor Ave., P.O. Box 147, Columbus, OH 43216-0147.

ICASC Sponsors Short Course On Rheology Principles

The ninth annual intensive short course, "Rheology: Principles and Practice," will be offered on April 29-May 1, Case Western Reserve University, Cleveland, OH. The course is sponsored by the InterUniversity Center for Adhesives, Sealants and Coatings (ICASC), which is jointly formed by The University of Akron and Case Western Reserve University.

Scheduled course lecturers include Irvin M. Krieger, of Case Western Reserve University; Richard Eley, of Glidden Coatings and Resins Co.; Alan Gent, of The University of Akron; and Robert M. Evans, Consultant.

Topics to be discussed include: introduction to rheology; rheometry; linear viscoelasticity; rheometry of coatings; simple fluids; dispersion rheology; adhesives and time-temperature superposition; polymeric fluids; rheology of sealants; and three-dimensional flow.

Write ICASC, Millis Science Center, Case Western Reserve University, Cleveland, OH 44106, for more details.

Short Courses Scheduled at Univ. of Southern Mississippi

The Polymer Science Department of the University of Southern Mississippi (USM), Hattiesburg, MS, has announced two short courses to be held this summer.

"Coatings Science for Coatings Technicians," short course is scheduled for July 22-26. This program is designed to provide coatings technicians lecture and hands-on laboratory instruction. The lecture will focus on basic principles of coatings design, synthesis, performance, and testing for industrial and trade sales coatings. The laboratory sessions will include instruction in, and use of, instrumentation and techniques for identifying, testing, and evaluating coatings.

Short course topics—tests performed on wet and/or applied coatings include: (I) Chemical Characterization: Infrared (FTIR), Gas Chromatography (GC), Molecular Weight by GPC, Differential Scanning Calorimetry (DSC), Nuclear Magnetic Resonance (Solid State, Solution, Multiple Probes), and X-ray; and (II) Physical Testing: Wet Paint and Applied Coatings.

The second course, "Coatings Science for Coatings Chemists," will be held August 5-9, and is designed to place special emphasis on coatings selection, design, formulation, testing, and durability. The topics

will be discussed within the overall objectives of waste reduction and lowering volatile organic compounds (VOC's) and consequently will emphasize latex, high solids, and powder coatings.

Items to be discussed include: The Design, Synthesis, Characterization, and Selection of Polymers; Selection and Formulation of Low VOC Coatings—Latex, High-Solids, and Powder Coatings; The Principles of Film Formation, Performance Requirements and Durability; Coatings Selection, Formulation, and Application; Appearance Properties of Coatings; The Concepts of Photoinitiation, Photopolymerization and in Particular Photodegradation; A Review of Associative Thickeners Technology; and Coating Analysis Tools.

The two courses will be held in the new Polymers Science Research Center at USM. Dr. Shelby F. Thames, Professor of Polymer Science, will be the Course Director for both.

For additional information, contact Ruth Holfield, Short Course Program Coordinator or Dr. Shelby Thames, Short Course Director, PSC Coatings Short Course, Southern Station, Box 10076, Hattiesburg, MS 39406.

Golden Gate Society to Focus on "Paint Technology and Quality For the 90s," at 1991 Conference, June 17, S. San Francisco, CA

The Golden Gate Society for Coatings Technology will hold a one-day conference "Paint Technology and Quality for the 90s," on June 17, 1991, at the Holiday Inn, S. San Francisco, CA. The objective of the conference is to help manufacturers become more efficient and less wasteful.

The scheduled program will provide methods of manufacturing and control. Equipment described by the speakers is designed to help manufacturers achieve emission goals.

The program is as follows:

"Computer Controlled Production for Industrial Paint Plants"—Puis Eigenmann, of Buhler, Inc.

"Statistical Quality and Process Control"—Bill Abercrombie, of J.M. Huber

"Criteria for Dispersion Equipment Control"—Christ Zoga, of Premier Mill Corp.

"Further Developments in Micro Fine Wet Grinding"—Edward Cossama, of Draiswerke, Inc.

"Formula Base Software"—Christy Hudson, of Pacific Microsoftware Engineering

"Recycling of Paint in the Plant"—Herbert C. Paulson, of Daly's Wood Finishing Products

"Computer Control Manufacturing"—Ken Edwards, of Dunn-Edwards

"Performance Oriented Packaging"—Mike McQuiston, of B.W. Norton Co.

Conference registration fee is \$70.00.

Hotel reservations must be made before May 31. Place reservations directly with the Holiday Inn at (800) 238-8000.

Contact Ron Hughes, Conference Co-Chairman, Ashland Chemical, 8600 Enterprise, Newark, CA 94560 for further details.

Paint VOC's Focus of ASTM Training Course

A two-day standards technology training course, "Paint Volatile Organic Compounds (VOC)," sponsored by American Society for Testing and Materials (ASTM), Philadelphia, PA, will be held May 8-9, in Los Angeles, CA, and November 7-8, in Toronto, Ont., Canada. This course includes laboratory demonstrations of gas chromatography, the Karl Fischer method, and others. The demonstrations will be held at the South Coast Air Quality Management District, in El Monte, CA for the May course; and at the Technical Service Laboratory, in Mississauga, Ont., Canada for the November program.

The basic principles of the ASTM test methods used to measure VOC under Ref-

erence Method 24 in the U.S. Environmental Protection Agency (EPA) New Source Performance Standard will be covered.

The course is designed for chemists and others who use EPA tests to determine if paints or coatings meet VOC requirements. Individuals from the paint industry, government regulatory bodies, commercial laboratories, and paint users can also benefit from the course.

For a free brochure, including program, registration, and hotel information, write Kathy Dickinson, ASTM, 1916 Race St., Philadelphia, PA 19103.



Univ. of Akron Receives \$350,000 from Rubbermaid

Gifts totaling \$350,000 have been awarded to The University of Akron, Akron, OH, by the Rubbermaid Foundation.

A monetary gift of \$275,000 will be distributed at \$55,000 per year over the next five years to the College of Polymer Science and Polymer Engineering and will be used for equipment purchases.

The Rubbermaid Foundation also pledged \$25,000 over the next five years to the University's Wayne College in Orrville.

Bowling Green Offers Spray Finishing Workshop

Bowling Green State University and DeVilbiss Ransburg Industrial Liquid Systems will be co-sponsoring a "Spray Finishing Technology Workshop," on May 13-17, at the Technical Training Center of DeVilbiss, in Toledo, OH.

The program will feature sessions on equipment and material selection, spray finishing techniques associated with industrial, furniture, contractor finishing, as well as automotive refinishing. In addition, topics associated with the latest technology—high volume low pressure, powder coating, robotic painting, plural component, and environmental and regulatory concerns—will be included.

Each participant will have an opportunity for "hands-on" practice and will earn 3.5 Continuing Education Units.

For additional details, contact Dr. Richard A. Kruppa, Professor of Manufacturing Technology, College of Technology, Bowling Green State University, Bowling Green, OH 43403.

ACS-Datcolor Donates Equipment to EMU and NDSU

Color control equipment has been presented to Eastern Michigan University (EMU), Ypsilanti, MI, by ACS-Datcolor, Princeton, NJ. The contribution will be used in the university's Interdisciplinary Technology Department's Polymers and Coatings Technology program.

The system and software will also be used for the university's Introduction to Color Technology class, offered by both EMU and the Detroit Color Council, whose objective is to "develop understanding of color as it relates to industrial processes."

The contribution consists of: an ACS-Datcolor 1800 system, providing full combinatorial color matching, batch correction, and color QC capabilities; a Spectro-Sensor II spectrophotometer; and an ACS Video Color System (VCS-11).

ACS-Datcolor also donated color control equipment to North Dakota State University for use in both undergraduate and graduate color science courses. The equipment will be used in research purposes into new color and appearance effects in coatings.

The contribution consists of an ACS-Datcolor Chroma Sensor CS-5 spectrophotometer and the loan of ACS-Datcolor Chroma-CALC paint and ink software packages.

Artificial Weathering; Subject of Symposium Sponsored by OCCA

"Progress in Artificial Weathering of Polymeric Materials," is the title of a one-day symposium sponsored by the Oil and Colour Chemists' Association, Wembley, Middlesex, England. The symposium will be held on May 9 at the Building Research Establishment, in Watford.

The symposium will consider the various artificial weathering procedures and the progress being made towards the establishment of a generalized European standard for surface coatings.

For further information on the technical program, contact Chris Pacey-Day, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, England HA0 2SF.

Cal Poly Develops Undergraduate Program in Polymers and Coatings

California Polytechnic State University, San Luis Obispo, CA, has announced the development of an undergraduate program in polymers and coatings. This program was developed with the support of the Los Angeles Society for Coatings Technology and the Golden Gate Society for Coatings Technology. The Societies have provided much of the equipment necessary for the coatings and polymers laboratory. They will provide internships and scholarships for students in the concentration, and help with recruitment of disadvantaged students from inner-city areas. The Societies will also provide guest speakers and help arrange field trips to appropriate companies several times a year. Support is also being sought from other industries.

This concentration will provide educational and professional experience to chemistry majors who wish to specialize in polymers and coatings science. The program meets the American Chemical Society requirements for certification as a chemistry/polymers degree. The Los Angeles Society has offered to help in the recruiting and retention of 20 or more new students per year for the concentration by promoting the program among employees, by publicizing the program in California high schools and community colleges, and by establishing scholarships. Twenty-three students began in the program in fall, 1990.

The concentration includes five courses in polymers and coatings, including two laboratory courses, and comprises a total of 18 quarter units. An industrial internship, lasting from three to six months, is a central part of the program. Graduates completing the concentration will have the academic knowledge, technical training, and applied experience to enter the polymer and coatings industries. Courses included in the concentration are listed as follows. The

concentration is designed to be compatible with the junior and senior year of the chemistry major.

Chem 444—Polymers and Coatings I: Overview of polymer synthesis and structure.

Chem 445—Polymers and Coatings II: Polymerization methods and mechanisms.

Chem 446—Surface chemistry of materials.

Chem 447—Polymers and Coatings Lab I: Synthesis and characterization of polymers.

Chem 448—Polymers and Coatings Lab II: Experimental techniques of producing and characterizing coatings.

Chem 449—Internship in Polymers and Coatings Industry.

The following course from the Metallurgical and Materials Engineering Department is also included in the concentration:

Met 306—Materials Engineering: Physical and mechanical properties of materials.

SUMMER SHORT COURSE IN PAINT CHEMISTRY—The Chemistry Department at Cal Poly, in conjunction with the Los Angeles Society, also offered a free short course in paint chemistry this past summer. The course was held on June 20-29, 1990, and students who completed the program worked in the

coatings industry as interns for the remainder of the summer. A similar course is planned for the summer of 1991.

INDUSTRY-RELATED RESEARCH—Students and faculty are involved in a number of research projects in the coatings area, with co-sponsorship of industry. Current and planned projects include analysis of amorphous carbon/diamond film coatings, testing of powder coatings for use in highly corrosive environments, and development of new drying oils. Since all students are required to complete a senior research thesis, further opportunities exist for industry to involve Cal Poly in their research project.

Special Academic Faculty Appointment—Dr. Robert Athey, President of Athey Technologies, El Cerrito, CA, has been appointed Associate Professor of Chemistry to assist in the development of the polymers and coatings concentration. Dr. Athey is a distinguished researcher and active educator for the coatings industry. He has extensive experience in the latex, plastics, paper, and rubber industries.

For further information on the polymers and coatings concentration at Cal Poly, contact Dane Jones, Chemistry Dept., California Polytechnic State University, San Luis Obispo, CA 93407.

Industrial Color Seminars Slated for May and June In Chicago, IL and Toronto, Ont., Canada

Applied Color Systems, Inc.—Datacolor, Lawrenceville, NJ, has announced its spring "Industrial Color Technology" seminar schedule.

Dates and locations for the seminars are as follows: May 15-16, Chicago, IL; and June 12-13, Toronto, Ont., Canada.

The programs are designed to focus on practical problem-solving in industrial applications with an eye toward providing fresh insights on new techniques. Topics to be covered include: colorimetry and factors affecting color; spectrophotometry and

metamerism; colorant characteristics and elements of formulation; color differences; Kubelka-Munk Turbid Media Theory application, and more.

Seminar lecturer is Ralph Stanzola, President of Industrial Color Technology, and winner of the 1981 Armin J. Bruning Award of the Federation of Societies for Coatings Technology.

Additional information on the seminars is available from ACS-Datacolor, 5 Princess Rd., Lawrenceville, NJ 08648.

Du Pont Offers Safety Seminars On Research and Engineering

Du Pont Safety and Environmental Resources, Wilmington, DE, is offering its Research & Engineering Management Safety Training Seminar. This two-day seminar is designed for those who oversee professionals in a research environment on how to integrate safety tools and strategies into their operations.

Dates and locations for 1991 will be: May 21-22—San Antonio, TX, and September 10-11—Hilton Head, SC.

Please direct inquiries to: Safety Seminars, Du Pont Safety and Environmental Resources, Customer Service Center, Brandywine Bldg. 15-305, 1007 Market St., Wilmington, DE 19898.

Eurocoat '91 to Be Held in Nice, France, Sept. 17-20

Eurocoat '91, the XIXth Congress and Exhibition of the Association of French Paint and Varnish Technicians (AFTPV), is scheduled to be held in Nice, France, on September 17-20.

The programming session will feature lectures relating to the paints, varnishes, printing inks, adhesives, tinting, and protection of plastics fields.

New innovations have been added to the XIXth Congress of AFTPV. The first one will deal with "Coloration and Protection of

Plastics." The topics presented will focus on coloring materials, additives, paints, and manufactured products.

Another new feature will be a presentation on "Color Matching." Lectures will cover the scope of color matching from simple visual examination to computer networks.

For more details, contact Annik Chauvel, AFTPV, 5, rue Etex, 75018 Paris, France.

Transducer

A transducer which reportedly has the capability to measure normal stress, in addition to measuring torque, is highlighted in a product bulletin. The transducer is provided as a complete assembly consisting of transducer and electronics. More information on the Normal Force Transducer can be obtained from Rheometrics, Inc., One Possumtown Rd., Piscataway, NJ 08854.

On-Site Solvent Recovery

Literature focuses on the environmental benefits, quality control, and cost savings incurred using on-site solvent recovery. The new brochure graphically illustrates how the solvent recovery system converts hazardous waste into reusable solvent. A copy of the publication is available from C.B. Mills, 1225 Busch Pkwy., Buffalo Grove, IL 60089.

Aqueous Copolymer Emulsion

Technical literature highlights an aqueous copolymer emulsion which can be applied either by spray or dip equipment. The product reportedly is miscible with water in all proportions and is designed to precipitate at low pH values to a granular, easily-filterable form. The report "Performance Review Lugalvan® HC-9549," is available from BASF Corp. Performance Chemicals, 100 Cherry Hill Rd., Parsippany, NJ 07054.

Color Measurement

A four-color, mini-product capabilities catalog which emphasizes a company's range of product capabilities has been published. Computer color matching, color quality control, retail color and decorating, and dispensing and batch weighing are highlighted in the publication. For further details on the "Color Measurement and Control Systems" catalog, write ACS-Datcolor, 5 Princess Rd., Lawrenceville, NJ 08648.

Chemical Lists

A booklet discusses 12 unique lists for marketing books, magazines, seminars, newsletters, symposiums, instruments, and other products and services. The literature also contains details on publications, meetings, and short courses. For a copy of the booklet "Key AOCs Lists," write Jennifer Nelson, AOCs Lists, P.O. Box 3489, Champaign, IL 61826-3489.

Compressed Air

A new, 65-page catalog which features compressed-air-powered products is in print. The literature contains photographs, drawings, technical bulletins, and applications. For a free copy of the catalog, write Vortec Application Engineering, 10125 Carver Rd., Cincinnati, OH 45242.

Weatherproofing

A product bulletin focuses on a new structure protection package for buildings and other structures having concrete, masonry, and dimension stone facades. The package has been designed to provide buildings with protection from hazardous conditions and expensive repairs which can result from water intrusion. Write GE Silicones, PR# CONST-01-91, P.O. Box 330, Poestenkill, NY 12140 for additional details on the structure protection package.

Copolymer Defoamer

A product data sheet highlights a modified polysiloxane copolymer defoamer for gloss and semigloss architectural paints and waterborne coatings. The defoamer also has applications in gravure and flexographic inks. Write Marketing Services, Drew Industrial Div., One Drew Plaza, Boonton, NJ 07005 for details on Drewplus® L-404.

Chemicals

A new, illustrated brochure which describes the products and capabilities of a company's chemical division is available. The eight-page publication profiles four product areas: intermediates and specialty chemicals, silanes and silicones, specialty lubricants, and plastic additives. A copy of the brochure can be obtained from Hüls America Inc., Chemical Div., P.O. Box 456, 80 Centennial Ave., Piscataway, NJ 08855.



R&D SPECIALIST:

ADVANCED ORGANIC COATINGS AND PAINTS

Work with the company that leads the way to aviation's future: Lockheed's legendary Skunk Works, also known as Lockheed Advanced Development Company (LADC).

The successful candidate will conduct and coordinate research and development in the field of advanced organic coatings; investigate application processes for newly developed and currently used materials; develop and test new coatings, films and paint products; and devise and direct the manufacture of specialty coating materials.

Requirements include extensive experience in new product R&D, specifically in the paints and coatings industry. A BS in Chemistry or Material Science is preferred. Must also be familiar with SCAQMD and OSHA regulations; current equipment application and finish requirements; use of automated and conventional spray equipment; and color matching and shading in grind portion. U.S. citizenship may be required.

LADC provides highly competitive salaries and benefits. For immediate consideration, send your resume to: Lockheed Advanced Development Company, Professional Staffing, P.O. Box 250, Dept. 0002, Sunland, CA 91041. Or FAX to: (818) 847-9458. Equal Opportunity Employer M/F/H.



Lockheed

Advanced Development Company

INNOVATION: giving shape to imagination.



Vinyl-Acrylic Emulsion

A new generation of vinyl-acrylic emulsion for interior and exterior paints is the focus of a brochure. The publication discusses the use of the emulsion in both interior and exterior paints, and provides typical emulsion properties, suggested formulations, and performance comparisons. For a copy of "Flexbond® 380 Dev—A New Generation Vinyl-Acrylic Emulsion for Interior and Exterior Paints," write Air Products and Chemicals, Inc., Polymer Chemicals Div., 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Air Quality

A brief review of the issues relating to air quality and atmospheric pollution is the subject of a new publication. The 20-page, four-color brochure discusses the issues of urban smog, stratospheric ozone, global warming (or the "greenhouse effect"), acid rain, and indoor air pollution. The text covers a definition of each problem, its sources, and possible solutions, and the national and international bodies working to remedy environmental problems. For a copy of "Breathing Easy," write The Dow Chemical Co., 2020 Willard H. Dow Center, Midland, MI 48674.

Paint Mixer

A new top-loading paint mixer is the subject of technical literature. The mixer features a cabinet of gun metal gray, a large top-loading lid, and a paint can holder and latch to accommodate metal or plastic pint, quart, or gallon cans of varying height. For further details on Auto Spense® Model 5604, write Red Devil, Inc., 2400 Vauxhall Rd., Union, NJ 07083-1933.

Aluminum Pigments

A product bulletin describes three new aluminum pigments designed for use in liquid inks. The products are based in isopropyl alcohol and can be used in both water- or solvent-based flexo and/or gravure inks. For details on the EternaBrite® products, write Silberline Mfg. Co., R.D. #2, Hometown, Tamaqua, PA 18252.

Plastic Cleaners

A line of plastic cleaners for preparing plastic substrates for finishing is the focus of technical literature. The cleaner includes special conditioners and anti-static compounds to assure maximum results. For additional information on Polyspray™ plastic cleaners, write Man-Gill Chemical Co., 23000 St. Clair Ave., Cleveland, OH 44117.

Wood Furniture Finishing System

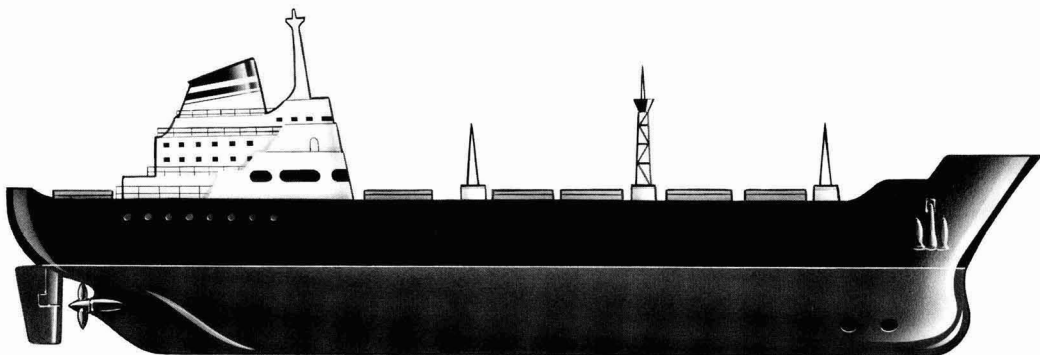
A waterborne air- or ultraviolet-curable finishing system for wood furniture has been introduced in a product data sheet. The system may be applied and cured on conventional furniture finishing lines and includes a palette of stains, a waterborne sealer, and a waterborne topcoat. More information is available from PPG Industries, Customer Service Center, 7601 Business Park Dr., Greensboro, NC 27409.

Plastics Coatings

A new, four-color brochure highlights a complete line of coatings for plastic substrates. The product line includes primers and topcoats for rigid, semi-rigid, and flexible plastics, both thermoset and thermoplastics. For a copy of the publication, write Akzo Coatings Inc., P.O. Box 7062, Troy, MI 48007-7062.

Standards

The 1991 ASTM Publications Catalog describes 68 volumes of the *Annual Book of ASTM Standards* and several hundred related technical publications. The catalog is available from ASTM Customer Service, 1916 Race St., Philadelphia, PA 19103.



We help protect more ships than sonar.

When a tough problem puts epoxy paint formulators between the devil and the deep blue sea, they come to Schering Berlin Polymers—the *polyamide people*.

With proprietary resin technology backed by worldwide support, we have curing agents to help you formulate coatings that stick to

clammy hulls. Or slippery floors. Or cold castings. And they'll keep sticking—even in some very tough environments.

In fact, *nobody* has more capability in high-performance polyamide resins—coatings, inks, or adhesives—than Schering Berlin Polymers.

So if a unique coating solution is

what you need, call John Craft at (800) 247-0741.

And in no time at all, we'll make sure we have you covered.



SCHERING BERLIN
Polymers

The polyamide people.

Box 1227, Dublin, Ohio 43017
Telefax 614/793-7711

Phenolic Resins

A 20-page booklet on phenolic resins for container coatings has been issued. The literature describes two phenolic resins designed to have compatibility with alkyds, epoxies, melamines, phenoxies, PVB, and vinyls. A copy of the booklet, "UCAR® Phenolic Resins for Container Coatings," designated F-60776, is obtainable from Union Carbide Chemicals and Plastics Co. Inc., Dept. L4489, 39 Old Ridgebury Rd., Danbury, CT 06817-0001.

Additives

A new, six-page, four-color technical brochure detailing a full line of additives for PVC-processing has been published. Included in the publication is an easy to read chart, with complete specifications and characteristics. Contact George Walsh, Unichema North America, 4650 Racine Ave., Chicago, IL 60609 for a copy of the brochure.

Carbon Dioxide Applications

How merchant CO₂ can be an environmentally safe and economical alternative to undesirable methods and products used in various commercial applications is the topic of a new brochure. The eight-page booklet explains the natural role of CO₂ in the environment and describes a number of applications for the gas, including water treatment, cryogenic recycling, grain fumigation, greenhouse atmospheres, solvent vapor recovery, and cryogenic cleaning. For more information, request Form #6924 from Liquid Carbonic, Advertising Dept., 135 S. LaSalle St., Chicago, IL 60603.

Wet Grinding

A new, full color, eight-page brochure which introduces a new patented concept in wet grinding and dispersing is in print. The literature contains text and photographs, and a wide range of application areas are defined. For more information, write Draiswerke, Inc., 3 Pearl Ct., Allendale, NJ 07401.

Hydrocarbon Detector

A new gas sensor designed to monitor hydrocarbon concentrations in the low parts per million ranges is the focus of literature. The flame ionization detector has been produced for sensitive detection applications such as workplace area monitoring, fugitive emissions detection, incinerator/recovery system efficiency checks, soil contamination measurement, fence line monitoring, and hydrocarbon breakthrough detection in solvent recovery systems. For additional details, write Control Instruments Corp., 25 Law Dr., Fairfield, NJ 07004-3295.

Thermal Analysis

A line of supplies and accessories for thermal analysis instruments is featured in a 52-page catalog. The literature includes photographs, illustrations, and relevant technical information to assist paint and coatings laboratories in selecting the correct parts for their operations. For a copy of the catalog, write PE Express, The Perkin-Elmer Corp., 761 Main Ave., Norwalk, CT 06859.

Liquid Packaging Machine

Literature introduces a liquid packaging machine which reportedly is capable of handling drums of various diameters and capacities. The product includes an automatic bung finder and automatic probe filler. Data on the Model DF 5500 BF Fully-Automatic Drum Filler are obtainable from Ambrose Co., 20325 71st Ave., N.E., Ste. D, Arlington, WA 98223.

Now - a single expandable system
measures particles from
**.005 to 700
MICRONS**

The MICROTRAC® Series 9200 system measures
particles over this wide range! And it's
modular: Get the ranges you need now -
FRA (0.1-700 microns), SRA (0.7-700 microns),
or UPA (0.005-3 microns). Expand later,
easily and economically.

Grow with
MICROTRAC ✦

Call 1-800-LEEDSCO

MICROTRAC
FRA

LEEDS & NORTHROP
A UNIT OF GENERAL SIGNAL

Sumneytown Pike, North Wales, PA 19454 USA
(215) 699-2000 • FAX (215) 699-3702

Book Review

ALKYLENE OXIDES AND THEIR POLYMERS

By
F.E. Bailey, Jr. and
Joseph V. Koleske

Published by
Marcel Dekker, Inc.
270 Madison Ave.
New York, NY 10016 (1990)
vi + 261 Pages, \$125.00

Reviewed by
Thomas J. Miranda
The Whirlpool Corp.
Benton Harbor, MI

This is Volume 35 of the Surfactant Science Series and covers the chemistry, applications, history, polymerization, physical properties, and utility of these interesting polymers. The authors, in excellent readable style, describe the early his-

tory, preparation of ethylene oxide and some of its uses. This is then followed by a chapter on the polymerization of ethylene oxide and its derivatives. This chapter provides information on the synthesis of poly(alkylene oxide)s, the various initiators and catalysts used for polymerization, and the mechanisms of polymerization. An interesting description is given for producing immortal polymers. Unlike living polymers, described by Szwarc, which can be killed by a protic compound like HCl, immortal polymers prepared from aluminum porphyrins, are not destroyed by protic species and are hence immortal.

Following the polymerization of 1,2 epoxides, a chapter deal with analytical methods and the chemistry of the poly(alkylene oxide)s including grafting, preparation of radiation curable derivatives and elastomers. A chapter is then devoted to the physical properties of poly(alkylene oxide)s and their derivatives. Solubility, phase behavior, crystallization, association complexes of

these polymers with salts which produce remarkable changes in the glass transition (increases), blends and dielectric phenomena are described.

The volume closes with a number of applications of these polymers including medical, slow release of drugs, cosmetic, surfactant, lubricant, textile chemicals, coolants, and in insulation and foam materials. In addition, the use of these important polymers includes fascia of automobiles, seating and arm rests using Reaction Injection Molding (RIM) and Reinforced Injection Molding (RRIM). Other interesting applications include electro and biomechanical energy polymers and their future potential.

The authors have succeeded in presenting a wealth of useful information, over 700 references to critical, but hard to find literature. This volume will be of good value to those in the adhesive, coatings, plastic, and polymer synthesis fields and will serve as a useful reference source.

We Won't Leave You Holding The Bag.



Order semi-bulk calcium carbonates from Genstar, and you won't have 40 empty bags lying around for every ton you order.

You'll also save \$5 a ton. Because we won't make you pay for bags you didn't order in the first place. And we'll process your order in 24 hours or less.

So if you'd like to give bags the boot, give Genstar a call: 301-527-4221.

Calcium Carbonates in
Semi-Bulk Bags From **GENSTAR**

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (215) 940-0777, FAX: (215) 940-0292.

1991

(May 13-16)—Federation "Spring Week." Seminar on the 13th and 14th; Board of Directors Meeting on May 15; and Society Officers Meeting on May 16. Sheraton Society Hill Hotel, Philadelphia, PA.

(Nov. 4-6)—69th Annual Meeting and 56th Paint Industries' Show. Convention Center, Toronto, Ontario, Canada.

1992

(Oct. 21-23)—70th Annual Meeting and 57th Paint Industries' Show. McCormick Place, Chicago, IL.

SPECIAL SOCIETY MEETINGS

1991

(May 2-4)—Pacific Northwest Society. Annual Symposium. Meridien Hotel, Vancouver, British Columbia, Canada. (John P. Berghuis, Kronos Canada, Inc., 3450 Wellington Ave., Vancouver, B.C., Canada V5R 4Y4).

(June 3-5)—"Resins for Coatings." Course sponsored by the Mexico Society. Cocoyoc Country Club, Mexico. (Gerardo del Rio, Telephone: 52 (5) 5-43-64-88; Fax: 52 (5) 6-82-79-75; or Jorge Rodriguez, Telephone: 52 (36) 12-72-72; Fax: 52 (36) 11-52-18).

(June 5)—"Increasing Productivity Through Employee Development and Motivation." Seminar jointly sponsored by the Chicago Society and the Chicago Paint and Coatings Association. (John G. DeVaney, Cabot Corp., 2655 Irving St., Portage, IN 46368).

(June 6)—Cleveland Society. 34th Annual Technical Conference. B.F. Goodrich R&D Center, Brecksville, OH. (Devilla Moncrief, Sherwin-Williams Co., Cleveland Technical Center, 601 Canal Rd., Cleveland, OH 44113).

(June 7-8)—Joint Meeting of the St. Louis and Kansas City Societies. Holiday Inn, Lake of the Ozarks, MO.

(Aug. 22-24)—Mexico Society. "Fourth Annual Technical Conference." Guadalajara, Jalisco. (Gerardo del Rio, Telephone: 52 (5) 5-43-64-88; Fax: 52 (5) 6-82-79-75; or Jorge Rodriguez, Telephone: 52 (36) 12-72-72; Fax: 52 (36) 11-52-18).

OTHER ORGANIZATIONS

1991

(Apr. 14-17)—"Raw Materials & Equipment" Seminar. Sponsored by the The Adhesives and Sealant Council, Inc. Adam's Mark Hotel, St. Louis, MO. (The Adhesive and Sealant Council, Inc., 1627 K St., N.W., Suite 1000, Washington, D.C. 20006).

(Apr. 15-17)—Surface Coating 1991. Sponsored by Chemical Coaters Association. Indian Lakes Resort, Bloomington, IL. (Chemical Coaters Assoc., P.O. Box 44275, Cincinnati, OH 45244).

(Apr. 22-25)—The Euro-Asian Interfinish Isreal 1991. Conference sponsored by the Metal Finishing Society of Isreal. Herzlia, Isreal. (Secretariat, Ortra, Ltd., 2 Kaufman St., Tel-Aviv 61500, Isreal).

(Apr. 22-26)—"Applied Rheology for Industrial Chemists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Apr. 25-27)—Second Annual "Surfaces '91" Trade Show. Sponsored by The Western Floor Covering Association. Las Vegas Convention Center, Las Vegas, NV. (Sheila Harman, B.P. Rice & Co., Inc., 13079 Artesia Blvd., Ste. 228, Cerritos, CA 90701-3312).

(Apr. 29-30)—"Computer Solutions for Formula-Based Manufacturing" Seminar. Sponsored by Pacific Micro Software Engineering and Great Lakes Systems. Lombard, IL. (Evelyn O'Neill, Operations Manager, Pacific Micro Software Engineering, 35-59th Place, Long Beach, CA 90803).

(Apr. 29-May 1)—"Rheology: Principles and Practice" Short Course. Sponsored by the Interuniversity Center for Adhesives, Sealants, and Coatings (ICASC). Case Western Reserve University, Cleveland, OH. (ICASC, Mills Science Center, Case Western Reserve, Cleveland, OH 44106).

(Apr. 29-May 2)—15th Annual Conference Course on "Thermal Analysis in Research and Production," on Apr. 29-May 1, and Fourth Intensive Short Course on "Viscoelastic Properties of Polymers," on May 2. Park Ridge Marriott Hotel, Park Ridge, NJ. (Edith A. Turi, Polytechnic University, 333 Jay St., Brooklyn, NY 11201).

(Apr. 29-May 3)—Evaluation and Durability Conference. Co-sponsored by Steel Structures Painting Council (SSPC), Pittsburgh, PA. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

(May)—ASTM Committee B-8 on Metallic and Inorganic Coatings meeting. Atlantic City, NJ. (George A. DiBari, International Nickel Co., Park 80 West—Plaza Two, Saddle Brook, NJ 07662).

(May 5-8)—"Trends in Color and Fashion." Conference co-sponsored by the Inter-Society Color Council (ISCC) and The Color Association of the United States. Doral Inn, New York, NY. (Jim DeGroff, ISCC, Colorcote Associates, Inc., P.O. Box 636, Old Wick, NJ 08858).

(May 6-9)—Powder & Bulk Solids Conference/Exhibition. O'Hare Exposition Center, Rosemont (Chicago), IL. (Angela Piermarini, Show Manager, Cahners Exposition Group, 1350 E. Touhy Ave., P.O. Box 5060, Des Plaines, IL 60017).

(May 6-10)—"Dispersion of Pigments and Resins in Fluid Media." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(May 7-9)—"Formulating Chemical Products." Short course sponsored by McMaster University. Venture Inn, Burlington, Ontario. (Stienna Thomas, JHE 136, Dept. of Chemical Engineering, McMaster University, Hamilton, Ont., Canada L8S 4L7).

(May 8-9)—"Paint Volatile Organic Compounds." Course presented by ASTM, Los Angeles, CA. (Kathy Dickinson, ASTM, 1916 Race St., Philadelphia, PA 19103).

(May 9)—"Progress in Artificial Weathering of Polymeric Materials" Symposium. Sponsored by OCCA, Watford, England. (Chris Pacey-Day, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, England HA0 2SF).

(May 12-15)—AOCS 82nd Annual Meeting & Expo. Sponsored by The American Oil Chemists' Society. Chicago Marriott Hotel, Chicago, IL. (Myra Barenberg, AOCS, P.O. Box 3489, Champaign, IL 61826-3489).

(May 13-17)—"Spray Finishing Technology Workshop." Sponsored by Bowling Green State University and DeVilbiss Ransburg Industrial Liquid Systems. Toledo, OH. (Richard A. Kruppa, Professor of Manufacturing Technology, College of Technology, Bowling Green State University, Bowling Green, OH 43403).

(May 13-18)—"Interpretation of IR and Raman Spectroscopy Course, Lectures, and Workshops." Vanderbilt University, Nashville, TN. (Fisk Infrared Institute, Box 15, Fisk University, Nashville, TN 37203).

(May 14-16)—PaintCon '91. Conference and exhibition sponsored by *Industrial Finishing* magazine. O'Hare Expo Center, Chi-

Rolla (UMR), Rolla, MO. (Norma Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(July 22-26)—"Coatings Science for Coatings Technicians" Short Course. Sponsored by the University of Southern Mississippi (USM), Hattiesburg, MS. (Ruth Holifield or Shelby Thames, Dept. of Polymer Science, USM, Southern Station, P.O. Box 10076, Hattiesburg, MS 39406).

(July 29-Aug. 2)—Gordon Research Conference on the Chemistry and Physics of Coatings and Films. Colby-Sawyer College, New London, NH. (George Pilcher, Akzo Coatings, Inc., 1313 Windsor Ave., P.O. Box 147, Columbus, OH 43216-0147).

(Aug. 5-9)—"Coatings Science for Coatings Chemists" Short Course. Sponsored by the University of Southern Mississippi (USM), Hattiesburg, MS. (Ruth Holifield or Shelby Thames, Dept. of Polymer Science, USM, Southern Station, P.O. Box 10076, Hattiesburg, MS 39406).

(Sept. 3-5)—2nd International Paint Congress. Sponsored by The Brazilian Association of Paint Manufacturers (ABRAFATI). Anhembi Convention Centre, São Paulo, Brazil. (Especifica S/C Ltd., Rua Augusta, 2516—2nd Floor, Ste. 22, 01412, São Paulo, SP, Brazil).

(Sept. 9-13)—63rd Introductory Short Course on "The Basic Composition of Coatings." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Sept. 10-12)—North American Hazardous Materials Management Conference and Exhibition. Sponsored by *HazMat World* magazine. Cobo Hall, Detroit, MI. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E, Ste. 408, Glen Ellyn, IL 60137).

(Sept. 17-20)—Eurocoat 91. XIX International Congress/Exhibition. Nice, France. (A. Chauvel, AFTPV, 5, rue Etex, 75018 Paris, France).

(Sept. 24-26)—The Polyurethanes World Congress 1991. Co-sponsored by the European Isocyanate Producers Association and the Polyurethane Division of The Society of Plastics Industry (SPI), Inc. of the USA. Acropolis Arts & Convention Center, Nice, France. (Fran Lichtenberg, Polyurethane Div., SPI, 355 Lexington Ave., New York, NY 10017).

(Sept. 29-Oct. 2)—RADTECH Europe '91 Conference and Exhibition. Edinburgh Exhibition and Trade Centre, Edinburgh, Scotland. (Exhibit Manager, RADTECH 91, c/o FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS, United Kingdom or Conference Secretary, RADTECH '91, c/o PRA, Waldegrave Rd., Teddington, Middlesex, TW11 8LD, England).

(October)—ASTM Committee B-8 on Metallic and Inorganic Coatings meeting. Philadelphia, PA. (George A. DiBari, International Nickel Co., Park 80 West—Plaza Two, Saddle Brook, NJ 07662).

(Oct. 2-4)—Hazardous Materials Management Conference and Exhibition/South (HazMat/South). Sponsored by *HazMat World* magazine. Georgia World Congress Center, Atlanta, GA. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E, Ste. 408, Glen Ellyn, IL 60137-5835).

(Oct. 7-10)—"Introduction to Coatings Technology." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Oct. 9-11)—"Verbundwerk '91." 3rd International Trade Fair on Composite Technology, Reinforced Plastics, Metals, and Ceramics. Rhein-Main-Halls, Wiesbaden, Germany. (Diana Schnabel, DEMAT, Postbox 110 611, 6000 Frankfurt 11, Germany).

(Oct. 16-18)—"Accelerated and Natural Weathering Techniques for Coatings and Polymers." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Oct. 21-25)—23rd Introductory Short Course on "Paint Formulation." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Oct. 28-Nov. 1)—"Fundamentals of Chromatographic Analysis." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Oct. 28-Nov. 1)—Ninth International Conference on "Photopolymers," on Oct. 28-30, and Fourth International Conference on "Polyimides," on Nov. 1. Sponsored by the Society of Plastics Engineers, Inc. (SPE). The Nevele Country Club, Ellenville, NY. (Prabodh Shah, c/o SPE, Mid Hudson Section, P.O. Box 546, Hopewell Junction, NY 12533).

(Nov. 4-5)—"Electrochemical Impedance: Analysis and Interpretation." Symposium sponsored by ASTM Committee G-1 on Corrosion of Metals. San Diego, CA. (John R. Scully, Sandia National Labs., Org. 1834, P.O. Box 5800, Albuquerque, NM 87185).

(Nov. 6-8)—POWDEX. Organized by Cahners Exhibition Group. Georgia World Congress Center, Atlanta, GA. (Angela Piermarini, Show Manager, Cahners Exposition Group, 1350 E. Touhy Ave., P.O. Box 5060, Des Plaines, IL 60017-5060).

(Nov. 7-8)—"Paint Volatile Organic Compounds." Course presented by ASTM, Toronto, Ont., Canada. (Kathy Dickinson, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Nov. 8-12)—1991 International Surface Finishing & Coatings Exhibition (SF China '91) and the 1991 International PC Board Making & Electro-Chemicals Exhibition (PCB China '91). Shanghai Exhibition Center, Shanghai, P.R. China. (Sinostar International Ltd., 10A Harvest Moon House, 337-339 Nathan Rd., Kowloon, Hong Kong).

(Nov. 10-15)—1991 National Conference and Exhibition of Steel Structures Painting Council (SSPC). Long Beach Convention Center, Long Beach, CA. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

1992

(Feb. 23-26)—Williamsburg Conference, "Comparison of Color Images Presented in Different Media." Co-sponsored by the Inter-Society Color Council and the Technical Association of Graphic Arts, Colonial Williamsburg, VA. (Milton Pearson, RIT Research Corp., 75 Highpower Rd., Rochester, NY 14623).

Advertisers Index

AIR PRODUCTS AND CHEMICALS, INC.	15
ALLIED SIGNAL	Cover 2
AQUALON CO.	2
ASHLAND CHEMICAL, INC.	13
CABOT CORP.	21
COOKSON PIGMENTS, INC.	5
DOW CORNING	Cover 3
DRY BRANCH KAOLIN	1
EXXON CHEMICAL	76
GENSTAR STONE PRODUCTS, INC.	74
HALOX	64
HARCROS PIGMENTS INC.	22
HENKEL CORP.	11
HÜLS AMERICA INC.	19
S.C. JOHNSON & SON	9
KTA-TATOR, INC.	61
LEEDS & NORTHRUP	73
LOCKHEED ADVANCED DEVELOPMENT CO.	71
RHEOMETRICS	65
SCHERING BERLIN POLYMERS	72
SHAMROCK TECHNOLOGIES, INC.	Cover 4
WITCO CORP.	55, 57, 59

NOTE: The Advertisers' index is published for the convenience of our readers and as an additional service to our advertisers. The publishers assumes no liability for errors or omissions.

'Humbug' from Hillman

I leave it to the scientific baby sitters in our midst to offer constructive and sympathetic assistance to Dave Duncan of Freeport, Texas. Here follows Dave's analysis, slightly edited, of an age-old problem. It sounds more like a pathetic call for help to me.

Scientific Principles Revealed in Feeding A Nine Month-Old-Baby

I went to school, some call it higher education, for four years to get a degree in a scientific field. During that time many basic concepts were expounded at great length. Some of these concepts are discernible in everyday life (e.g., rocket ships, radio astronomy, nuclear physics, etc.), but frequently their application is somewhat obscure. Occasionally, some of my training does help me understand things that go on around me.

For example, one day while sitting at the high chair, feeding our nine-month-old, it hit me. No, it wasn't just the food flying from the spoon that hit me, but much more. Steric hindrance is a chemical principle that is used to explain why two materials that should react with each other, do not. In simplest terms, the reactive atom in one molecule is prevented from contacting the complementary atom in the second molecule because something is geometrically hindering these two atoms from getting close enough to react with each other. This complex abstract principle is a stumbling block to many would-be chemists and here is the perfect analogy. Why can I not get a spoonful of food to enter (react with) the mouth? They are tragically destined not to meet, due to the steric hindrance of the ever-moving arms which effectively block the path!

Still more enlightenment was to come. The Heisenberg Uncertainty Principle is a really rough principle in physics. Simply, it states that the faster a body is in motion, the less precisely you can define its location at any given instant. This principle is the basis for justifying the claim that an electron, about 1,000,000 times smaller than an atom is present at any and all points on the surface of that atom at any given instant. Here, in front of me was nine months of perfect example. Those tiny hands, those short little arms, how could they block me from putting those peaches in that mouth? Because those hands and arms seem to be everywhere at once, just like the little electron.

Ah, now that I have effectively neutralized the steric hindrance, these peaches should go right in. ZIP! The little mouth moves from right to left. PIZ! The little mouth moves from left to right. Now I take aim. I thrust. ZIP, PIZ, ZIP! There was a song that went, "My mama said not to put beans in my ears, beans in my ears, beans in my ears." I guess strained peaches would not violate that sound bit of medical advice. Then it dawned on me, was Heisenberg only stating what we already know,—that it is hard to hit a moving target?

It's hard to imagine; a neatly dressed little boy; a small amount of peaches neatly contained in a jar; paper towels for cleaning any incidental spills—to transform into this mess! Food is on the wall behind me. Food-contaminated towels are on the floor. Food and slobber are on those once clean clothes. Food covers that sweet smiling face. (Thank goodness that eyebrows are wash and wear.) This is a good example of the thermodynamic

law of entropy! There is no truth to the rumor that the law was postulated by a physicist as he looked at his teenager's room, although that has been cited many times as the classic demonstration of this thermodynamic law. It is the natural order of things to change from a state of order to a state of disorder. Looking around me, I think, "Boy, can you say that again."

Although, I have never seen it in any textbook, or stated as a lab objective, there is one law of science that was demonstrated in every lab I have ever been in. That law is Murphy's Law,—"If anything can go wrong, it will." I suspect it resides under the guise of "experimental error" in the text books. Feeding this kid is definitely an example of things that could go wrong, going wrong.

The thought has occurred to me that this would be an exceptionally instructive exercise for a lab experiment. Feeding a nine month old baby would reveal numerous scientific concepts to uninitiated undergraduates. But then the practical side takes over. Ordering a nine-month-old baby from a raw material supplier would be rather difficult. Biological supply houses can supply frogs, rabbits, and mice galore, but nary a baby.

At that moment, my wife walked in. "What in the world happened here?"

"Entropy," I answer.

"I mean, how did peaches get in his ear?"

"It is all a function of Heisenberg's Uncertainty Principle!" I said.

"For heaven's sake, all you have to do is put the food in his mouth."

"That might be true, but you did not account for Steric Hindrance," I advised.

"What?! Oh, forget it. I wish you could do things without making such a mess."

—Dave Duncan

While you are still trying to interpret Ray Dickie's "Well Known Axioms Translated into Governmental Language," here are some more on which to ponder.

—Individuals who make their abode in vitreous edifices would be advised to refrain from catapulting petrous projectiles.

—Exclusive dedication to necessitous chores without interlude of hedonistic diversion renders John one habitudinous fellow.

—A revolving lithic conglomerate accumulates no congeries of a small bryophytic plant.

—The person presenting the ultimate cackination possesses the optimal cackination.

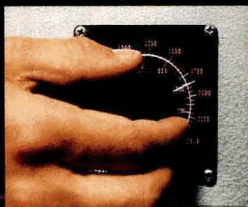
—Abstention from any aleatory understanding precludes a potential escalation of a lucrative nature.

—Missles of ligneous or petrous consistency have the potential of fracturing my osseous structure, but appellations will eternally remain innocuous.

—Persons of imbecilic mentality divagate in parameter which cherubic entities approach with trepidation.

—Elementary sartorial techniques initially applied preclude repetitive actions to square of three.

—Herb Hillman
Humbug's Nest
P.O. Box 135
Whitingham, VT 05361



We're turning up the heat on our high-performance resins.

High-performance silicone resins have become a hot topic at Dow Corning.

After all, we've increased our production capacity by more than 50%. We've instituted a rigid process control system. And we've established a 95% on-time delivery program which we're working hard to beat.

Some might be satisfied with all that. Not us. We're intensifying our efforts, especially in product quality.

We're finding technologies that significantly extend – in many cases double – the shelf life of our resins. We're developing new high-performance resins with lower volatile organic content. And, as always, we're looking for ways to improve your paint and coating weatherability, durability, and temperature resistance.

It's an all-out effort spearheaded by the most experienced staff in silicone resin chemistry.

Find out how our dedication can benefit you.

Call 1-800-637-5377, Ext. 8241.

DOW CORNING

New Texture Series.

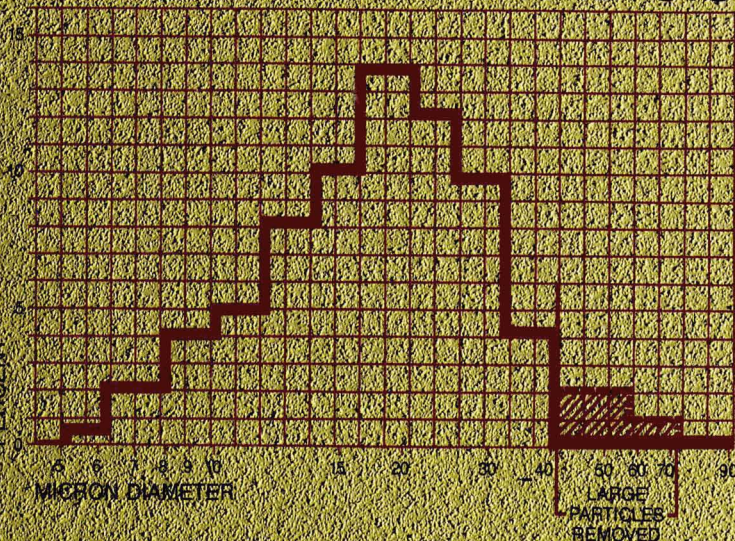
Even-sized 25, 40, 55 and 75 micron stir-in textures.

unretouched photo shown at 3x actual size

When your coating is being utilized for easy-care textured finishes, and an even suede-like texture is your goal... the new Texture series is your answer. In carefully configured particle ranges (see Coulter diagram at left) we screen out the oversize particles to eliminate any abrasive "feel" to the end product. Offered in 4 sizes—25, 40, 55 and 75 microns, they are compatible to solvent and water-base formulations. With a high melt viscosity useful for bake or air dry systems. It will not lose particle definition at 350° F. bake cycles. Manufactured of crystalline polypropylenes, the stir-in powders disperse easily under high-speed mixing equipment. A small quantity of the selected micron size will provide uniform texture.

Call our coatings lab for more details, specs, samples.

PARTICLE SIZE ANALYSIS



Sales Regions:

Georgia Kinsmen Corp.
Atlanta, GA (404) 355-9550

Illinois Shamrock Regional Office
Chicago, IL (708) 629-4652

Michigan A.T. Callas Co.
Troy, MI (313) 643-9280

Missouri Cemsac Chemical
St. Louis, MO (314) 532-4330

Ohio Sexton & Co.
Cincinnati, OH (513) 542-1925

Pennsylvania S.E. Firestone Associates
Philadelphia, PA (215) 635-1366

J.M. Gillen Co.
Cuddy, PA (412) 257-3300

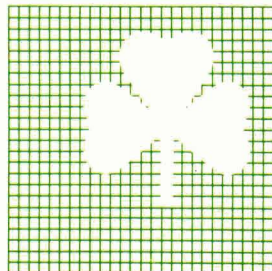
Texas Stamat, Inc.
Dallas, TX (214) 333-2181

Canada Industrial Colours & Chem.
Brampton, ONT (416) 453-7131

Shamrock Technologies, Inc.
Foot of Pacific St., Newark, N.J. 07114

Phone: (201) 242-2999

Fax: 201-242-8074/Telex: 138691



Shamrock