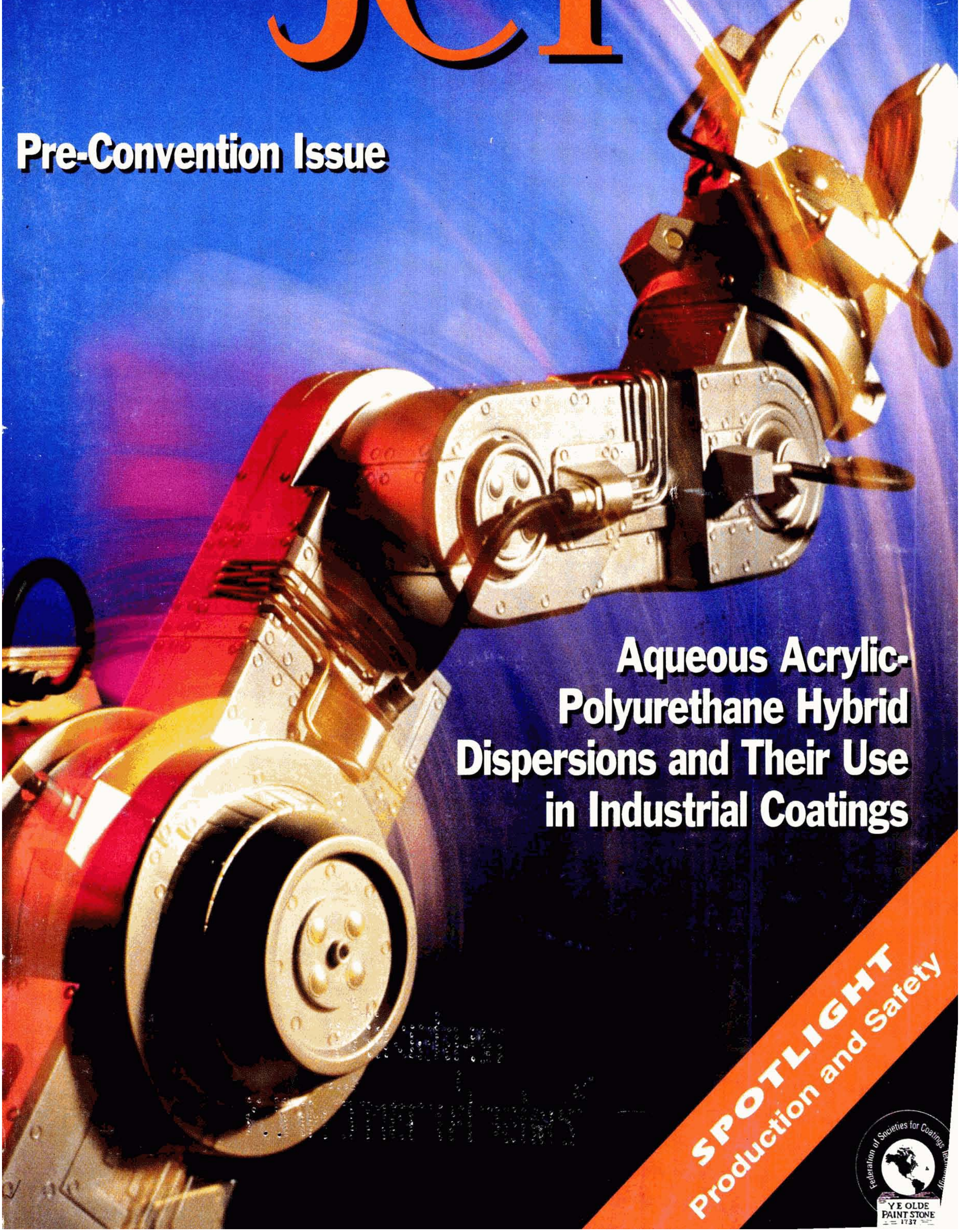
September 1996

JCT

JOURNAL OF COATINGS TECHNOLOGY

Pre-Convention Issue



Aqueous Acrylic-Polyurethane Hybrid Dispersions and Their Use in Industrial Coatings

SPOTLIGHT
Production and Safety

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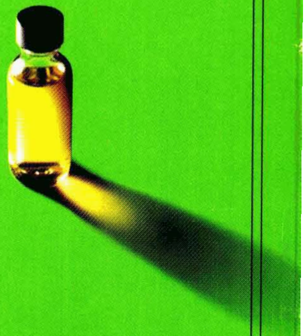

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INTERNATIONAL COATINGS EXPO
AND TECHNOLOGY CONFERENCE

SEPTEMBER 1996 VOL. 68, NO. 860

Technical Articles

39 Aqueous Acrylic-Polyurethane Hybrid Dispersion and Their Use in Industrial Coatings—C.R. Hegedus and K.A. Kloiber

This paper discusses an improvement in waterborne coatings technology through the development and application of acrylic-polyurethane hybrid dispersions.

49 Liquid, Sprayable, "Zero" VOC Coatings Utilizing Cycloaliphatic Epoxies—R.F. Eaton and K.T. Lamb

Addressed is a topic of interest to the general coatings industry. This manuscript illustrates a good experimental technique and an approach to achieve the objective—lower VOC.

57 Use of Castor Oil in the Preparation of Various Oil-Based Binders—O.S. Kabasakal et al.

The preparation of resins from castor oil is reviewed and an innovative approach to the preparation of resins for air-dry coatings is described.

63 Film Formation of Vinyl Acrylic Latexes: Effect of Surfactant Type, Water and Latex Particle Size—G.A. Vandezande and A. Rudin

A timely review of latex technology with excellent bibliography relations of T_g, *particle size, and surfactant type on MFFT and drying rates are discussed in this manuscript.*

Federation News

Spotlight

Departments

THE JOURNAL OF COATINGS TECHNOLOGY (ISSN 0361-8773) is published monthly by the Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422-2350, Phone (610) 940-0777; Fax: (610) 940-0292.

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Guide for Authors

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GENERAL

The Journal of Coatings Technology is published monthly by the Federation of Societies for Coatings Technology for its membership of approximately 7,000 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*, and *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 International Coatings Technology Conference 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.

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...for the Journal

Four complete copies should be sent to the Editor, Journal of Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422. 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 International Coatings Technology Conference Presentation

Ten complete copies of the manuscript are required for committee review. The set of copies should be addressed to Mike Bell, Director of Educational Services, FSCT, 492 Norristown Rd., Blue Bell, PA 19422.

...for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to Mike Bell at the address previously listed.(For complete details, see "Roon Awards" section of the Journal in the January 1995 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 repititious 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 solicted. 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 8½ 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 afterwords 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.

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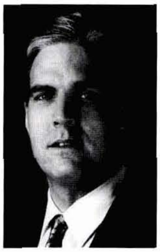


In 1996, the citizens of the United States will again be given the opportunity to select the president in an open election. As part of this process, citizens over 18 years old have the chance to vote for the presidential ticket to lead the country for the next four years.

During this time, voters take the time to learn about the candidates, what they stand for and their vision for the future. While this race is usually narrowed down to two or three major candidates, there are often several others from smaller political parties also on the ballot.

This year, FSCT members are also given the chance to make selections. Like the voters, these selections will impact their future in the coatings industry. The 1996 International Coatings Technology Conference and Annual Meeting Technical Program provides industry participants educational programs with offerings as diverse as the candidates in the national election. Scheduled for October 22-25, 1996, in Chicago, the event is designed to offer both technical and economic variety to the attendees.

Starting with five pre-convention training seminars and a one-day Executive Forum, and continuing with four two-day technology courses, the conference will have just about something for everyone. The one-day programs include: Faster to Market with Better Products Through Design of Experiments, Effective Technical and Scientific Writing, Surfactant Chemistry, Winning Technical Presentations, Coatings Spray Applications, and the Executive Forum, Managing Technology for Strategic Success in the Coatings industry.

The two-day Technology Conference courses include Advances in Coatings Characterization, Substrates and Coatings, Polymer Chemistry for the Coatings Formulator, and Back to Basics: General Overview of Coatings Technology.

In addition to the one- and two-day conference programs, the more cost-conscious attendee will have the option of registering for the Annual Meeting Technical Program. This year, sessions include the Roon Award Competition Papers, the APJ/Voss Awards Competition Papers, and two sessions of International offerings. In addition, the Technical Focus Speaker, featuring F. Louis Floyd of Duron Paints and Wallcovering delivering a lecture entitled "Pigment Flocculation is a Figment of Your Imagination," will lead off the program on Wednesday afternoon. David R. Bauer of the Ford Research Laboratory will deliver the Mattiello Memorial Lecture, "Predicting In-Service Weatherability of Automotive Coatings: A New Approach," to cap off the event on Friday morning.

All options include attendance at the FSCT's new International Coatings Expo.

Information on all of the options and selections available for the 1996 Annual Meeting and International Coatings Technology Conference can be found on page 19 of this month's JCT.

Michael G. Bell
Director of Educational Services

Technical Abstracts

Spanish translations provided by Jesús Camacho, of Instituto Mexicano de Tecnicos en Pinturas y Tintas.

Aqueous Acrylic-Polyurethane Hybrid Dispersions and Their Use in Industrial Coatings—C.R. Hegedus and K.A. Kloiber

JCT, Vol. 68, No. 860, 39 (1996)

Acrylic and polyurethane aqueous dispersions have been used extensively in coating applications, both independently and as physical blends. The resulting coatings display a balance of properties from the inherent characteristics of acrylics and polyurethanes. Nonetheless, these properties often fall short of those predicted from the traditional "rule of mixtures." In contrast, a process has been developed whereby acrylic monomers and urethane prepolymers are intimately mixed and mutually polymerized in an aqueous dispersion, thereby resulting in "hybrid" polymer dispersions. This process causes an interpentrating network (IPN) of the polymers which subsequently display unique properties compared to standard acrylic, polyurethane, or macroscopically blended acrylic/urethane dispersions. These properties appear to be directly attributable to the acrylic-polyurethane hybrid morphology. Scanning electron microscopy (SEM) and atomic force microscopy (AFM) were used to study film formation, coalescence, and coating surface topography. Thermal analysis was performed to characterize glass transition and thermal degradation. The microscopy and thermal response data were used to further understand the molecular mixing and polymer morphology resulting from the hybrid polymerization and polymerization process. In addition, clear and pigmented coatings were formulated using the hybrid dispersions. Performance properties were compared and differences were explained relative to morphological effects. These morphological effects are responsible for performance advantages over traditional binder systems in waterborne coatings.

Dispersiones Hibridas de Acrilico-Poliuretano Acuosas y Su Uso en Recubrimientos Industriales—C.R. Hegedus y K. A. Kloiber

Las dispersiones acuosas de acrilico y polìuretano han sido usadas de manera extensa en las aplicaciones de los recubrimientos, tanto de forma independiente y como parte de mezclas fìsicas. Los recubrimientos resultantes mustran un balance de propiedades a partir de las características inherentes de los acrílicos y los poliuretanos. Sin embargo, estas propiedades seguido se quedan cortas de los resultados esperados a partir de la tradicional "regla de las mezclas." En contraste, ha sido desarrollado un proceso en el cual monomeros de acrílico y prepolimeros de uretano están intimamente mezclados y mutuamente polímerizados en una dispersión acuosa, por lo cual resulta en dispersiones de polímeros hibridos. Este proceso causa una red interpenetrable (IPN) de lo polímeros los cuales subsecuentemente despliegan propiedades únicas comparadas a acrílico normal, poliuretano o las dispersiones de acrílico-uretano mezcladas macroscópicamente. Estas propiedades son directamente atribuibles a la morfología hibrida de acrílico-polìuretano. Los métodos de microscopía de busqueda de electrón (SEM) y el microscopio de fuerza atómica (AFM) fueron usados para estudiar la formación de película, la coalescencia y la topografía superficial del recubrimiento. El análisis térmico se llevó a cabo para caracterizar la transición vitrea y la degradación térmica. Los datos obtenidos mediante el microscopio y la respuesta térmica fueron usados para lograr un mayor entendimiento del mezclado molécular y la morfología del polímero resultante de la polimerización hibrida y el proceso de polmerización. Posteriormente se formularon usando dispersiones hibridas recubrimientos claros y pigmentados. Las propiedades de este desempeño se compararon y las diferencias fueron explicadas conforme a los efectos morfológicos. Estos efectos morfológicos son los responsables de las ventajas en el desempeño sobre los tradicionales sistemas de aglomeración de los sistemas base agua.

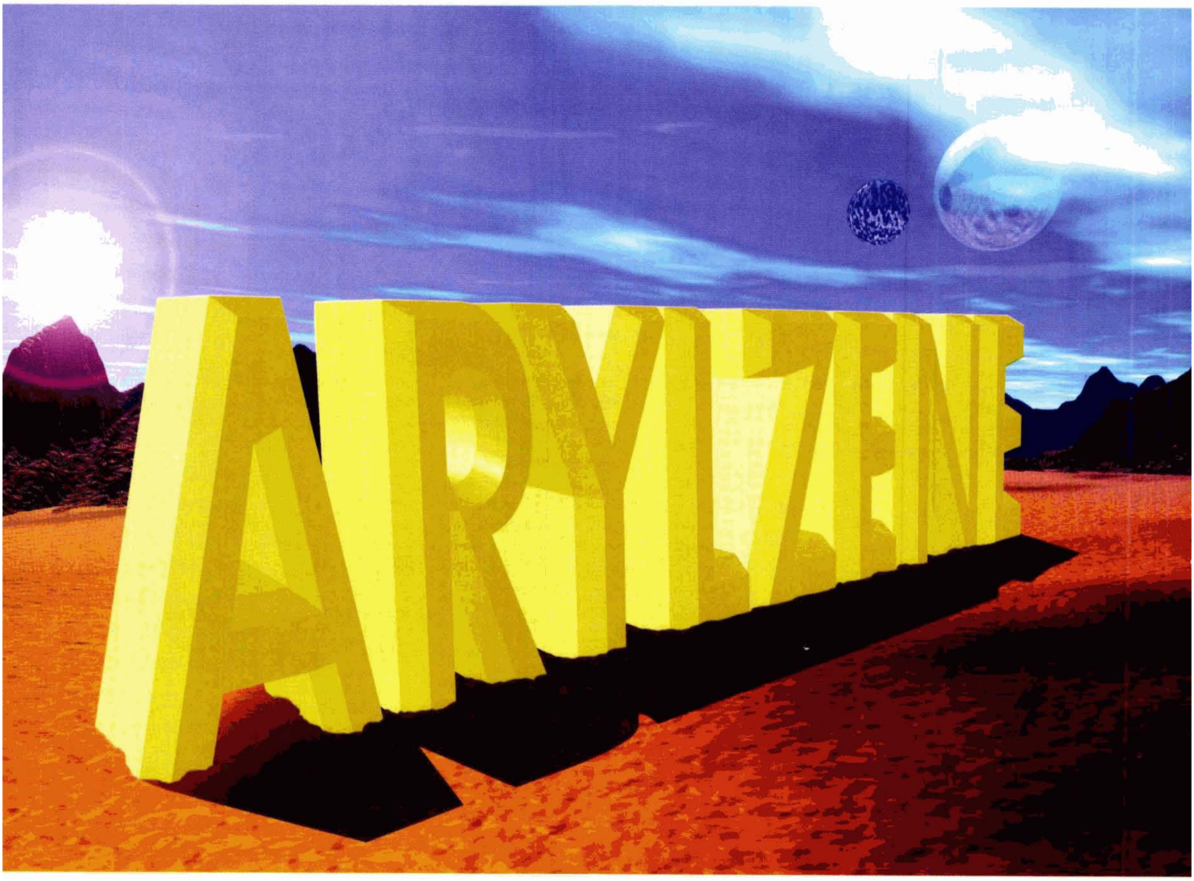
Liquid, Sprayable, "Zero" VOC Coatings Utilizing Cycloaliphatic Epoxies—R.F. Eaton and K.T. Lamb

JCT, Vol. 68, No. 860, 49 (1996)

Zero VOC, hazardous air pollutant free coatings formulations can be readily prepared from liquid cycloaliphatic epoxies and narrow polydispersity caprolactone polyols. These formulations can be applied by conventional spray equipment and are a viasble liquid alternative to powder coatings. Using conventional liquid spray equipment, the capital investment for the installation of a new powder coating line can be avoided. With modification, these coatings can be diluted with water and thickened with conventional cellulosic thickeners used in waterborne coatings. In this study we will discuss the influence of key formulating variables like epoxy/hydroxyl mole ratio, catalyst concentration, polyol molecular weight, and polydispersity on coating properties. Viscosity reduction and sag resistance are also discussed.

Liquido, Dispersable, Recubrimientos de "Cero" VOC mediante el Uso de Epóxicos Cicloalifáticos—R.F. Eaton y K.T. Lamb

Las formulaciones de recubrimientos libres de HAPS y cero VOC pueden ser rapidamente preparadas a partir de epóxicos cicloalifáticos líquidos y políoles de caproaláctona polidispersos. Estas formulaciones pueden ser aplicadas mediante el uso de equipo convencional de dispersión y son una alternativa viable para los recubrimientos en polvo. Usando el equipo convencional de dispersión de líquido, se puede evitar la inversión de capital para la instalación de una nueva línea para recubrimientos en polvo. Con la modificación, estos recubrimientos pueden ser diluidos con agua y engrosadas con espesantes celulosicos convencionales usados en recubrimientos base agua. En este estudio discutiremos la influencia de variables de formulación clave como la relación molar epoxí/hidróxilo, concentración de catalizador, peso molécular del poliol y la polidispersabilidad de las propiedades del recubrimiento. También se analizan la reducción de la viscocidad y resistencia al pandeo.


ARYLZENE

Use of Castor Oil in the Preparation of Various Oil-Based Binders—O.S. Kabasakal et al.

JCT, Vol. 68, No. 860, 57 (1996)

Styrenated oil, urethane oil, and oil modified alkyd resin were prepared by using castor oil in a different way. For this purpose, castor oil was initially subjected to an interesterification reaction with linseed oil, and the resulting intermediate was employed in the preparation of oil-based binders. Urethane oil and alkyd resin were obtained through the reactions of the interesterification product with toluene diisocyanate and phthalic anhydride, respectively. For the production of styrenated oil, thermally labile azo groups were inserted into the interesterification product and then this intermediate was reacted with styrene. Styrenated oil showed the best alkali resistance.

Uso de los Aceítes de Ricino en la Preparación de Varios Aglomerantes Base Aceíte—O.S. Kabasakal et al.

Se prepararon aceíte de estireno, aceíte de uretano y resina alquidálica modificada de aceíte, con aceíte de ricino pero mediante un método diferente al usual. Para este proposito, el aceíte de ricino inicialmente fué sometido a una reacción de interesterificación con aceíte de linaza y el intermediario resultante se empleo en la preparación de los aglomerantes base aceíte. El aceíte de uretano y la resina alquidálica se obtuvieron a partir de las reacciones del producto de interesterificación con diisocianato de tolueno y anhídrido ftálico respectivamente. Para la producción de aceíte de estireno, se insertaron grupos azo térmicamente lábiles dentro del producto de la interesterificación y entonces este intermediario se hizo reaccionar con estireno. El aceíte de estireno mostró la mejor resistencia a la prueba alcálina.

Film Formation of Vinyl Acrylic Latexes; Effects of Surfactant Type, Water and Latex Particle Size—G.A. Vandezande and A. Rudin

JCT, Vol. 68, No. 860, 63 (1996)

The process of film formation from an 85/15 vinyl acetate/butyl acrylate latex was studied with respect to the effects of particle size and surfactant type on minimum film formation temperature (MFFT), glass transition temperature (T_g), drying rates, and optical clarity of the coalesced films.

Water plasticizes this polymer and thus only wet viscoelastic parameters and T_g values are realistic in film formation theories. The polymer is plasticized by ethoxylated alkylphenol nonionic surfactants. The surfactants with shorter ethylene oxide chains are better plasticizers and poorer steric stabilizers than their longer analogs. The type and concentration of stabilizing entities on the latex particle surfaces have very significant effects on the drying and coalescence properties of these latexes. Coalescence is somewhat faster with smaller latex particle sizes but larger particle size products dry at a faster rate than smaller ones in the absence of surfactant effects.

Formación de Película de Latex de Vinil Acrílico; Efectos del Tipo de Surfactante, Agua y el Tamaño de Partícula de Latex—G.A. Vandezande y A. Rubin

El proceso de formación de película a partir de un latex de vinil acetato/butil acrílato 85/15 fué estudiado respecto a los efectos de tamaño de partícula y tipo de surfactante en la temperatura de formación de película mínima (MFFT), temperatura de transición vitrea (Tg), las razones de secado y la claridad óptica de las películas coalecidas.

El agua plastífica este polímero y así solamente los parámetros viscoelásticos húmedos y los valores de Tg son realistas conforme a las teorías de formación de película. El polímero es plastificado por surfactantes noiónicos de etoxílados alquilfenol. Los surfactantes con cadenas de óxido de etileno más cortas son mejores pastificantes y más pobres estabilizadores estéaricos que sus análogos más largos. El tipo y concentración de las entidades de estabilización en la superficie de las partículas de látex tienen efectos muy significativas en las propiedades de coalescencia y de secado de estos látex. La coalescencia es algo más rápida con tamaño de partícula de látex más pequeño pero los productos de tamaño de partícula más grandes secan a una razón más rápida que algunas más pequeñas en la ausencia de los efectos del surfactante.


Out-distancing
the
competition.

The Futures Group Joint Study with D/L Labs To Focus on the Coatings Industry in 2000

To address the ever-changing coatings industry, D/L Laboratories, New York, NY, and The Futures Group, Glastonbury, CT, will conduct a scenario-based study titled *The Coatings Industry: Creating New Opportunities for 2000 and Beyond*. Consisting of four possible scenarios, this study will explore issues of key importance to the coatings industry and enable subscribers to "stress test" current strategies and develop new ones.

According to Saul Spindel, President of D/L Laboratories, "Members of our industry who explore how the plausible futures may unfold—and then test their present assumptions against those futures—will be much less likely to spend valuable resources on ineffective strategies."

Core questions and issues to be addressed in this study include:

✔ The direction and import of powder technologies in automotive and other sectors, as well as UV and radiation curing mechanisms;

✔ Possible environmental regulations and how to best develop products that comply with the new laws;

✔ Future shifts in consumer lifestyles and preferences, and the impact of consumer buying power on the coatings industry;

✔ Possible alliances and new players that may change the face of the industry; and

✔ Impact of the trend towards globalization and offshore production facilities on distribution channels.

"The coatings industry is a fast-changing environment characterized by surprise, consolidation, and technological upheaval," continued Mr. Spindel. "The planning tools we have chosen to help us prepare for the next decade and beyond are the vivid 'future scenarios' prepared by The Futures Group. With these insights, subscribers to the study will be able to better adjust current strategies, as well as develop new ones—especially those dealing with the prickly areas of consolidation, imports, sophisticated new technologies and environmental controls."

"The ability to more accurately anticipate and conceptualize the future workplace, as well as discover previously unidentified opportunities, will prove critical to gaining the competitive advantage," added Vaud Massarsky, Managing Director of The Futures Group. "Scenario-based analysis identifies a wide array of possible future business environments, allowing a flexibility not found in traditional forecasting."

In addition, The Futures Group and D/L Labs will offer a two-day seminar to all subscribers to explain the mechanics, goals, and deliverables of the study.

Group of Investors Purchase Teledyne's Readco Products

The assets of Teledyne's Readco Products, York, PA, have been purchased by a group of investors organized by the Pennsylvania Growth Fund. The new company will be known as Readco Manufacturing, Inc., and will continue operations at the 901 Richland Ave., York, PA, address.

PPG and CSI to Market Pressure-Treated Wood

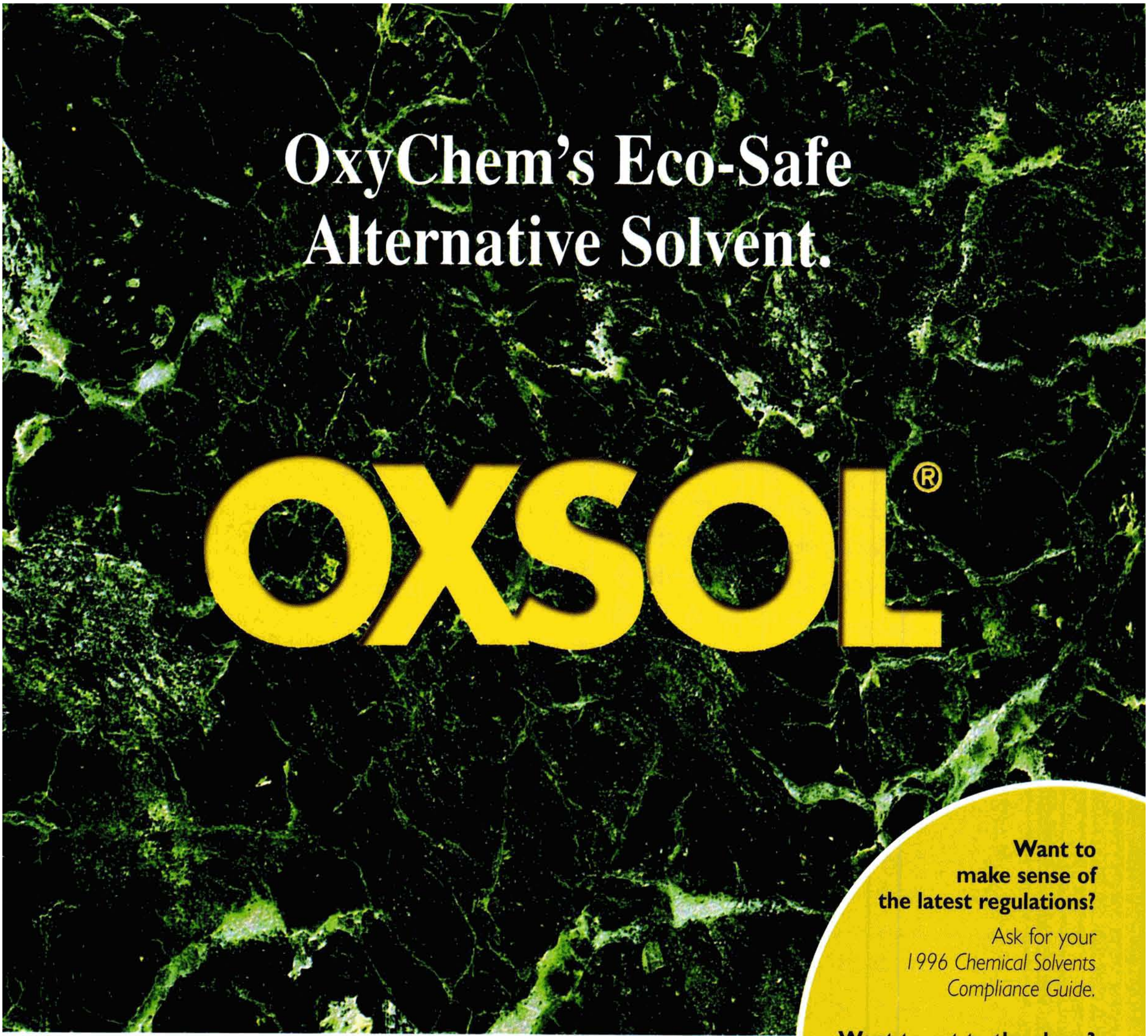
PPG Architectural Finishes Inc., a unit of PPG Industries, Pittsburgh, PA, and makers of the Olympic® brand of exterior wood protection coatings, has formed an agreement with Chemical Specialties Inc. (CSI), Charlotte, NC, to market pressure-treated wood with built-in Olympic waterproofing formula protection.

Through the agreement, Olympic's MP_5™ waterproofing formula will be combined with CSI's chromated-copper-arsenate (CCA) during the pressure treating process, resulting in a wood product designed to prevent cracking, splitting, warping, and twisting, in addition to traditional rot and decay protection of pressure-treatment.

Marketing Agreement Announced by Foerster

Foerster Instruments, Inc., Pittsburgh, PA, has announced a new marketing agreement with UniWest, Pasco, WA. Foerster's portable testing instruments include the Defectometer, Sigmatest, Defectoscop, and Magnetoscop.

UniWest manufactures several eddy current instruments and eddy current probes for use by the aerospace, chemical processing, power generation, and pipe manufacturing industries.



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Circle No. 112 on the Reader Service Card

Bennett and Bollenbach to Address NPCA's Annual Meeting; CLEARCorps Project Underway in Three Operating Sites

The 109th Annual Meeting of the National Paint & Coatings Association (NPCA), Washington, D.C., will feature a Keynote Address by William "Bill" Bennett, former U.S. cabinet member, best-selling author, and current co-director—with Jack Kemp and Jeane Kirkpatrick—of Empower America. Dr. Bennett has replaced Jack Kemp, who was unable to honor his speaking engagement after accepting the Republican Vice Presidential nomination.

Dr. Bennett's distinguished career includes his 1981 appointment as chairman of the National Endowment for the Humanities by President Reagan, being named Secretary of Education in 1985, and his selection by President Bush as Director of the Office of National Drug Control Policy.

In addition, Stephen Bollenbach, the new Chief Executive Officer and President of the Hilton Hotels will address attendees to the annual meeting.

A former Walt Disney executive, Mr. Bollenbach was involved in Disney's $19 billion acquisition of ABC/Capital Cities, the second largest acquisition in U.S. business industry history. Other positions held by Mr. Bollenbach include President and CEO of Host Marriott Corporation, Chief Financial Officer of the Trump Organization, and Chief Financial Officer and Board of Directors member of the Holiday Corporation. He currently serves on the Board of Directors for America West Airlines, as well as for the Hilton Hotels.

NPCA's annual meeting will be held October 23-25, 1996, at the Palmer House (Hilton), in Chicago, IL. For more information, contact Cheryl Matthews, NPCA, 1500 Rhode Island Ave., N.W., Wshington, D.C. 20005-5597.

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The Community Lead Education and Reduction Corps (CLEARCorps) project, funded by NPCA and managed by the Shriver Center at the University of Maryland Baltimore County (UMBC), has been launched.

In the first few months of operation, more than 40 AmeriCorps Members (the official designation for program workers), have been hired and trained in lead hazard reduction and community service. CLEARCorps members working in the three operating sites (Baltimore, MD, Charleston, SC, and Minneapolis, MN) have educated over 700 community residents on lead hazards and simple effective ways to avoid exposure, lined-up over 125 properties for intervention services, and completed work in some 15 units providing a lead-safe environment for children who would otherwise have been considered "at-risk" by public health officials. CLEARCorps reduces and manages the risk of exposure to lead already present in the homes, at no cost to the home owner.

ISO Certification

The manufacturing and research and development facility of **Cardolite Corp.**, Newark, NJ, has been granted ISO 9002 certification.

Pinturas Condor S.A., Quito, Ecuador, has obtained ISO 9001 certification.

Nyacol Products Inc., Ashland, MA, a subsidiary of PQ Corp., Valley Forge, PA, has qualified for ISO 9002 certification.

The manufacturing facilities of **Buckman Laboratories, Inc.**, in Memphis, TN, and Cadet, MO, passed their sixth ISO surveillance audits with no findings or concerns.

Controlotron Corp., Hauppauge, NY, has received ISO 9002 certification.

Ciba Polymers, Brewster, NY, has announced that their epoxy resins production unit in McIntosh, AL, has earned ISO 9001 certification.

The Automotive OEM Business Unit of **The Sherwin-Williams Automotive Finishes Corp.**, Troy, MI, has achieved ISO 9001 certification for their technical laboratory. This certification also elevates the business' manufacturing plant and distribution operations, located in Richmond, KY, from ISO 9002 to ISO 9001.

The St. Louis branch of **INX International Ink Co.**, Elk Grove Village, IL, was awarded ISO 9002 registration.

Macbeth Division of Kollmorgen Instruments Corp., New Windsor, NY, was granted ISO 9001 certification.

Harcros Pigments, Inc., a manufacturer of natural and synthetic iron oxides, has earned ISO 9002 certification for its Easton, PA; East St. Louis, MO; and Fairview Heights, IL, locations.

Ultra Additives Purchases Manufacturing Facility

Ultra Additives, Inc., Paterson, NJ, has purchased an additional manufacturing facility in the Charlotte, NC, area.

Located on a seven-acre site in Clover, SC, the 20,000 square foot plant is designed for bulk/tank wagon defoamer shipments. The facility includes its own technical service lab to support regional customers. All operations, including storage, are indoors. There are secondary containment systems supporting loading and unloading, storage and production areas to minimize any potential releases to the surrounding environment.

Dow Chemical to Increase Epichlorohydrin Production

The Epoxy Products and Intermediates business of The Dow Chemical Co., Midland, MI, has announced the location of its low-cost capacity expansion of epichlorohydrin.

Dow will increase the production capacity of epichlorohydrin at its Freeport, TX facility. The company's capacity expansion will add 250 million pounds of epichlorohydrin per year. The expansion is expected to be completed by late 1998.

Currently, Dow produces 700 million pounds of epichlorohydrin annually in its existing sites in Freeport and Stade, Germany.

CDF Corp. Expands Production Capacity

CDF Corp., Plymouth, MA, has acquired the California-based Cal-Formed Plastics' Liner Division. With this acquisition, CDF has expanded its geographic base and production capacity.

CDF specializes in packaging solutions for the chemical, paint, petroleum, ink, food, and pharmaceutical industries. Cal-Formed Plastics, a division of Camden Industries, Los Angeles, CA, was an early pioneer in the development of industrial drum liners.

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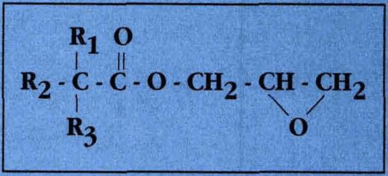

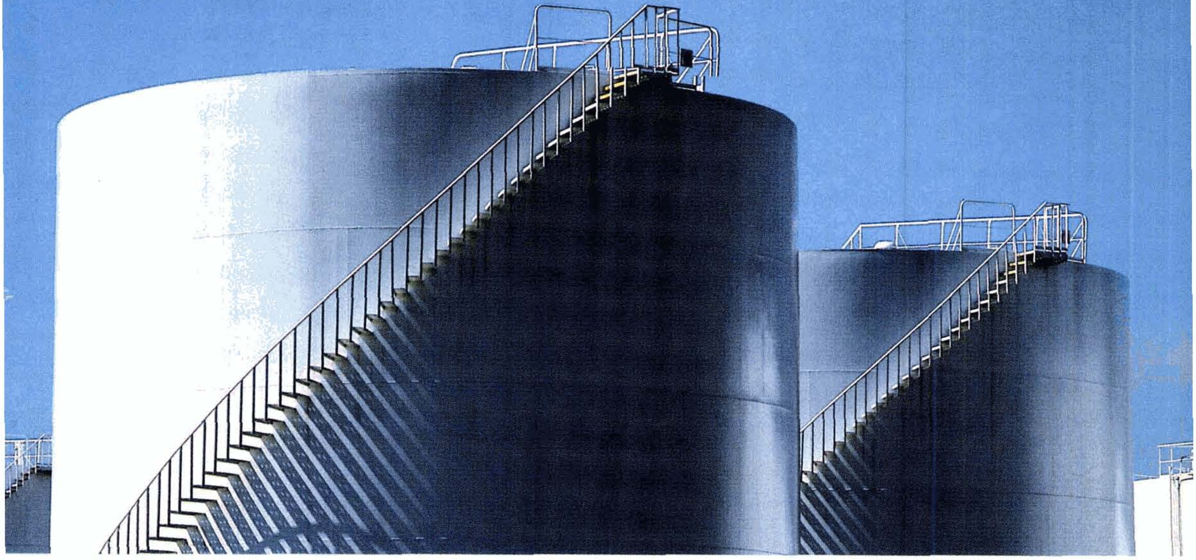

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Circle No. 207 on the Reader Service Card

Pacific Northwest Society Seeks Papers for 50th Annual Symposium Slated for May 8-10

The 50th Annual Meeting of the Pacific Northwest Society for Coatings Technology is scheduled for May 8-10, 1997, at the Panamerican Hotel, in Vancouver, British Columbia.

Potential authors are invited to submit papers for presentation at the symposium. The Society is seeking papers related to the chemistry, formulation, physical properties, and application of water-based, low VOC solvent-based, powder, or any other advanced coating systems.

Please submit title, abstract, and author or speaker's name by **November 30, 1996** to the following: Yvon Poitras, Horizon Chemicals Ltd., 10311 Cornerbrook Crescent, Richmond, BC, Canada, V7E 4H5; phone: (604) 271-6772; fax: (604) 271-6774; or Paul Andreassen, Consolidated Coatings Corp., 7651 Vantage Way, #310, Richmond, BC, Canada, V4G 1A6; phone: (604) 946-7626.

NPCA to Host Coatings Care™ Program Symposium

The National Paint & Coatings Association (NPCA), Washington, D.C., will conduct an orientation symposium for its Coatings Care™ program on October 14, 1996 at Mitretek Systems, McLean, VA.

Coatings Care provides NPCA member companies with an opportunity to pursue a common, effective management approach for their health, safety, and environmental programs. This orientation is designed to assist members in implementing Coatings Care and to enhance participants ability to use the initiative as a management tool and information resource.

The one-day symposium will include an overview, key implementation activities, information on accessing the Coatings Care Resource guide, and a discussion on the challenge of Coatings Care. In addition, participants will have the opportunity to attend sessions focusing on the individual codes of management practices—manufacturing management, transportation and distribution, product stewardship, and community responsibility.

For more information, contact Cheryl Matthews, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005.

UMass-Lowell Course Focuses On Economic Development

The University of Massachusetts Lowell, Lowell, MA, will conduct a conference on "Concurrent Commercialization: Taking New Technology to Market," on September 27, 1996 at the Radisson Heritage Hotel, Chelmsford, MA.

This conference, which focuses on new techniques to solve the business problems associated with taking new technologies to market, will address the following questions:

(1) Is there a sufficient market for your product at this time?

(2) What market trends exist that will define your business options?

(3) What specific product features are fundamental to different customer segments—what are just nice to have?

(4) How much will the customer in each segment pay?

(5) How can you position your technology to beat the competition?

(6) How can you best control the development process?

Entrepreneurs who have new science in search of a market or those with identified market needs requiring technical solutions will benefit from this conference. It is designed to address the business problems faced by those who are either developing or currently commercializing new technical or engineered products. In addition, participants will gain market savvy in the development cycle of their new technology.

To obtain additional information, please contact Valerie Kijewski, University of Massachusetts Lowell, One University Ave., Lowell, MA 01854.

Regulatory Update September 1996

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 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
July 29, 1996—61 FR 39356
Diethyl Phthalate; Toxic Chemical Release Reporting; Community Right-to-Know
Action: Final rule

The Environmental Protection Agency (EPA) has announced the deletion of diethyl phthalate (DEP) from the list of chemicals subject to the Toxic Release Inventory (TRI) reporting requirements under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) and section 6607 of the Pollution Prevention Act. By promulgating this rule, effective July 29, 1996, EPA is relieving facilities of their obligation to report releases of and other waste management information on DEP that occurred during the 1995 reporting year, and for any future activities.

For general information on EPCRA section 313, contact the EPCRA Hotline, 1-800-535-0202. For specific information on this rulemaking, contact Daniel Bushman, EPA, (202) 260-3882.

Environmental Protection Agency
July 23, 1996—61 FR 38250
Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NSR)
Action: Notice of proposed rulemaking

In order to reduce costs and the regulatory burden on industry, the Environmental Protection Agency (EPA) has proposed amendments to its new source review (NSR) program for preconstruction permits. EPA expects these modifications to significantly reduce the procedures that new or modified major sources must follow before beginning construction.

The proposed rulemaking would reduce the number of sources required to comply with NSR provisions by basing that determination on a facility's actual emissions, and would streamline procedures for regulated sources. Sources would be allowed to establish plant-wide emission limits, which would let them make changes as long as they don't exceed the overall limit, and would be eligible for exemptions for pollution-prevention programs.

All comments must be received by October 21 and should be mailed, in duplicate, to EPA, Air Docket Section, Docket A-90-37, 401 M Street S.W., Washington, D.C. 20460.

For additional information, contact Dennis Crumpler, EPA, (919) 541-0871.

Department of Transportation
Research and Special Programs Administration
July 25, 1996—61 FR 38642
Transportation of Hazardous Materials By Rail; Miscellaneous Amendments; Response to Petitions for Reconsideration
Action: Final rule; response to petitions for reconsideration

The Research and Special Programs Administration (RSPA) published a letter in which it denied petitions for reconsideration of a provision in the June 5, 1996 rule concerning the transportation of hazardous materials by rail. The provision allows rail shippers and carriers to discontinue use of the RESIDUE placard on June 30, 1996. This date falls three months before the rule's effective date.

For further information, contact Beth Romo, RSPA, (202) 366-8553, or James Rader, Federal Railroad Administration, (202) 366-0510.

Department of Transportation
Research and Special Programs Administration
July 29, 1996—61 FR 39522
Applicability of the Hazardous Materials Regulations to Loading, Unloading and Storage
Action: Advance notice of proposed rulemaking (ANPRM); notice of meeting

The Research and Special Programs Administration (RSPA) is sponsoring a series of meetings to seek ideas, proposals, and recommendations regarding the applicability of the Hazardous Materials Regulations (HMR) to particular hazardous materials transportation activities. This information will help the agency to consolidate, revise and update existing rulings and decisions regarding the HMR and to determine whether there is a need to amend the current requirements.

Written comments must be received by November 30 and should be sent to Dockets Unit (DHM-30), Office of Hazardous Materials Safety, RSPA, Department of Transportation, Washington, D.C. 20590-0001. Comments must include Docket Number HM-223 and Notice Number 96-15. Please submit five copies if possible.

For additional information, contact Nancy Machado, RSPA, (202) 366-4400.

Environmental Protection Agency
July 31, 1996—61 FR 39891
Di-(2-ethylhexyl) Adipate; Toxic Chemical Release Reporting; Community Right-to-Know
Action: Final rule

The Environmental Protection Agency (EPA) has deleted di-(2-ethylhexyl) adipate (DEHA) (CAS No. 103-23-1) from the list of chemicals subject to Toxic Release Inventory reporting requirements, as required under section 313 of EPCRA. By promulgating this regulation, EPA is relieving facilities from their obligation to report releases of and other waste management information on DEHA that occurred during the 1995 reporting year and for any future activities. This rulemaking may affect facilities that formulate or produce adhesives and sealants and was effective July 31.

For additional information on this rule, contact Daniel Busman, EPA, (202) 260-3882; e-mail: bushman.daniel@epamail.epa.gov. For information on EPCRA Section 313, contact the EPCRA Hotline, (800) 535-0202.

Environmental Protection Agency
August 13, 1996—61 FR 41991
Compliance Assurance Monitoring
Action: Notice of public meeting; notice of document availability

The Environmental Protection Agency (EPA) is issuing a revised version of the Compliance Assurance Monitoring (CAM) approach as part of the agency's intended adoption of regulations concerning enhanced monitoring and compliance certification provisions under Title V of the Clean Air Act. In order to provide potentially affected facilities with a chance to present their views on the CAM approach, EPA will be accepting written comments on a draft regulatory package on the issue.

Written comments must be received by October 15 and should be sent, in duplicate, to EPA Air Docket (LE-131), Room M-1500, Waterside Mall, 401 M Street S.W., Washington, D.C. 20460. Please indicate Docket No. A-91-52 on all copies. Copies of the draft regulatory package can be found on EPA's Technology Transfer Network bulletin board, (919) 541-5742.

For additional information, contact Peter Westline, EPA, (919) 541-1058.

Hazardous Materials Transportation Seminars—The U.S. Department of Transportation's Research and Special Programs Administration (RSPA), in cooperation with the Transportation Safety Institute and the Cooperative Hazardous Materials Enforcement Development program, is sponsoring a series of seminars on multimodal hazardous materials transportation. Representatives from air, highway, rail and water transportation will update participants on hazmat issues. Separate breakout sessions will be held on topics such as basic hazardous materials awareness, Canadian regulations, hazmat training, recent rulemakings, performance-oriented packaging, and using the federal Hazardous Materials Regulations.

Seminars will be held February 25-27, 1997 in Hartford, CT.; May 28-30, 1997 in Dallas, TX; and August 5-7, 1997 in Chicago, IL. The registration fee is $150. For more information, contact the Transportation Safety Institute at (800) 858-2107; e-mail: ETHIERP@rspa.dot.gov.

Superfund Update—The inability to reach an agreement on bipartisan language to reform the Superfund hazardous waste cleanup program, as well as an emphasis on other environmental issues, has led Senate and House Republicans to declare that time has probably run out for reform this year. Throughout the summer, with the House bill stalled in committee, Senate negotiators had hoped to work out a compromise on their own Superfund measure with Democrats, but with few legislative days left this session, Congressional leaders were forced to abandon their efforts.

Reforming the retroactive liability provisions of the Superfund program was once again the primary issue that dominated the disagreements between Republicans and Democrats. Republicans wanted at least a partial repeal of retroactive liability, which holds companies responsible for waste that was disposed of legally before enactment of Superfund in 1980. However, Democrats bitterly opposed any shift of cleanup costs away from polluters and onto the federal government, leading to the current legislative gridlock over the issue.

A group of Democrats headed by Senator Frank Lautenberg (D-NJ), the ranking minority member of the Superfund subcommittee, have introduced a separate bill (S. 2028) to encourage the development of urban brownfields, a move opposed by Republicans who prefer to keep brownfields development as part of an overall Superfund reform package. Additionally, Senator Lautenberg introduced legislation (S. 2027) that would reauthorize the taxes that fund the Superfund program, which expired at the end of 1995, despite a recent Congressional Budget Office report that the program currently has enough funds to continue operating through 2000. However, Bill Archer (R-TX), the chairman of the House Ways and Means Committee which has jurisdiction over tax legislation, has stated that he opposes reauthorizing the taxes until the program itself has been overhauled.

Fair Warning Bill Passed By House Judiciary Committee—H.R. 3307, the Regulatory Fair Warning Act, was approved by a party-line vote on August 1 by the House Judiciary Committee. The bill would provide companies with an affirmative defense against sanctions for regulatory violations. A company would not be fined for a violation if (1) a federal agency failed to provide adequate fair warning of a rule's requirements or prohibitions; or (2) it relied on a written statement by a state or federal official that the action was in compliance.

The bill's primary sponsor Representative George Gekas (R-PA) has stated that the measure would safeguard individuals who unknowingly violated the law. Opponents of the bill, which includes the EPA, believe it would provide companies with a loophole to escape penalties for violations. However, H.R. 3307 is not likely to be considered on the House floor this year, due to time constraints.

States Proposed Legislation and Regulations

ARIZONA

Hazardous Waste (Regulation)—A final regulation (2 AZAR 3292; 7/5/96) of the Arizona Department of Environmental Quality (DEQ) incorporates federal hazardous waste management standards, establishes requirements to reduce organic air emissions from hazardous waste management facilities, specifies treatment criteria for organic toxicity characteristic wastes, and updates provisions for testing and monitoring activities. The rule went into effect June 13. Contact Lynn Keeling, DEQ, (602) 207-2223.

CALIFORNIA

Air Quality (Regulation)—A final regulation (96 CARR 1336; 7/12/96) of the California Air Resources Board (CARB) amends requirements for the air toxics "hot spots" fee standards by providing exemptions from fees, and establishing a method for determining risk assessment fees. The rule was effective June 28, 1996. Contact Judith Tracy, CARB, (916) 322-2884.

Environmental Audits (Notice)—The California Environmental Protection Agency (CalEPA) has issued a final policy on environmental audits to encourage facilities to prevent and correct regulatory violations. Among other things, the policy permits a reduction of fines up to 90% for self-reporting, provides a review option so that facilities can have their programs certified by the state, and expands federal standards for criminal prosecution. Copies of the policy are available over the Internet at www.cahwnet.gov/epa. Contact CalEPA, (916) 327-2064.

Graffiti—CA A. 2295 (Sweeney and Thompson) authorizes a court to order a person convicted of a graffiti offense to keep the damaged property or another property free of graffiti for a specified period of time. On August 6, the measure was considered by the Senate.

CA A. 2331 (Goldsmith and Alpert) requires the court to suspend driving privileges of a person convicted of defacing another's property with graffiti. The Senate Appropriations Committee released the bill with a favorable recommendation on August 12.

CA A. 2433 (Harvey) increases the maximum fine and community service time for multiple convictions for graffiti offenses. On August 12, the Senate amended the legislation.

Hazardous Materials Transportation—CA A. 2201 (House) repeals provisions requiring the inspection of vehicles used to transport hazardous waste; and the adoption of regulations for containers used to transport hazardous waste. On August 8, the bill was read in the Senate.

CA S. 1706 (Wright) authorizes the issuance of a variance from the requirements regulating the management of hazardous waste if it is determined that the waste is eligible. On August 12, the bill was amended by the assembly.

CA S. 1757 (Calderon) exempts a surface impoundment constructed before July 1, 1986 from the land disposal prohibitions for hazardous waste under the Resource Conservation and Recovery Act (RCRA) and federal minimum treatment standards. On August 12, the legislation was considered by the full assembly.

Hazardous Waste (Proposed Regulation)—A proposal (96 CARR 1212; 6/21/96) issued by the California Department of Toxic Substances Control (DTSC) would eliminate (1) land disposal restriction notification requirements for certain non-RCRA wastes; (2) standards for case-by-case extensions of the prohibition date for RCRA wastes; (3) treatability variance standards for RCRA wastes; and (4) waste treatment standards. Contact Nancy Ostrom, DTSC, (916) 322-3385.

Lead—CA A. 1195 (Morrissey) requires the adoption of regulations that exempt employers with *de minimis* amounts of lead use from certain fees. The legislation was read on the Senate floor on August 8.

Occupational Safety and Health—CA A. 2634 (Burton) adds painters to the list of individuals for whom cancer which occurs during employment is an injury under the workers compensation law. The bill, which had failed passage out of the Assembly Committee on Insurance, was released from the committee without further action.

Toxic Substances—Proposition 65 (Proposed Regulation)—The California Office of Environmental Health Hazard Assessment (OEHHA) has proposed a regulation which would specify the type of information that private parties must include when serving a 60-day notice of violation to alleged violators of Proposition 65. Proposition 65 requires companies to warn consumers if a product contains a specific chemical known to the state to cause reproductive toxicity or cancer. Contact William Soo Hoo, OEHHA, (916) 322-0493.

Water Quality—CA A. 2620 (Morrissey) provides that dischargers shall not be required to meet water quality standards that exceed levels set by the federal Safe Drinking Water Act, except under specified circumstances. On July 1, the bill failed to pass out of the Senate Committee on Toxics and Public Safety Management.

COLORADO

Hazardous Waste (Regulation)—The Colorado Department of Public Health and Environment (DPHE) adopted an emergency regulation (19 COR 2; 7/10/96) which amends current land disposal restriction standards to conform with federal requirements. The rule went into effect June 5. Contact DPHE, (303) 692-3300.

An emergency regulation (19 COR 2; 7/10/96) adopted by the Colorado DPHE postpones the effective date for organic air emission standards for tanks, containers, and surface impoundments until October 6, 1996. Contact Karen Osthus, DPHE, (303) 692-3321.

CONNECTICUT

Hazardous Materials Transportation (Proposed Regulation)—A proposal issued by the Connecticut Department of Public Safety (DPS) would update standards for the storage, use, and transportation of flammable and combustible liquids, emphasizing the design, construction, and operation of installations. Contact Janet Ainsworth, DPS, (860) 865-8300.

DELAWARE

Lead—SE S. 448 (Blevins) permits the promulgation of regulations for the training and certification of individuals engaged in lead-based paint activities and for the accreditation of lead paint hazard control training programs. The governor signed the bill on July 18.

HAWAII

Water Quality (Proposed Regulation)—A proposed regulation of the Hawaii Department of Health (DOH) would amend current water pollution control standards by increasing filing fees and modifying procedures for notice of intent and general permits. Contact Lawrence Mike, DOH, (808) 586-4309.

IDAHO

Air Quality (Proposed Regulation)—The Idaho Department of Health and Welfare (DHW) has proposed a regulation (1996 IDAB 5; 7/3/96) which amends air pollution control standards by (1) eliminating existing excess emissions provisions under Tier I of the standards; (2) allowing the state to excuse excess emission violations if specific conditions are met; (3) altering permits to construct requirements; and (4) extending the deadline for submission of a completed Tier I application. Contact Sue Richards, DHW, (208) 373-0502.

ILLINOIS

Air Quality—IL S. 1408 (Luechtefeld and Rea) provides for legislative review of any proposed memorandum of understanding which may require the state to undertake emissions reductions in addition to those specified by the Clean Air Act Amendments. The governor signed the legislation on July 26.

INDIANA

Air Quality (Regulation)—A regulation (19 INR 2855; 7/1/96) adopted by the Indiana Department of Environmental Management (DEM) adds acetone to the list of chemicals that are considered to be non-photochemically reactive. The rule became effective June 12. Contact Phil Doyle, DEM, (317) 232-8420.

Air Quality (Proposed Regulation)—A proposal (19 INR 2918; 7/1/96) of the Indiana DEM would incorporate by reference proposed federal standards for making control technology determinations for major sources of hazardous air pollutants. Contact Mike Brooks, DEM, (317) 233-5686.

The Indiana DEM intends to issue amendments (19 INR 2933; 7/1/96) to the Title V air operating permit program and permit review provisions. The proposal would specify reporting requirements, incorporate EPA guidelines for program and permit approval and review, streamline the permit application and revision process, and establish emission caps. A hearing on the rule will be held on September 4 in Indianapolis. Contact Patricia Troth, DEM, (317) 233-5681.

KENTUCKY

Air Quality (Proposed Regulation)—The Kentucky Department for Environmental Protection (DEP) intends to propose a regulation (23 ARKY 22; 7/1/96) which would establish descriptions for emissions not regulated at the source; require the submittal of checklists for insignificant activities; set up methods for identifying significant terms of new source review; and clarify the procedures for determining compliance status. Contact John Hornback, DEP, (502) 573-3382.

Air Quality (Regulation)—An emergency rule (23 ARKY 62; 7/1/96) of the Kentucky DEP concerning Part 70 operating permits would establish applicability standards; and would clarify permit application, issuance and renewal procedures. The regulation became effective June 14. Contact John Hornback, DEP, (502) 573-3382.

A final regulation (23 ARKY A3; 7/1/96) issued by the Kentucky DEP would amend the definition of "volatile organic compound" (VOC) to exempt the compound acetone. The rule went into effect June 6. Contact John Hornback, DEP, (502) 573-3382.

Lead (Proposed Regulation)—The Kentucky Department for Health Services (DHS) plans to issue a proposal (23 ARKY 39; 7/1/96) which would establish training and certification standards for individuals engaged in lead-hazard detection and abatement, would set up permit fees and procedures, and would adopt requirements for performing lead abatement work. Contact William Moore, DHS, (502) 564-7900.

LOUISIANA

Air Quality (Regulation)—A final regulation (22 LAR 453; 6/20/96) of the Louisiana Department of Environmental Quality (DEQ) amends requirements for storage tank covers and clarifies closure seal criteria for internal and external floating roofs. The rule, effective June 20, is applicable to sources in specific parishes that emit at least 50 tons of VOCs per year. Contact Patsy Deaville, DEQ, (504) 765-0399.

MASSACHUSETTS

Air Quality (Regulation)—The Massachusetts Department of Environmental Protection (DEP) adopted a final rule (794 MAR 65; 6/28/96) which amends the definition of VOC to exclude acetone. The regulation became effective June 28. Contact Greg Elder, DEP, (617) 292-5810.

Hazardous Waste (Proposed Regulation)—A proposed regulation (795 MAR 58; 7/12/96) of the Massachusetts DEP would specify that individuals planning to establish and/or operate household hazardous waste collection centers for paint-related materials only are subject to a 21-day presumptive approval period. Contact James Paterson, DEP, (617) 556-1096.

MONTANA

Air Quality (Proposed Regulation)—A proposal (1996 MTAR 1172; 7/3/96) issued by the Montana Board of Environmental Review (BER) would amend current air quality regulations to allow facilities to make minor changes without revising their air quality preconstruction permits. Contact BER, (406) 444-2544.

Air Quality (Regulation)—The Montana BER adopted final regulations (1996 MTAR 1843, 1844; 7/3/96) which amend the definition of VOC and update current air quality provisions to conform with federal standards. The regulations were effective July 4. Contact BER, (406) 444-2544.

NEW JERSEY

Air Quality (Regulation)—A final regulation (28 NJR 3414; 7/1/96) adopted by the New Jersey Department of Environmental Protection (DEP) establishes an open market VOC emissions trading program. The rule, which went into effect July 1, was operational August 2. Contact Samuel Wolfe, DEP, (609) 292-0716.

Community Right-to-Know (Proposed Regulation)—A proposed regulation (28 NJR 3493; 7/15/96) of the New Jersey DEP would update the list of environmental hazardous substances to conform with the federal requirements under SARA section 313 by deleting copper phthalocyanine compounds substituted with only hydrogen and/or bromine and/or chlorine. Contact DEP, (609) 292-0716.

NEW YORK

Air Quality (Regulation)—A regulation adopted by the New York Department of Environmental Conservation (DEC) establishes standards that meet the requirements for adopting and implementing a federal operating permit program for specific categories of air pollution sources. The rule was effective July 7. Contact Maris Tirums, DEC, (518) 457-6379.

A final rule (18 NYSR 14; 6/26/96) of the New York DEC amends regulations for the operating permit program. Among other things, the rule, effective July 7, (1) incorporates federal new source performance standards, national emission standards for hazardous air pollutants, and maximum achievable control technology requirements; (2) establishes provisions for the development and issuance of general permits; (3) creates a single emission point permit to allow construction and operation of sources; (4) eliminates air permit application fees; (5) specifies air emissions permitting requirements; and (6) details thresholds and criteria for major air permit projects. Contact Patrick Lavin, DEC, (518) 457-7688.

The New York DEC adopted a final rule (18 NYSR 6; 7/17/96) which establishes an annual fee of $27.19 per ton of each regulated air contaminant for affected facilities and sets up procedures for calculating annual fees for the current year. The regulation was effective June 28. Contact David Finlayson, DEC, (518) 457-2823.

Air Quality (Notice)—The New York DEC has made available to the public application forms, instructions and computer file formats for the electronic filing of Title V air pollution facility applications. Contact DEC, (518) 457-7688.

NORTH CAROLINA

Air Quality (Proposed Regulation)—The North Carolina Department of Environment, Health and Natural Resources (DEHNR) plans to propose a regulation (11 NCR 443; 7/15/96) which would (1) allow the DEHNR to perform initial modeling concerning the air toxics program; (2) include a pollution prevention plan as part of maximum feasible control technology; and (3) exempt certain insignificant activities. Contact Thom Allen, DEHNR, (919) 733-7015.

A proposed regulation (11 NCR 472; 7/15/96) of the North Carolina DEHNR would, among other things, alter the mechanism for activating reasonably available control technology requirements for VOCs in certain areas; incorporate by reference federal national emission standards for hazardous air pollutants; and amend Title V permitting procedures and exemptions for case-by-case situations. Contact Thom Allen, DEHNR, (919) 733-7015.

Hazardous Waste (Proposed Regulation)—The North Carolina DEHNR intends to issue a proposal (11 NCR 442; 7/15/96) which would specify the criteria for the establishment and operation of facilities that collect and store household hazardous wastes and hazardous wastes from conditionally exempt small quantity generators. Contact Joan Troy, DEHNR, (919) 733-0692.

OKLAHOMA

Hazardous Materials Transportation (Regulation)—A final rule (13 OKR 2837; 6/17/96) of the Oklahoma Department of Public Safety (DPS) incorporates by reference federal requirements concerning hazardous materials transportation regulations and enforcement of motor carrier safety. The rule went into effect June 28. Contact John Hardridge, DPS, (405) 521-6103.

Solid Waste (Regulation)—The Oklahoma Corporation Commission (CC) adopted a final regulation (13 OKR 2945; 7/1/96) which updates requirements for underground storage tanks, including provisions for the shut down of operations in the event of noncompliance with the standards. The rule went into effect July 11. Contact Jeffrey Southwick, CC, (405) 52-4457.

Solid Waste (Proposed Regulation)—The Oklahoma Department of Environmental Quality (DEQ) has proposed a regulation which would eliminate the fees for new solid waste permits and for the transfer of solid waste permits. Contact Chris Varga, DEQ, (405) 745-7100.

OREGON

Air Quality (Regulation)—The Oregon Department of Environmental Quality (DEQ) adopted a rule (36 ORRB 7; 7/1/96) which increases the annual base fee for regulated major industrial sources to $2,569 and increases the emission fee for such sources to $30.07 per ton. The regulation was effective May 31. Contact Susan Greco, DEQ, (503) 229-5213.

Air Quality (Proposed Regulation)—A proposed regulation (36 ORRB 18; 7/1/96) issued by the Oregon Department of Environmental Quality (DEQ) would incorporate by reference the U.S. EPA's national emission standards for hazardous air pollutants, but limits the requirements to major sources of hazardous air pollutants only. Contact Susan Greco, DEQ, (503) 229-5213.

PENNSYLVANIA

Solid Waste (Proposed Regulation)—A proposal (26 PAB 3073; 6/29/96) of the Pennsylvania Environmental Quality Board (EQB) would incorporate by reference federal standards for underground storage tank (UST) owners and operators and would establish a permitting program for USTs. Contact Karl Sheaffer, EQB, (717) 772-5800.

Regulatory Agenda (Notice)—The state of Pennsylvania's Office of the Governor and Department of Environmental Protection (DEP) has issued a regulatory agenda (26 PAB 3170; 7/6/96) for the period of August 1996 through fall 1997, which includes topics such as underground storage tanks, solid waste management, recycling, hazardous waste, and air pollution control. Contact DEP, (717) 783-1303.

RHODE ISLAND

Air Quality (Proposed Regulation)—A proposed regulation of the Rhode Island Department of Environmental Management (DEM) would (1) amend requirements for air pollution control permits and operating permit fees; (2) revise the definition of "best available control technology"; (3) change the due date for annual emissions fees to September 1; and (4) modify fee provisions for sources that apply for an emissions cap. Contact Douglas McVay, DEM, (401) 277-2808.

SOUTH CAROLINA

Hazardous Materials Transportation—SC S. 1366 (Holland) provides that any person or corporation who aids in the violation of certification and registration requirements for the transportation of hazardous waste is guilty of a misdemeanor. The governor signed the legislation on June 4.

TEXAS

Air Quality (Proposed Regulation)—The Texas Natural Resource Conservation Commission (NRCC) has proposed a regulation (21 TXR 6872; 7/23/96) which would provide an exemption to specific source owners and operators from the requirement to submit grandfather emission rates in the operating permit application. Contact Kevin Bloomer, NRCC, (512) 239-5730.

Lead (Proposed Regulation)—A proposed regulation issued by the Texas Real Estate Commission (REC) would require the seller of a dwelling unit to disclose the presence of lead-based paint and/or lead-based paint hazards. Contact Mark Moseley, REC, P.O. Box 12188, Austin, TX 78711-2188.

Hazardous Materials Transportation (Proposed Regulation)—A regulation (21 TXR 6612; 7/16/96) proposed by the Texas NRCC would eliminate exemptions from reporting discharges or spills of hazardous substances and would conform with federal hazardous materials transportation standards by deleting the provision for a written follow-up for spills or discharges to the U.S. Department of Transportation. Contact Marianne Baker, NRCC, (512) 239-0475.

UTAH

Air Quality (Regulation)—The Utah Department of Environmental Quality (DEQ) has adopted a final regulation (96 UTSB 70; 6/15/96) which revises the definition of VOC to conform with the federal definition. The rule became effective June 6. Contact Jan Miller, DEQ, (801) 536-4042.

Air Quality (Proposed Regulation)—A proposal (96 UTSB 35; 7/1/96) issued by the Utah DEQ would incorporate by reference federal new source performance standards for sources of air pollution. Contact Jan Miller, DEQ, (801) 536-4042.

VIRGINIA

Air Quality (Proposed Regulation)—The Virginia Department of Environmental Quality (DEQ) intends to issue a proposal (12 VAR 2279; 7/8/96) which would develop a general permit for stationary sources to be excluded from the federal operating permit program, provided that the sources maintain their actual annual emissions at a level that is less than the potential to emit applicability thresholds. Contact Robert Mann, DEQ, (804) 698-4419.

WASHINGTON

Air Quality (Withdrawal)—The Washington Department of Ecology (DOE) has announced the withdrawal of a proposed rule to amend operating permit program requirements, including monitoring, recordkeeping and reporting provisions for insignificant emissions. Contact Tom Todd, DOE, (360) 407-7528.

WEST VIRGINIA

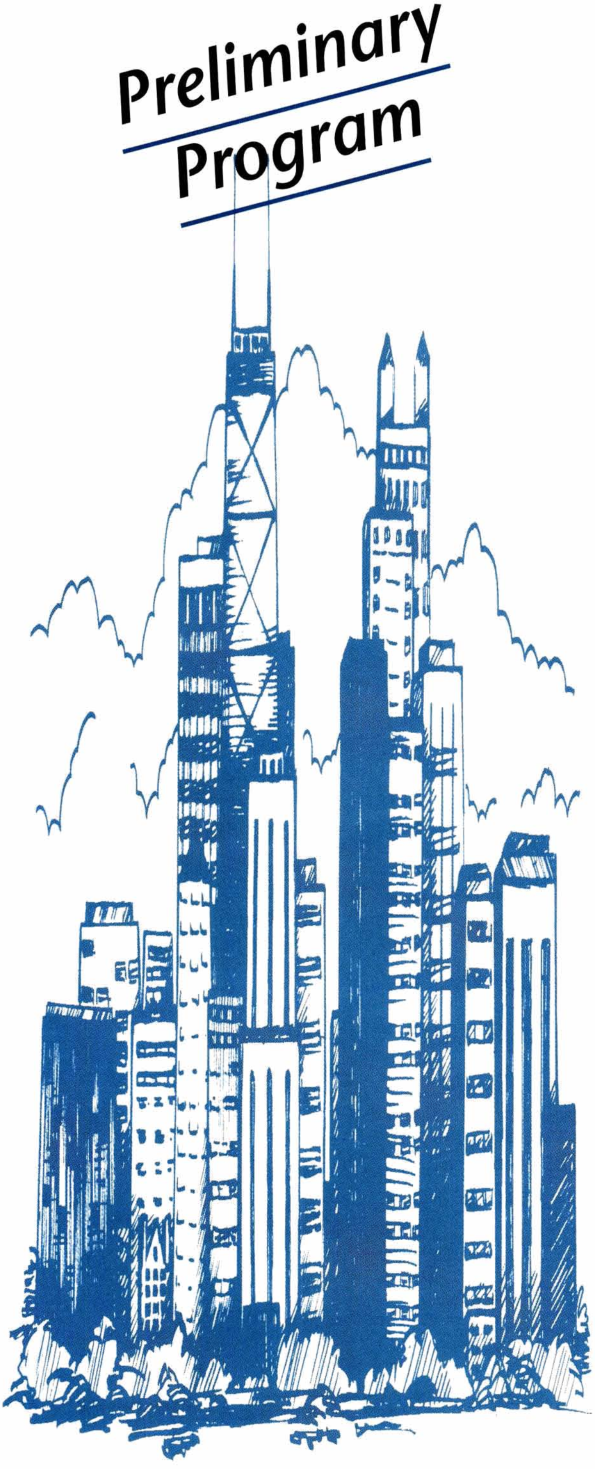
Air Quality (Proposed Regulation)—A proposed regulation (13 WVR 1178, 1187, 1193, 1210, 1224; 7/12/96) of the West Virginia Division of Environmental Protection (DEP) would amend provisions concerning (1) standards of performance for new stationary sources of air pollution; (2) the prevention and control of air pollution from hazardous waste treatment, storage and disposal facilities; and (3) emission requirements for hazardous air pollutants. Contact Dale Farley, DEP, (304) 348-2275.

WISCONSIN

Toxic Substances (Regulation)—The Wisconsin State Emergency Response Board (SERB) adopted a final regulation which amends requirements for temporary construction facility hazardous chemical inventory reporting. The rule became effective September 1. Contact SERB, (608) 242-3232.

WYOMING

Hazardous Waste (Regulation)—A final rule of the Wyoming Department of Environmental Quality (DEQ) concerning hazardous waste management standards incorporates federal air emission standards for tanks, containers and surface impoundments. The regulation went into effect June 17. Contact Robyn Dommel, DEQ, (307) 777-7752.



Federation of Societies for Coatings
Technology Presents

ice
INTERNATIONAL
COATINGS EXPO

1996

FSCT Annual Meeting

International Coatings Expo

Technology Conference

October 22-25, 1996
McCormick Place North
Chicago, Illinois

FSCT

- **Annual Meeting**
- **International Coatings Expo**
- **Coatings Technology Conference**

FEDERATION OF SOCIETIES
FOR COATINGS TECHNOLOGY
ice
INTERNATIONAL
COATINGS EXPO
AND TECHNOLOGY CONFERENCE

October 22-25, 1996
McCormick Place North
Chicago, Illinois

Preliminary Program/Registration/Housing Information

"Insights and Innovations"

International Coatings Expo (ICE)—*the new "PAINT SHOW"*

Encompassing the spectrum of coatings manufacturing, the new format of the FSCT's annual convention will feature a record-breaking exhibition of over 300 supplier companies in the International Coatings Expo. Held in conjunction with the FSCT Annual Meeting Technical Program, "ICE" will present over 100,000 square feet of exhibits. Come meet these suppliers face-to-face. Problem-solving opportunities abound at "ICE '96"!

Coatings Technology Conference

NEW

New to the 1996 FSCT Annual Meeting is the International Coatings Technology Conference. The conference provides a forum for learning at all levels of the coatings industry, from the newly hired technician to top level management. Each course has been designed for specific areas of your organization, including lab personnel, sales and marketing staff, manufacturing, quality assurance and research and development.

Technical Conference program includes:

- **Five Pre-Convention Training Seminars**, on Tuesday, October 22.
- **An Executive Forum**, covering Technology Management, Tuesday, October 22.
- **Four two-day Coatings Technology Conference Courses**, Wednesday and Thursday, October 23-24, 1996.
- **Complimentary Attendance to the International Coatings Expo and FSCT Annual Meeting Technical Presentations** for all one- and two-day and full conference registrations.
- **Set of Course Materials** is provided to the attendees of each individual program.

Federation of Societies for Coatings Technology
YE OLDE
PAINT STONE
1737

1996 Annual Meeting Technical Program

"Insights and Innovations"

Wednesday, October 23, 1996

Opening Session
8:30 a.m.

Seventy-fourth Annual Meeting of the Federation of Societies for Coatings Technology opened by President Darlene Brezinski

FSCT Heckel Award

Presentation of George Baugh Heckel Award, FSCT's highest honor, will be made to **George R. Pilcher,** of Akzo Nobel Coatings Inc.

E.W. Fasig Keynote Address

Keynote Speaker—**Ten Thousand Dollar Per Square Centimeter Coatings**—Walter C. McCrone, of McCrone Research Institute

> *There are many compositions of coatings useful for protection, for aesthetics, and for providing properties such as electrical conductivity, adhesion, etc. None, however, is more expensive than some of the aesthetic coatings. Coatings applied to a canvas by Leonardo da Vinci have sold for more than $20,000/cm. Other old-masters are not far from the same price range. One result of this is the growing temptation for some modern artists to "change their name" to Rembrandt, Titian, Raphael— or even Leonardo. There is an increasing need for scientific techniques to detect art forgeries. Mr. McCrone's presentation describes how these complex coatings are analyzed by Polarized Light Microscopy supplemented by Fourier Transform Infrared Absorption and Scanning Electron Microscopy with Energy Dispersion X-ray analysis to detect these mis-attributions.*

Technical Focus Speaker
1:00 p.m.- 2:00 p.m.

Pigment Flocculation is a Figment of Your Imagination—F. Louis Floyd, Duron, Inc.

Roon Award Competition Papers—
2:00-4:00 p.m.

A Unifying Model for Understanding Associative Thickener Influences on Waterborne Coatings—J. Edward Glass, Mao Chen and Zeying Ma, North Dakota State University, and Robert Buchacek and Jack Dickinson, DuPont

Rheological Changes During the Drying of a Waterborne Latex Coating—Matthew Gebhard, Rohm and Haas Co. and Frank Löfflath, PPG Industries, Inc.

New Developments in Acrylate Modified Epoxy-Amine Cure Coatings—Michael A. Bailey, Tim Cauffman and Richard Costin, Sartomer Co.

Mechanistic Considerations of Particle Size Effects on Film Properties of Hard/Soft Latex Blends—Sarah Eckersley and Bradley Helmer, The Dow Chemical Co.

Thursday, October 24, 1996

APJ/A.F. Voss Award Competition Papers
9:00 a.m.-10:00 a.m.

An Investigation of the Effects of Formulation on Selected Properties of UV Curable IPN Coatings—Detroit Society for Coatings Technology

Direct VOC Analysis of Water-Based Coatings by Solid Phase Micro Extraction and Gas Chromatography—Los Angeles Society for Coatings Technology

FSCT Annual Industry Luncheon
12:00 noon

International Papers I
2:30 p.m.-3:30 p.m.

Component Thinking in Paint Production—Carola Grundfelt-Forsius, Tikkurila OY, *(presented on behalf of SLF)*

High Durable Coating Systems for Steel Structures and Their Performances—Hiroyuki Tanabe, Masanori Nagai and Masafumi Kano, Dai Nippon Toryo Co., Ltd. *(presented on behalf of JSCM)*

Friday, October 25, 1996

FSCT Annual Business Meeting
9:00 a.m.-10:00 a.m.

International Papers II
9:00 a.m.-10:30 a.m.

Environment-Friendly Antifouling Paint—A. Perichaud and J. Coquillaud, Catalyse Company *(presented on behalf of AFTPVA Section of FATIPEC)*

Solventless Aliphatic Polyisocyanates Hardeners for Low VOC PU Formulations in the Coatings Industry—Pierre Ardaud and Eugenie Perroud, Rhone-Poulenc *(presented on behalf of FATIPEC)*

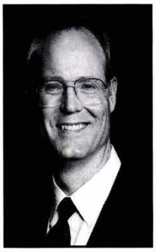
Title to be determined—S.G. Lawrence, Ciba Pigments Division *(presented on behalf of OCCA)*

Mattiello Memorial Lecture
10:30 a.m.-11:30 a.m.

Predicting In-Service Weatherability of Automotive Coatings: A New Approach—David R. Bauer, Ford Motor Company

Annual Meeting Highlights

George R. Pilcher to Receive Heckel Award



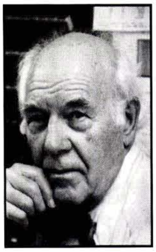
George R. Pilcher, Technical Director, Coil and Extrusion Business Unit, for Akzo Nobel Coatings Inc., Columbus, OH, will be the recipient of the Federation's highest honor, the George Baugh Heckel Award, for 1996. Mr. Pilcher, a member of the CDIC Society, will receive the award at the Opening Session of the Annual Meeting on Wednesday, October 23.

The Heckel Award recognizes the outstanding contributions that Mr. Pilcher has made to the Federation's interest and prestige while serving the organization in many capacities, which include being a member of the Publications, Mattiello Lecture, Roon, and Program Committees, a member of the Journal of Coatings Technology Editorial Review Board, and serving as President of the Coatings Industry Education Foundation.

F. Louis Floyd Named Technical Focus Speaker

F. Louis Floyd, Vice President for Technology, of Duron Paints and Wallcovering, Baltimore, MD, will open the Federation's Annual Meeting Program as Technical Focus Speaker. The Technical Focus Speaker presentation honors on-going work in critical technical areas. Mr. Floyd's presentation entitled, "Pigment Flocculation is a Figment of Your Imagination," will be given on Wednesday, October 23, at 1:00 p.m.

Walter McCrone Presents Keynote Address

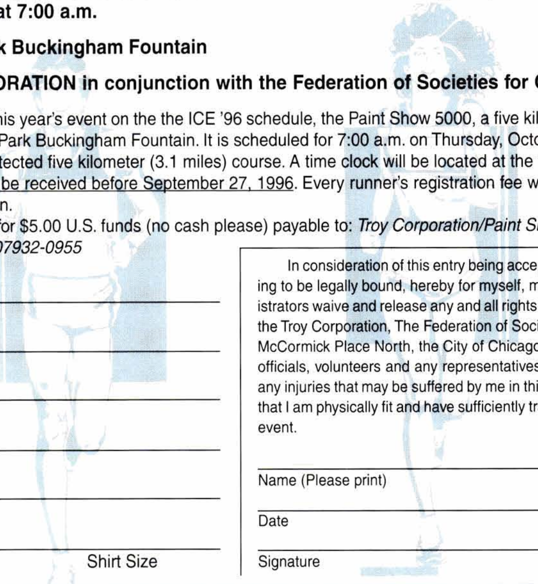


Renowned forensic scientist, Walter C. McCrone, will be the Keynote Speaker at the Opening Session of the FSCT's Annual Meeting. Mr. McCrone is Director Emeritus of the McCrone Research Institute, a non-profit corporation devoted to fundamental research in, and teaching of, microscopy and crystallography. In 1974, he, with his wife, Lucy, found the Vinland Map to be a 20th century fake, and, in 1980, he reported the Shroud of Turin to be a fine medieval painting. Mr. McCrone's presentation will focus on "Ten Thousand Dollar Per Square Centimeter Coatings."

Mattiello Lecture to be Given by David R. Bauer

Focusing on recent work in the area of prediction of coating service life, Dr. David R. Bauer, of Ford Research Laboratory, will present the Joseph J. Mattiello Memorial Lecture during the FSCT Annual Meeting. As Senior Staff Technical Specialist in the Manufacturing Systems Department of the Ford Research Labs, Dr. Bauer directs long-term research on paint application, characterization, and evaluation. Chosen from among those who have made outstanding contributions to science, Dr. Bauer will present the Mattiello Lecture on Friday, October 25 at 10:30 a.m. His presentation will be on "Predicting In-Service Weatherability of Automotive Coatings: A New Approach."

Paint Show 5000



A five kilometer fitness run especially for attendees at the International Coatings Expo '96 in Chicago, IL
Thursday, October 24, 1996 at 7:00 a.m.

Start/Finish at the Grant Park Buckingham Fountain

Sponsored by: TROY CORPORATION in conjunction with the Federation of Societies for Coatings Technology

All runners are invited to join this year's event on the the ICE '96 schedule, the Paint Show 5000, a five kilometer fun and fitness run starting and finishing at the Grant Park Buckingham Fountain. It is scheduled for 7:00 a.m. on Thursday, October 24, 1996. Participants will run on a measured, police-protected five kilometer (3.1 miles) course. A time clock will be located at the finish.

Entry fee: $5.00. Entries must be received before September 27, 1996. Every runner's registration fee will be donated to the Coatings Industry Education Foundation.

Mail entry forms with a check for $5.00 U.S. funds (no cash please) payable to: *Troy Corporation/Paint Show 5000, 8 Vreeland Rd., P.O. Box 955, Florham, Park, NJ 07932-0955*

Name
Title
Company
Address
City/State/Zip
Telephone Shirt Size

In consideration of this entry being accepted, I the undersigned intending to be legally bound, hereby for myself, my heirs, executors and administrators waive and release any and all rights and claims I may have against the Troy Corporation, The Federation of Societies for Coatings Technology, McCormick Place North, the City of Chicago, IL, race sponsors, their staff, officials, volunteers and any representatives, successors or assignees for any injuries that may be suffered by me in this event. I further hereby certify that I am physically fit and have sufficiently trained for the completion of this event.

Name (Please print)
Date
Signature

Coatings Technology Conference

Executive Forum

Managing Technology for Strategic Success in the Coatings Industry

MONDAY EVENING (DINNER) & TUESDAY (WORKSHOP)
OCTOBER 21-22, 1996 • CHICAGO HILTON AND TOWERS

Course Description

This interactive, executive level workshop introduces the participants to the management tools and techniques required to fully link the R&D function with the strategic objective of the business. Based on the principles of "Third Generation R&D," the program uses presentations, group exercises and case studies. The course is designed for R & D group leaders; technical directors; senior chemists; marketing directors or managers; sales directors or managers; small business owners; and anyone with strategic leadership responsibility in their organization.

Attendees will learn:

- Methods to determine the feasibility of new technology
- How to assess the validity of new concepts and ideas
- Ways to use time and money more wisely in the pursuit of new advances in technology
- How to better understand the impact of R&D on the bottom line
- Techniques to associate marketing and technology while pursuing new ideas

Registration limited to 30 attendees

Course Instructors

- John Martin (Arthur D. Little)
- Eric Carlson (Arthur D. Little)
- Stephen Rudolph (Arthur D. Little)

Pre-Convention Training Seminar

Faster to Market with Better Products through Design of Experiments

TUESDAY, OCTOBER 22, 1996
CHICAGO HILTON AND TOWERS

Seminar Description

Design of Experiments (DOE) will give the coatings technologist five important benefits: cutting the time from inception to market; increasing product quality; lower raw material costs; research and development productivity; and manufacturable products. The understanding of DOE will allow the attendee to make a greater contribution to his or her company. The course is targeted at laboratory and R&D personnel and project managers and technicians interested in becoming more effective in the R&D function.

Attendees will learn:

- Better planning and project management
- How to better allocate resources through the use of time saving methods
- Techniques to achieve greater certainty of results
- Ways to focus efforts to predict coatings properties
- Methods to develop truer selection criteria/ evaluation
- The purpose of various testing procedures and how to know when to use them, and when not to use them
- The importance of not reaching conclusions before experiments

Instructor

- Charles Rooney (Orr & Boss)

Pre-Convention Training Seminar

WORKSHOP
Effective Technical & Scientific Writing

TUESDAY, OCTOBER 22, 1996
CHICAGO HILTON AND TOWERS

Seminar Description

For all levels of laboratory and R&D personnel along with applicators and anyone with responsibility for writing memos, letters, reports, manuals, specifications and proposals on a routine basis. The session includes in-class writing exercises designed for practical application, and allows time for individual attention. Participants are invited to submit writing samples in advance for a confidential review by the instructor.

Attendees will learn:

- Skills and techniques to improve technical communication
- How to improve effectiveness in communicating technological issues
- Methods of data collection and tabulation to maximize impact of data on the presentation
- Proven techniques to make technical issues understandable
- How to translate technical terms for non-technical readers
- How to improve writing skills: structure and format
- Ways to "rethink how you write"
- How to write the first draft of a document
- Approaches to use when writing for another person
- Editing techniques and a review of punctuation and usage

Instructor

- Sal Iacone (Consultant)

Experience turns waterborne wood coatings into a beautiful finish.

Enhancing the valuable characteristics of wood has long been the business of SC Johnson Polymer. Our broad knowledge and experience dates back to the turn of the century, when our founder, Samuel Johnson, developed a high-quality finish to protect the parquet flooring he made. And his uncompromising standards are still the rule today.

Our pioneering efforts in the development and production of polymers for waterborne wood coatings have since forged SC Johnson Polymer as a leader in compliant technology. Offering a unique balance of application, appearance and resistance properties, our waterborne polymers in many cases actually exceed the performance of solvent based polymers.

After all, what good is compliant technology if it doesn't offer exceptional performance?

Our dedication to the future of the industry will continue to push the standard of wood coatings toward even cleaner, better performing polymers. With SC Johnson Polymer on your side, you can expect practical solutions to ever-changing problems. For a beautiful finish, the choice is clear. SC Johnson Polymer.

SC Johnson
Polymer

Pre-Convention Training Seminar

Surfactant Chemistry

TUESDAY, OCTOBER 22, 1996
CHICAGO HILTON AND TOWERS

Seminar Description

For R&D personnel, synthesizers, formulators and applicators in the coatings and ink industries, this course provides a better understanding of surfactants and polymers, new technologies and uses in this area, a working knowledge of surfactant synergy in waterborne technology, details on coatings and flows, and information on defoamers.

Seminar Topics and Instructors

- "Introduction: Coatings and Flows"—Skip Scriven, University of Minnesota
- "General Surfactant Properties"—Steve Snow, Dow Corning
- "Classes of Surfactants, Wetting Phenomena"—Bob Stevens, Air Products and Chemicals
- "Surface Tension, Coatings Defects and Substrate Wetting"—Joel Schwartz, Air Products and Chemicals
- "Pigment Surface Wetting, Dispersion Stabilization and Defoaming"—Ed Orr, BYK Chemie

Pre-Convention Training Seminar

Winning Technical Presentations

TUESDAY, OCTOBER 22, 1996
CHICAGO HILTON AND TOWERS

Seminar Description

For laboratory and R&D personnel at all levels, marketing and sales staff, and anyone responsible for delivering technical presentations. Attendees will learn how to develop effective visuals; proper speaking techniques and data organization; how to handle question and answer sessions; tips on transferring written information to speaking terms; and how to communicate clearly to all audiences. This program combines lecture, interaction and small group projects.

Attendees will learn:

- How to effectively develop visuals for technical presentations
- Proper speaking techniques
- How to organize data
- Tips to transfer written information for a speech
- How to handle question and answer sessions
- Presentation style and format
- How to effectively communicate to all audiences
- The ability to aim presentations to any size audience, from one to hundreds

Instructor

- Carter Johnson (Buying Time Seminars)

Registration limited to 25 attendees

Pre-Convention Training Seminar

Coatings Spray Applications

TUESDAY, OCTOBER 22, 1996
BINKS MANUFACTURING CO., FRANKLIN PARK, IL
(Transportation Provided)

Seminar Description

Provides both experienced and novice applicators, field service personnel, specifiers and formulators with information on current and upcoming technologies as they apply to the application of coatings and finishes. Considered as a Learning Exchange Seminar, attendees will learn how to properly select, maintain and operate spray finishing equipment and to answer a variety of questions related to spray finishing.

Seminar Topics

- "Spray Applications"
- "HVLP: High Volume, Low Pressure"
- "Spray Gun Service"
- "Electrostatics: Liquid and Powder"
- "Personal Protection/Spray Booths"
- "Hands on Spraying: Air Spray, HVLP, Air/Airless"

Instructor

- Jerry Hund, Binks Manufacturing

Attendance is limited.

Technology Conference Course

Advances in Coatings Characterization

WEDNESDAY - THURSDAY, OCTOBER 23-24, 1996
MCCORMICK PLACE NORTH

Course Description

Provides a quick review of key analytical techniques in the coatings industry, along with an update on recent methods. Attendees will also see examples of successful application of these techniques to solve practical paint and coatings problems. This course is targeted towards laboratory directors, QC managers, customers/specifiers, graphic arts industry personnel and analytical personnel.

Course Topics and Instructors

- "Optical and Electron Microscopy Analysis of Coatings"—Skip Palenik, MicroTrace Associates
- "Elemental and Molecular Analysis of Coating Surfaces"—Paula Clark, Air Products and Chemicals
- "Infrared/Raman Spectroscopy of Coatings"—Marek Urban, North Dakota State University
- "Three-Dimensional Coatings Topography Analysis"—Andrew Gilicinski, Air Products and Chemicals
- "Particle Size Analysis of Latex Systems"—Ted Provder, ICI Glidden Paints
- "Thermal Analysis of Coatings and Polymers"—Mike Neag, ICI Glidden Paints

THE MOST EFFECTIVE CORROSION AND TANNIN STAIN RESISTANCE: NO BRAG...JUST FACT!

For well over two decades, **HALOX®** has been dedicated to the research, development, and manufacture of innovative, non-toxic, corrosion-inhibiting and tannin-stain resistance pigments. Today, we're the unquestioned leader in the field, supplying our inhibitive pigments to the coatings industry worldwide. And, that leadership attests to the effectiveness and dependability of our products.

Our non-toxic **XTAIN®**, for example... compatible with a variety of resin systems -- protects wood from the dark discoloration associated with tannin stain.

To fortify paint with maximum corrosion resistance and get chromate performance without the chromates, **SZP-391** is THE non-toxic solution. And, for cost effective performance and versatility, our heavy metal-free **CW-491** is the pigment of choice. Naturally, these and all of our other HALOX products come with **SQP:** responsive SERVICE, superior QUALITY, and proven PERFORMANCE. Call or write for complete product specifications and documented results. What you'll get will be the facts, pure and simple. Plus a promise:

We'll try not to blow our own horn too much!

HALOX®

SQP: ONLY FROM HALOX.

Every product contains it. Every employee is dedicated to it. Every customer benefits from it!

For more information on all the HALOX products, call 219-933-1560 or write to:
HALOX® Pigments, 1326 Summer Street,
Hammond, Indiana 46320-2240 U.S.A.

Circle No. 114 on the Reader Service Card

- "Rheology of Coatings and Polymers"—Richard Eley, ICI Glidden Paints
- "Mechanical Properties of Polymers and Coatings"—Loren Hill, Monsanto Corp.
- "Basics and Practice of EIS for Protective Coatings"—Richard Granata, Lehigh University
- "Application of Electrochemical Impedance to Problem Solving in the Coatings Industry"—Peter Kamarchik, PPG Industries
- Vendor Demonstrations

TECHNOLOGY CONFERENCE COURSE

Substrates and Coatings

WEDNESDAY - THURSDAY, OCTOBER 23-24, 1996
MCCORMICK PLACE NORTH

Course Description

Provides attendees with a better understanding of the effects substrates have on coatings performance. Attendees will learn of the various considerations to examine in order to develop the right coating for the right substrate. This course is aimed at formulators, laboratory and R&D chemists, technical service and sales personnel, along with coatings specifiers.

Course Topics and Instructors

- "Plastic ABS Substrates"—Bruce Thill, Dow Chemical
- "Coatings on Plastics"—James D. McGuiness, Red Spot Paint and Varnish
- "Wood Coatings and Substrates: Wood Properties and Their Effect on Finish Performance"—Sam Williams, USDA Forest Products Lab
- "Metal Substrates"—Doug Grossman, Q Panel
- "Coatings for Metals"—Simon Boocock, SSPC
- "Concrete as a Paintable Surface"—Eric S. Kline, KTA-Tator
- "Coatings for Concrete"—Dave Hazlett, Tnemec

Technology Conference Course

Polymer Chemistry for the Coatings Formulator

WEDNESDAY - THURSDAY, OCTOBER 23-24, 1996
MCCORMICK PLACE NORTH

Course Description

Provides current information on polymer chemistry for coatings formulators, R&D chemists, and sales and marketing personnel with strong technical backgrounds or interests. Attendees will realize a greater understanding of the essential concepts of polymer science and the underlying principles to determine coatings using scientific principles as opposed to trial and error and is also relevant for ink, sealant and adhesive industry personnel.

Course Topics and Instructors:

- "Polymer Fundamentals"—Frank Jones, Eastern Michigan University
- "Step-Growth Polymerization"—Fritz Walker, Air Products and Chemicals
- "Chain Growth Polymerization"—J. David Nordstrom, DuPont Automotive
- "Introduction to Emulsion Polymerization"—Alvin C. Lavoie, Rohm and Haas Co.
- "Vinyl Polymers"—Jennifer Cogar, McWhorter Technologies
- "Acrylic Polymers"—Patricia Lesko, Rohm and Haas Co.
- "Polyester and Alkyd Resins"—Paul R. Baukema, Akzo Nobel Coatings, Inc.
- "Chemistry and Technology of Polyurethane Coatings"—Terry Potter, Bayer Corp.
- "Analytical Techniques (Polymer Characterization)"—Bill Simonsick, DuPont Marshall Labs
- "The Chemistry of Epoxy Resins"—David A. Dubowik, Air Products and Chemicals
- "Amino Resins and Crosslinking Agents"—Nicholas Albrecht, Cytec Industries, Inc.
- "Rheological and Mechanical Properties of Coatings"—Manoj Gupta, BASF Corp.
- Problem Solving/Round Table Discussions

Technology Conference Course

"Back to Basics": General Overview of Coatings Technology

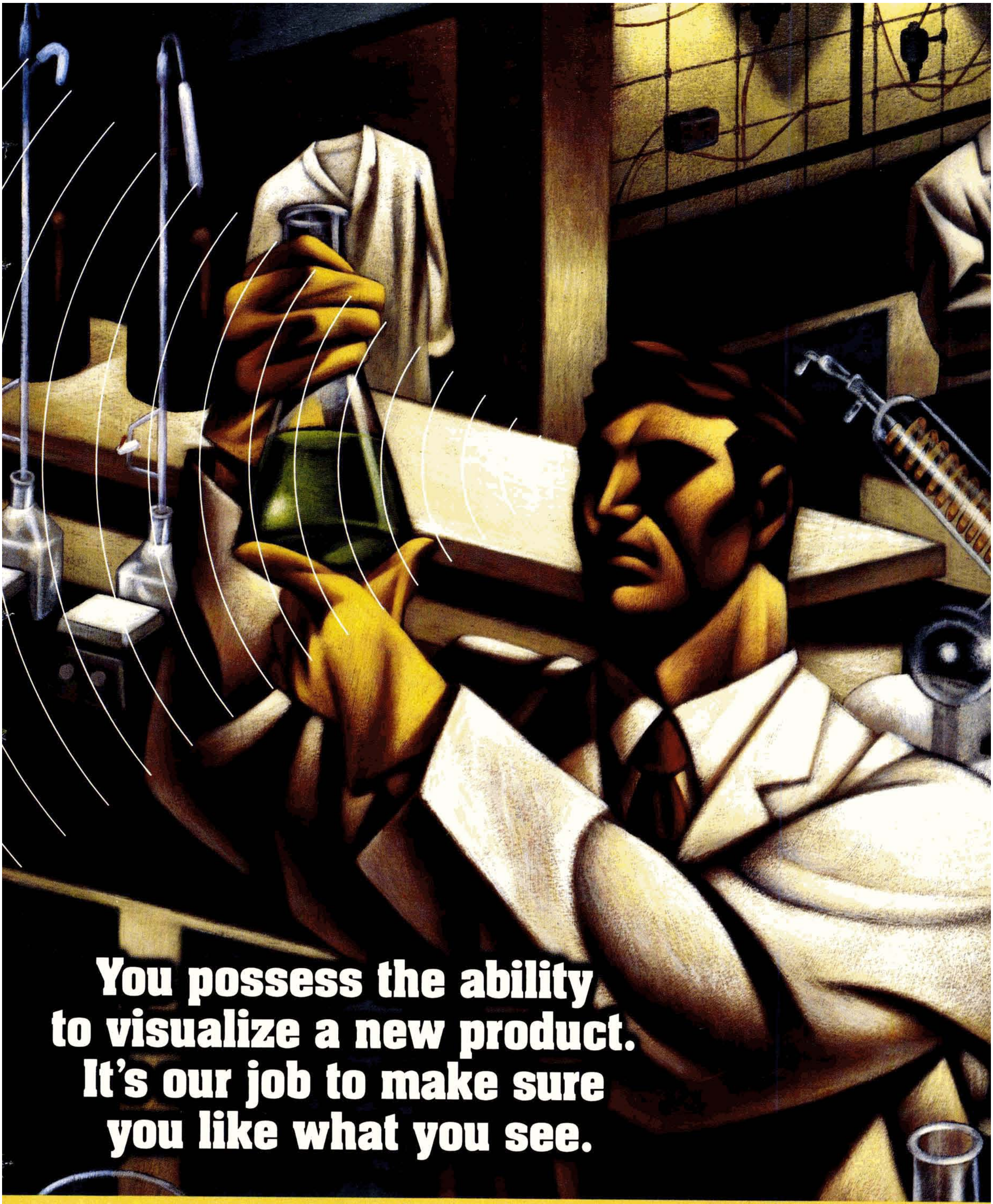
WEDNESDAY - THURSDAY, OCTOBER 23-24, 1996
MCCORMICK PLACE NORTH

Course Description

For chemists new to the industry or with minimal experience, lab technicians, and sales, marketing and field support personnel. The program will provide attendees with an overview of coatings types; a review of basic coatings composition; and cost savings ideas for formulation.

Course Topics and Instructors:

- "Introduction to Paints and Coatings"—Donald Denny, E.W. Kaufmann
- "Oils, Varnishes and Alkyds"—Bruce Johnson, Engineered Polymer Solutions
- "Resins: Solvent Type OEM Industrial"—Donald Fritz, Retired
- "Water-Reducible Resins: An Overview"—Jeff Danneman, Reichhold Chemical
- "Resins: Emulsion, Architectural and Industrial"—Robert J. Klein, Air Products and Chemicals
- "The Role of Acetylenic Glycols in Waterborne Coatings"—Sam Morell, S.P. Morell and Company
- "Additives II"—Tim Savage, Troy Chemical
- "Introduction to the Use of Pigments in Coatings"—Tom Brown, Consultants Consortium
- "Color Pigments: Matching Price and Performance"—Jim Delaney, Ciba-Geigy Pigments
- "Basic Paint Formula Calculations"—George Schmitz, S.P. Morell and Company
- "Paint Testing"—Saul Spindel, D/L Laboratories
- "Paint Application: Industrial and Architectural"—William Fabiny, Sermagard Coatings


You possess the ability to visualize a new product. It's our job to make sure you like what you see.

Social Guest Program

Activities for Social Guest registrants begin on Wednesday afternoon with a Welcome Social* at the Chicago Hilton and Towers Hotel.

On Thursday, Social Guests enjoy a continental breakfast and afterwards depart on motorcoaches for a tour of Chicago's downtown area. A visit to the Art Institute of Chicago will be included in the tour. Participants will view the traveling exhibition of the works of Edgar Degas. Organized by the National Gallery in London and the Art Institute of Chicago, the exhibit features his later works between 1886, when he participated in the last impressionists exhibit and 1918, the year of his death.

An exclusive luncheon for Social Guests will be included in the tour.

The fee for Social Guests of $60 in advance and $70 on-site includes the Social Guests activities, three days admittance to the Expo, and attendance to the Opening Session. Space is limited and pre-registration is strongly suggested.

**Sponsored in part by Air Products & Chemicals*

(The category Social Guest is not to be used by co-workers or associates in the industry. It applies to the Spouse or Significant Other of the industry attendee.)

Shuttle Service

Shuttle service between the official ICE hotels and the McCormick Place North will be offered according to the following schedule:

Tues., Oct. 22	7:30 a.m. - 5:00 p.m.
Wed., Oct. 23	7:30 a.m. - 6:00 p.m.
Thurs., Oct. 24	7:30 a.m. - 6:00 p.m.
Fri., Oct. 25	7:30 a.m. - 3:00 p.m.

Ground Transportation

From O'Hare International Airport: Shuttle bus service is available via Continental's Airport Express; fare is $14.75 one way. Taxi fares run upwards of $25 to the downtown hotels. The Chicago Transit Authority (CTA) operates rail service from O'Hare to downtown Chicago for $1.25 one way.

From Midway Airport: Shuttle bus service is available via Continental's Airport Express; fare is $10.75 one way. Taxi fares run upwards of $18 to the downtown hotels.

Hotel Reservation Instructions

To place a reservation, complete the hotel reservation form and contact the ICE Housing Bureau "One-Stop Chicago" serviced by the Chicago Convention and Tourism Bureau. A one-night's deposit of $125 is required to process each reservation.

You may phone, fax, or mail your reservations to One-Stop Chicago. Use only one method to place your reservation to avoid a duplication of requests and deposits being processed.

A confirmation of your reservation will be mailed to you by One Stop Chicago.

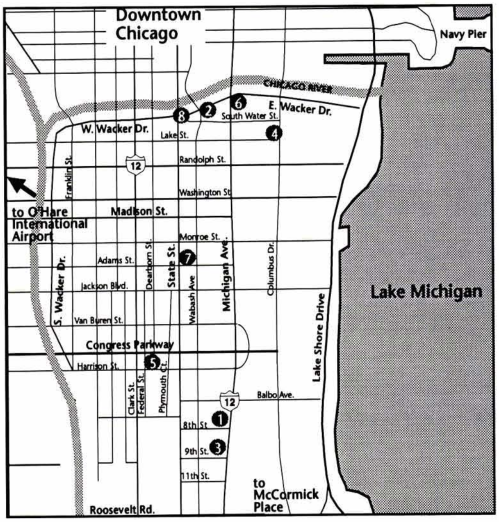
The cut-off date is September 23. After September 23, reservations will be accepted on a space available basis only.

Deposits are refundable provided that reservations are canceled with hotels at least 72 hours prior to the date of arrival. Before October 2, notify One-Stop Chicago of cancellations. After October 2, contact the hotel directly.

FSCT Convention Hotels

There are eight official ICE hotels in Chicago. Serving as the headquarters property will be the Chicago Hilton and Towers. Convention rates for each hotel are noted below.

Chicago Hilton & Towers ***(FSCT Headquarters)***	
Main hotel	$140, $165, $190 single $160, $185, $ 210 double
SOLD OUT	
Towers level	$235 single, $255 double
Palmer House Hilton ***(NPCA Headquarters)***	
Main hotel	$142 single or double
SOLD OUT	$180, $200, $215 double
Towers level	$230 single, $250 double
Hyatt Regency	$142 single or double
Fairmont	$164 single or double
Essex Inn SOLD OUT	$108 single or double
Clarion Executive Plaza	$125 single or double
Renaissance Chicago	$160 single or double
Hyatt on Printers Row SOLD OUT	$151 single or double



Key to Chicago Map

1. Chicago Hilton and Towers
2. Clarion Executive Plaza Hotel
3. Essex Inn
4. Fairmont Hotel - At Illinois Center
5. Hyatt on Printers Row
6. Hyatt Regency Chicago
7. Palmer House Hilton
8. Renaissance Chicago

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
ice
INTERNATIONAL COATINGS EXPO
AND TECHNOLOGY CONFERENCE

1996 Housing Application Form

Reservations must be placed with the Housing Bureau. Hotels will not accept reservations directly.
Reservations must be received by **September 23, 1996.**

1. To Make Reservations

TO CALL:

U.S. & Canada (toll-free)
800-424-5248

Domestic & Overseas
847-940-2152

Prior to calling, have the following available:

- Name of Convention ('**ICE 96**')
- Your 1st, 2nd, 3rd, & 4th choice of hotel
- Arrival/Departure dates
- Number of rooms required
- Type of room needed (single, double, etc.)
- Credit card #, expiration date
- Names of room occupants
- Address
- Phone and fax numbers

TO FAX:

U.S. & Canada (toll-free)
800-521-6017

Domestic & Overseas
847-940-2386

- Please print or type all items to ensure accuracy
- Complete each part below in detail for correct and rapid computer processing
- Form may be duplicated or supplemental room list must be attached using same format as below

TO MAIL:

Send completed form and payment to:
One Stop Chicago
P.O. Box 825
Deerfield, IL 60015-0825

Prior to October 2, all reservations, changes, and cancellations must be made with One Stop Chicago. After this date, these changes must be made with the hotel directly. Reservation depositis are refundable provided that they are cancelled with the hotel at least 72 hours prior to date of arrival.

2. Hotel Information

Select 4 hotels of your choice to facilitate processing. Requests are given priority in the order received. First choice is assigned IF AVAILABLE. Be sure to list definite arrival and departure dates.

1st ______________________ Rate________ 3rd ______________________ Rate________
2nd ______________________ Rate________ 4th ______________________ Rate________

Names of Occupants	Room Type*	Arrival	Departure
	☐ single ☐ dbl/dbl ☐ double		
	☐ single ☐ dbl/dbl ☐ double		
	☐ single ☐ dbl/dbl ☐ double		
	☐ single ☐ dbl/dbl ☐ double		
	☐ single ☐ dbl/dbl ☐ double		

* Room Key: single (1 person, 1 bed); double (2 people, 1 bed); double/double (2 people, 2 beds).
Requests for the Chicago Hilton and the Palmer House will be limited to 10 rooms per exhibitor company.

3. Deposit Information

Advance deposit required at the time of booking. Reservations will not be processed without a deposit. Deposits are $125 per room. Deposits may be made by major credit card or check (U.S. dollars). Your credit card will be billed immediately.

☐ Enclosed is my check payable to One Stop Chicago for the amount of $ __________

Please bill my: ☐ AMEX ☐ MC ☐ Visa

Credit Card Number ______________________ Expiration Date ______________
Name of Card Holder ______________________ Signature ______________________

4. Send Confirmations to:

Name: ______________________ Telephone: ______________________
Company: ______________________ FAX: ______________________
Address: ____
City/State (Province): ______________________ Zip Code (Mailing Code): ______________
Country (if other than U.S.): ______________________
♿ ______________________ requires special assistance. Please attach a written description of your needs.

Registration Fees

Training taken to maintain or improve your professional skills is usually tax deductible as an ordinary and necessary business expense. Consult with your tax advisor for applicability.

REGISTER NOW AND SAVE!

Registration Package—Advance Pricing*	Member	Non-Member
ICE Expo and FSCT Annual Meeting Presentations	**$75**	**$100**
Full Technology Conference & Expo	$495	$595
Coatings Technology Conference Two-Day Course	$395	$495
Executive Forum	$395	$495
Pre-Convention Training Seminars	$195	$295
Social Guest Program	$60	$60
Retired FSCT Member and Spouse (each)	$30	—
Student (valid student ID requried)	$15	$15

**On-site registrants will be charged a premium.*

No advance registrations will be accepted after 12:00 midnight on September 11. All credit card transactions are processed in U.S. Dollars and are subject to current exchange rates. International checks must be submitted in U.S. Dollars, paid in U.S. Banks. Badges will be mailed in advance to pre-registered ICE and Conference attendees and their pre-registered Social Guests.

Badge holders will be distributed at the ICE registration verification areas located at McCormick Place North as well as the Chicago Hilton and Towers and Hyatt Regency.

Technology Conference attendees registration credentials will be distributed in Chicago at the ICE Conference Registration area located in the Chicago Hilton Hotel on Tuesday and at McCormick Place North on Wednesday and Thursday.

Registration Hours

McCormick Place North

Tues., Oct. 22	7:30 a.m. - 5:00 p.m.
Wed., Oct. 23	7:30 a.m. - 5:00 p.m.
Thurs., Oct. 24	7:30 a.m. - 5:00 p.m.
Fri., Oct. 25	7:30 a.m. - 12 Noon

Chicago Hilton and Towers

Mon., Oct. 21	5:00 p.m. - 7:00 p.m.
Tues., Oct. 22	7:30 a.m. - 5:00 p.m.
Wed., Oct. 23	7:30 a.m. - 10:00 a.m.

Hyatt Regency Chicago

Tues., Oct. 22	7:30 a.m. - 5:00 p.m.
Wed., Oct. 23	7:30 a.m. - 10:00 a.m.

Expo Hours

Wed., Oct. 23	10:00 a.m. - 5:00 p.m.
Thurs., Oct. 24	9:00 a.m. - 5:00 p.m.
Fri., Oct. 25	9:00 a.m. - 12 Noon

FSCT's refund policy: Cancellations received on or before October 9 will be charged $15. Cancellations received after that date will be charged $50. No refunds will be issued for cancellations received after October 16. All refunds will be processed after November 1.

Special Airfare Discounts

Special arrangements have been made with United and Delta Airlines for reduced airfares for ICE attendees. To participate, call the FSCT Travel Desk or the airlines directly.

Contact the FSCT Travel Desk and mention "ICE96"

Phone	800-448-FSCT
Int'l callers	215-628-2549
Fax	215-628-0310

Contact the airlines directly by calling

United 800-521-4041	mention code: 563UA
Delta 800-241-6760	mention code: I 3633

NPCA Annual Meeting

The National Paint and Coatings Association will hold its annual meeting on Wednesday and Thursday, October 23-24, at the Palmer House in Chicago.

NPCA will admit registered attendees of the FSCT International Coatings Expo to the Forum Sessions being held during its annual meeting at no additional charge. The Forum Sessions will be held at the Palmer House on October 23 and October 24.

1996 PRE-REGISTRATION FORM

FSCT International Coatings Expo & Technology Conference

• Chicago, IL •

October 22 • 23 • 24 • 25, 1996

- ■ **Fax** completed form to **(805) 654-1676**
- ■ **Mail** completed form with payment to: ICE Registration, c/o RCS, 2368 Eastman Ave., Ste. 11, Ventura, CA 93003-7797
- ■ *Registration Helpline:* (610) 940-0777, 8:30 - 4:30 ET

Deadline: September 11, 1996. Register Today!

To pre-register, this form must be postmarked no later than September 11, 1996. Forms received after then will be returned with a notice advising you to register on-site. Form must be filled out completely for processing. A confirmation of your registration will be sent to you. Badges will be sent in advance to U.S. registrants. International registrants may obtain their badges at the international registration desk in Chicago. ICE badges must be worn for admission to the convention programs and Expo.

1. Industry Attendee Badge Information:

CP ☐

FIRST NAME (Nickname) ☐☐☐☐☐☐☐☐☐☐☐☐

FIRST NAME ☐☐☐☐☐☐☐☐ LAST NAME ☐☐☐☐☐☐☐☐☐☐☐

COMPANY ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

MAILING ADDRESS (or P.O. Box) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

CITY ☐☐☐☐☐☐☐☐☐☐☐☐☐☐ STATE/PROV. ☐☐

COUNTRY (other than U.S.) ☐☐☐☐☐☐☐☐☐☐ POSTAL CODE ☐☐☐☐☐☐☐☐☐☐

TELEPHONE NO. ☐☐☐☐☐☐☐☐☐☐ FAX NO. ☐☐☐☐☐☐☐☐☐☐

2. Social Guest Badge Information:

CP ☐

FIRST NAME (Nickname) ☐☐☐☐☐☐☐☐☐☐☐☐

FIRST NAME ☐☐☐☐☐☐☐☐ LAST NAME ☐☐☐☐☐☐☐☐☐☐☐

CITY ☐☐☐☐☐☐☐☐☐☐☐☐☐☐ STATE/PROV. ☐☐

COUNTRY (other than U.S.) ☐☐☐☐☐☐☐☐☐☐ POSTAL CODE ☐☐☐☐☐☐☐☐☐☐

3. Registrant Profile:

FSCT Member? 1 ☐ Yes 2 ☐ No

Society Affiliation ______________________

Information below must be completed for registration to be processed

Your Company (Check one only)

- 31 ☐ Manufacturers of Paints, Varnishes, Lacquers
- 32 ☐ Manufacturers of Printing Inks
- 33 ☐ Manufacturers of Sealants, Caulks, Adhesives
- 34 ☐ Manufacturers of Powder Coatings
- 35 ☐ Manufacturers of Raw Materials
- 36 ☐ Manufacturers of Equipment and Containers
- 37 ☐ Sales Agents for Raw Materials and Equipment
- 38 ☐ Government Agency
- 39 ☐ Research/Testing/Consulting
- 40 ☐ Educational Institution
- 41 ☐ Paint Consumer
- 42 ☐ Environmental Services
- 43 ☐ Other______________

Your Position (Check one only)

- 51 ☐ Management/Administration
- 52 ☐ Mfg. & Engineering
- 53 ☐ Quality Control
- 54 ☐ Research & Development
- 55 ☐ Technical Sales Service
- 56 ☐ Sales & Marketing
- 57 ☐ Consultant
- 58 ☐ Educator/Student
- 59 ☐ Other ______________

4. Registration Information:

Enter your selected options below. (See accompanying page for description of each registration option) ***NOTE: Seminar and course attendance is limited.*** *If checking a conference seminar or course, provide second choice.*

	Member	Nonmember	AMOUNT
☐ **Expo & Annual Meeting Presentations *(Oct. 23-25)***	**$ 75** (A)	**$100** (B)	$________
☐ **Retired Member** (Expo & Annual Meeting Only)	$ 30 (C)	—	$________
☐ **Social Guest of Retired Member**	$ 30 (D)	—	$________
☐ **Student** (Expo & Annual Meeting Only)	$ 15 (E)	$ 15 (E)	$________
☐ **Full Conference & Expo *(Oct. 22-25)*** *Check below* *Check one training seminar and one conference course*	**$495** (I)	**$595** (J)	$________
☐ **Conference Two-Day Course *(Oct. 23-24)*** *Check below*	$395 (K)	$495 (L)	$________
☐ **Executive Forum *(Oct. 22)***	$395 (G)	$495 (H)	$________
☐ **Pre-Convention Training Seminar *(Oct. 22)*** *Check below*	$195 (M)	$295 (N)	$________
☐ **Social Guest Program *(Oct. 23-25)***	$ 60 (F)	—	$________
☐ **FSCT Industry Luncheon Ticket *(Oct. 24)*** *No. of tickets* ____	$ 30 (X)	$ 30 (X)	$________

Oct. 22 Training Seminars

- T1 ☐ Surfactant Chemistry
- T2 ☐ Technical Presentations
- T3 ☐ Technical & Scientific Writing
- T4 ☐ Design of Experiments
- T5 ☐ Spray Application

______________ (second choice)

Oct. 23-24 Conference Courses

- C1 ☐ Substrates & Coatings
- C2 ☐ Coatings Characterization
- C3 ☐ Polymer Chemistry
- C4 ☐ Back to Basics

______________ (second choice)

TOTAL DUE $________

5. Method of Payment:

Total Amount Due $__________

(circle method of payment):

CK Check MO Money Order MC MasterCard

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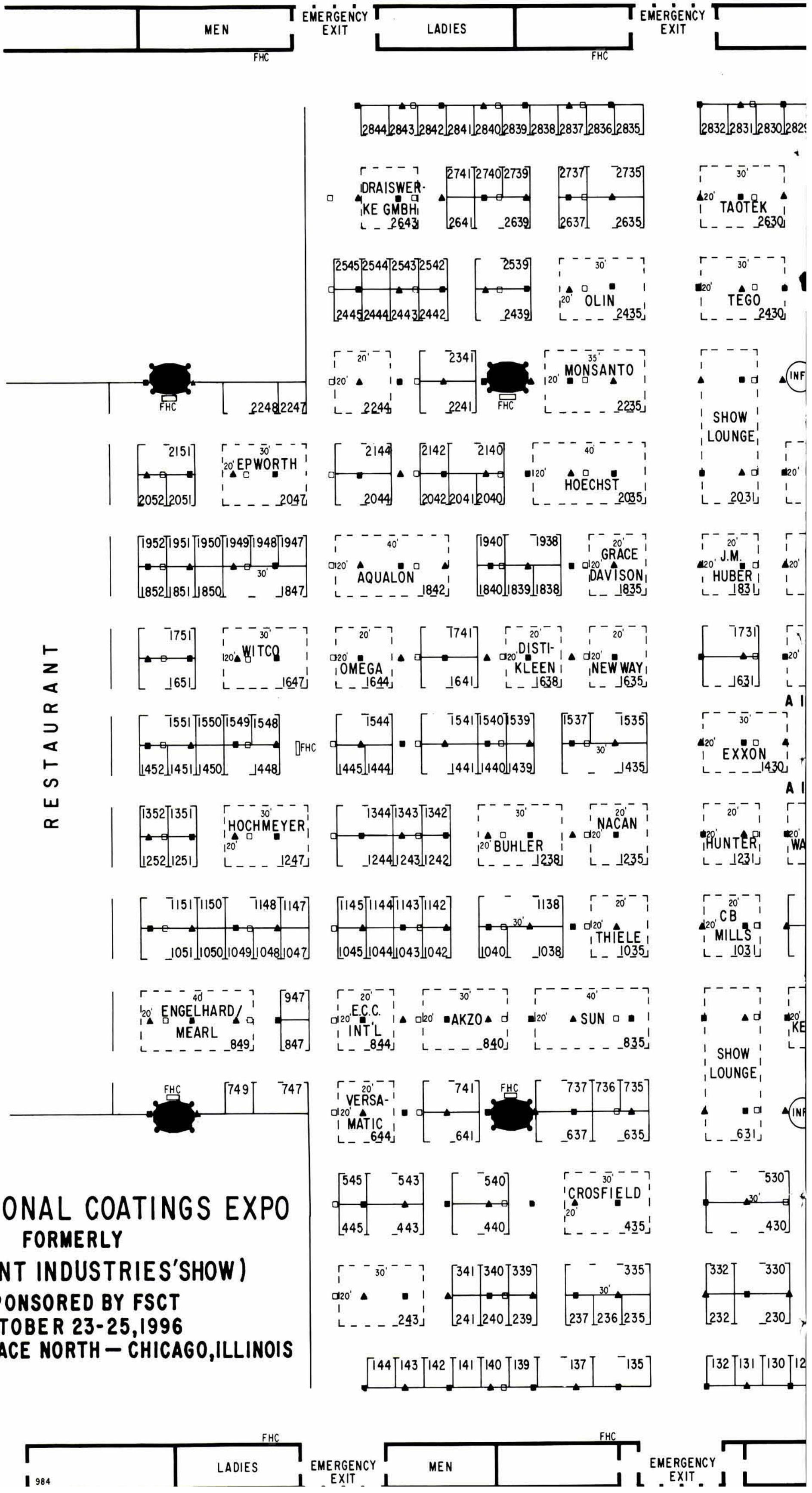

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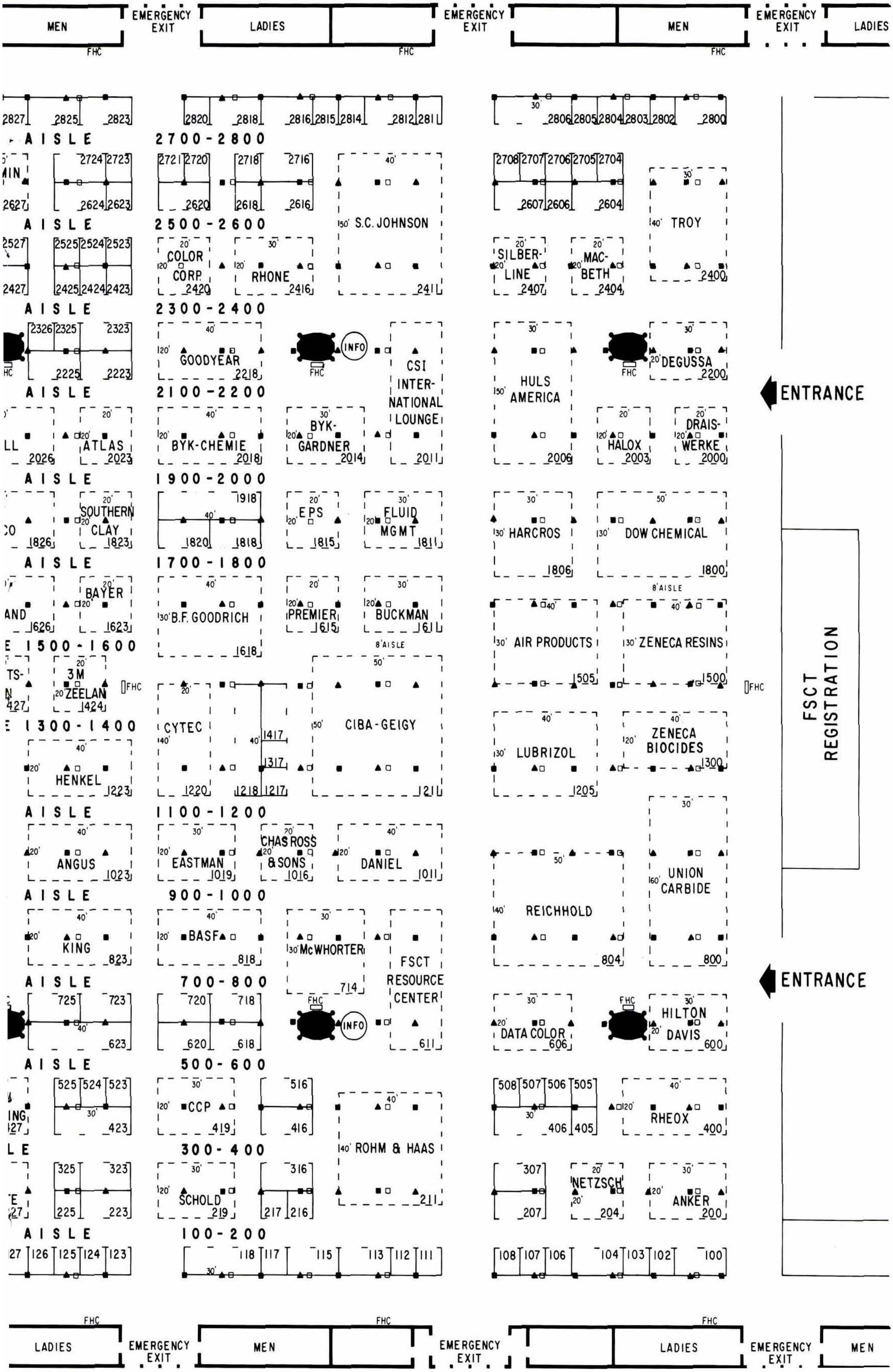
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Aqueous Acrylic-Polyurethane Hybrid Dispersions and Their Use in Industrial Coatings

Charles R. Hegedus and Kristen A. Kloiber—Air Products and Chemicals, Inc.*

Acrylic and polyurethane aqueous dispersions have been used extensively in coating applications, both independently and as physical blends. The resulting coatings display a balance of properties from the inherent characteristics of acrylics and polyurethanes. Nonetheless, these properties often fall short of those predicted from the traditional "rule of mixtures." In contrast, a process has been developed whereby acrylic monomers and urethane prepolymers are intimately mixed and mutually polymerized in an aqueous dispersion, thereby resulting in "hybrid" polymer dispersions. This process causes an interpentrating network (IPN) of the polymers which subsequently display unique properties compared to standard acrylic, polyurethane, or macroscopically blended acrylic/urethane dispersions. These properties appear to be directly attributable to the acrylic-polyurethane hybrid morphology.

INTRODUCTION

Over the past decade and probably into the next century, the coatings industry will have experienced a revolutionary period of technological change. A major contributor to this surge is increasing concern for health, safety, and the environment. Just as the industrial revolution of the 1800s was caused in part by the need for improved production and manufacturing techniques for a growing population, the recent advances in coatings technology have been "pulled" by the need for less hazardous and non-toxic materials. Reducing volatile organic compounds (VOCs) in paints and coatings is of particular interest due to their adverse effects on the environment. Nonetheless, the performance attributes of traditional solvent-based coatings, which in many cases were more than adequate, are still desired. In order to meet this demand of lower VOCs with acceptable performance, research and development of low VOC coatings, especially waterborne, high-solids, and powder, has escalated dramatically. This paper discusses an improvement in waterborne coatings technology through the development and application of acrylic-polyurethane hybrid dispersions. Unlike simple physical blends which have distinct acrylic and polyurethane domains, the hybrids form an interpenetrating network (IPN) of acrylic and urethane polymer chains at the molecular level. As will be discussed in the following, this approach offers unique advantages to the coatings formulator and applicator.

BACKGROUND

Two of the most popular vehicles for water-based coating systems are acrylic and polyurethane dispersions.[1-5] Since the introduction of acrylic polymers in the 1950s, they have been widely used as binders in interior and exterior architectural coatings. Yet their use in industrial applications, which are more demanding, was limited due to their relatively poor chemical resistance and mechanical properties compared to high performance solvent-based coatings. This limitation has changed over the past 10 to 20 years mainly because of the combined improvements in polymer synthesis and coating formulation. The addition of co-solvents which perform as coalescing aids has allowed the use of higher molecular weight acrylics (MW > 10^6), which are stronger, harder, and less permeable than earlier versions. Unlike solvent-based systems, waterborne latex vehicles allow these higher molecular weight polymers to be used without adverse viscosity effects. In addition, surfactants and defoamers are being utilized which enhance pigment dispersion and stability; allow good application, flow, and leveling; and improve opacity, gloss, and color.[6]

Presented at 1994 Waterborne, High-Solids & Powder Coatings Symposium, New Orleans, LA.

*7201 Hamilton Blvd., Allentown, PA 18195-1501.

Table 1—Comparison of Acrylic and Polyurethane Dispersion Properties[9]

Acrylic	Urethane
Advantages	
Non-yellowing	Solvent resistance
Outdoor resistant	Mechanical stability
Broad adhesion characteristics	Film forming properties
Compatibility with other ingredients	Gloss
Pigmentability	Less thermoplastic
Shear stability	Elongation/tensile strength
Thickener response	Wide scope for variations of composition and properties
Relative low price	Toughness
Disadvantages	
Thermoplasticity	Cost
Film formation	Limited outdoor durability
Coalescence/plasticizers	pH stability
Mechanical properties	Presence of NMP/MEK/TEA
Chemical resistance	Adhesion
	Compatibility

These improvements have allowed formulators of industrial coatings to take advantage of the positive attributes of acrylic resins: good weathering properties, well understood structure-property relationships, and relatively low cost.

In the mid-1970s, aqueous polyurethane dispersions (PUDs) were considered exotic and their use was sparse. Since that time, both technological advancements and environmental issues have caused their commercial application to become widespread. This is especially true in some industrial applications which were previously dominated by solvent-based counterparts. Early polyurethane dispersions were relatively unstable and experienced film formation problems. They required external surfactant additives for dispersion stabilization and substrate wetting. Unfortunately, these additives also rendered the resulting coatings susceptible to damage by water. As waterborne polyurethane technology evolved, this deficiency was addressed by incorporating stabilizing anionic, cationic, and non-ionic groups directly onto the polymer chain. Most commonly today, anionic stabilization is obtained by reacting carboxylic acid functionality directly onto the backbone. Generally, these waterborne polyurethanes are one-component, fully reacted thermoplastics. It recently has been confirmed that coatings from these waterborne dispersions display the same hard/soft domain morphology as their solvent-borne counterparts.[7,8] This morphology, along with the chemical structure of the polyurethane backbone, is greatly responsible for their unique and versatile properties. Therefore, it is not surprising that the waterborne versions can provide properties such as chemical, solvent, abrasion, and scratch resistance, as well as flexibility and toughness. However, these properties are obtained at the expense of increased cost. *Table* 1 provides a more thorough listing of advantages and disadvantages of both acrylic and polyurethane dispersions.

Table 2—Applications of Polyurethane/Acrylic Blends[9]

PVC ink and coatings
Wood flooring (gym, bowling)
Furniture lacquers
Parquet lacquers
Cork lacquers
Decorative paints
Automotive cosmetic black
Plastic and metal coatings
Industrial joinery
Floor polishes
Adhesives
Screen printing ink
Business machine coatings

In order to take advantage of the beneficial properties of each of these waterborne resins, it has become popular to physically mix them.[9] In many cases, this allows a compromise between the superior performance properties of the polyurethane and the lower cost of the acrylic. *Table* 2 is a partial listing of applications utilizing acrylic-polyurethane blends. Although some benefits have been obtained from this approach, properties of the resulting physical blends do not match up to expected values as predicted from the simple "rule of mixtures." For example, *Figure* 1 illustrates the tensile strength of 100% acrylic, 100% polyurethane, a 50/50 blend, and a 50/50 hybrid. From the arithmetic rule of mixtures,[10] one might expect the 50/50 blend to have a tensile strength residing on the line attaching the two pure materials (i.e., approximately 4200 psi). However, as illustrated by the graph, the actual strength of the blend is considerably less, ~2900 psi.[11] Similar effects have been observed with other mechanical and chemical resistance properties. The reasons for these types of undesired effects with blends have not been well defined but certainly the inhomogeneity caused by separate acrylic and polyurethane domains is a contributor. These areas may have excessive internal stresses and/or incomplete coalescence which will cause increased permeability and reduced cohesive strength.

An alternative approach to physically mixing acrylic and polyurethane dispersions is to form a dispersion of particles, each consisting of intimately entangled acrylic and polyurethane chains. This is accomplished by *in situ* polymerization of the respective monomers and prepolymers which have been previously mixed, thereby forming "hybrid" particles. The key to this process is that the polymerization mechanisms for these polymers are different; that is, polyurethane is formed by step growth polymerization and acrylic is formed by free radical, chain growth polymerization. A comparison of these respective processes is illustrated in *Figure* 2.

It should be noted that the hybrid process described is not designed to be co-polymerization where the acrylic and urethane segments are attached directly through primary bonds, nor is it a blend with large acrylic and polyurethane domains. This process appears to result in acrylic and polyurethane chains which are intimately mixed at the molecular level and presumably held together with numerous entanglements and secondary intermolecular bonding forces. However, it is possible that a minor extent of grafting between urethane and acrylic chains does occur, and this would increase the stability of the system. One benefit of this process is the increased tensile strength of the resulting materials as compared to its blended counterpart mentioned (*Figure* 1). In the case of the hybrid material, its tensile strength is approximately 5900 psi, well above that of the blend and the value predicted by the rule of mixtures. In fact, it is nearly as high as that of the 100% polyurethane. The effect of improved performance of hybrids over physical blends also is apparent with other properties such as toughness, durability, and chemical/solvent resistance. To investigate the use of these hybrid materials in coating applications, five commercially available aqueous dispersions were characterized and compared: an acrylic, a polyurethane, and three acrylic-polyurethane hybrids. In addition, one of the hybrids was formulated into a topcoat and evaluated along with a commercially available acrylic topcoat.

EXPERIMENTAL

Materials

The acrylic, polyurethane, and hybrid dispersions evaluated in this study (*Table* 3) were designated AC1, PU1, H560, H570, and H580, respectively. The acrylic and polyurethane dispersions were prepared using the common commercial process. Details of the hybrid dispersion process are described in references 12 and 13. All five dispersions were evaluated as clear coatings without the use of co-solvents or additives. As an example of a formulated system, the H570 dispersion was used in a control topcoat formula (*Table* 4). The pigmented coating was prepared by first adding the surfactants to the hybrid dispersion in a one liter glass jar while under mild agitation. After 15 min, the defoamer was added and the mixture was agitated for an additional 15 min. The titanium dioxide was mixed into the dispersion which was then stirred for 15 min. At this time, the jar was filled half-way with five mm diameter glass shot. The jar was then sealed and placed on a paint shaker for 30 min, after which the coating was poured through a fine paint filter. An additive package containing ultraviolet absorber, light stabilizer, and carrier solvent was post added under mild agitation. The resulting paint had a Hegman fineness-of-grind (ASTM D 1210) greater than seven. This coating was compared to a commercially available waterborne acrylic topcoat.

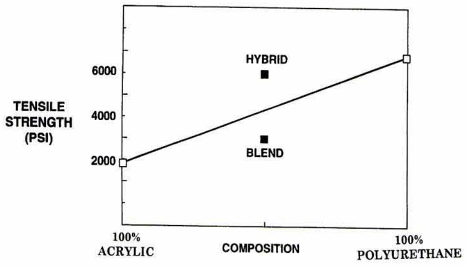

Figure 1—Performance of hybrid polymer.

Procedures

Unformulated (neat) dispersions, along with the pigmented topcoats, were applied to steel and aluminum

Table 3—Typical Properties of Aqueous Acrylic-Polyurethane Hybrid Dispersions

	H560	H570	H580	AC1	PU1
Appearance	Milky white	Milky white	Milky white	Milky white	Milky white
Viscosity					
Brookfield (cP)	100	50	37.5	25	26
Ford 4 (sec)	27	21	18	—	—
Nonvolatiles (% by weight)	42-44	42-44	42-44	50	30
Organic solvent content (% NMP)	6-8	6-8	6-8	0	—
Water content (%)	49-51	49-51	49-51	50	—
VOC as supplied					
g/L	150	150	150	0	—
lbs/gal	1.3	1.3	1.3	0	—
Dispersion density					
g/ml	1.0	1.0	1.1	1.1	1.1
lbs/gal	8.6	8.6	8.7	8.7	8.9
Bulking value (gal/lbs)	0.116	0.116	0.115	0.115	0.112
pH	7.5-8.5	7.5-8.5	7.5-8.5	9.0	8.0
Refractive index (of polymer film)	1.53	1.49	1.50	—	—
Particle charge	Anionic	Anionic	Anionic	—	Anionic
Particle size	Colloidal	Colloidal	Colloida	Colloidal	Colloidal

Table 4—White Topcoat Composition and Formulation Parameters

Component	% by Weight	Supplier
Hybridur 570	74.23	Air Products
Surfynol 465	0.23	Air Products
Aerosol OT-75 surfactant	0.23	American Cyanamid
Foamaster VF	0.31	Henkel
Titanium dioxide, R960	21.90	DuPont
Texanol	1.85	Eastman
Tinuvin 384	0.50	Ciba Geigy
Tinuvin 292	0.75	Ciba Geigy

Formulation Parameters	
Density	1.24g/ml
VOC	<165 g/L
Pigment volume concentration	15%
Weight percent solids	54.5%
Volume percent solids	45.6%
Viscosity	
Brookfield	163 cps
Ford 4	24 sec
pH	8.5

Table 5—Coating Test Procedures

Property	Procedure
Storage stability (pigment setting)	ASTM D 869
60° gloss	ASTM D 523
Color	ASTM D 2244
Contrast ratio	ASTM D 2805
Adhesion	
Tape adhesion	ASTM D 3359
Scrape adhesion	ASTM D 2197
Impact and flexibility	
Gardner impact	ASTM D 2784
G.E. impact	Federal Test Method 6226 in Federal Standard 141B
Mandrel bend	ASTM D 1737
Hardness	
Pencil	ASTM D 3363
Persoz pendulum	ASTM D 4366
Solvent resistance (double rub)	ASTM D 4752
Xenon arc weatherometer	ASTM G26
QUV (UV-B & condensation)	ASTM G53

specimens to a dry film thickness of 50 ± 5 microns using conventional air spray. The steel panels were cold rolled 1020 steel with a zinc phosphate treatment (Bonderite 952) and a chromate sealer (Parkoline 60). The aluminum specimens were 2024-T3 with a chromate conversion coating (Alodine 1200), except for the aluminum impact and flexibility specimens which were 2024-0 temper with a chromic acid anodize treatment and hot water seal (military specification MIL-A-8625, Type I). The coatings were dried for 10 days at 21°C and 50% relative humidity prior to testing.

The applied coatings were characterized for optical, mechanical, and environmental exposure properties using the procedures listed in *Table* 5. In addition, liquid retains of the pigmented coatings were evaluated for pigment settling and storage stability under ambient conditions according to ASTM D 869.

Thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), and dynamic mechanical analysis (DMA) were performed to characterize the thermal response properties of coatings from the acrylic-polyurethane dispersions. In order to eliminate water and organic solvent effects, unformulated samples of all three dispersions were prepared by allowing the samples to cure for 10 days at ambient conditions and subsequently placing them in a vacuum until a constant weight was obtained. A DuPont 2100 thermal analyzer was used for the TGA and DSC.

TGA was performed from room temperature to 600°C at a heating rate of 10°C/min. To look at the oxidation of the samples, they were run with both an air purge (100 cc/min) and nitrogen, respectively.

DSC was performed with nitrogen purging the cell (50 cc/min) and at a heating rate of 10°C/min from –100° to 200°C. In order to investigate potential morphological changes during heating, a sample of each material was subjected to this heating, quench cooled to –100°C, and reheated to 250°C.

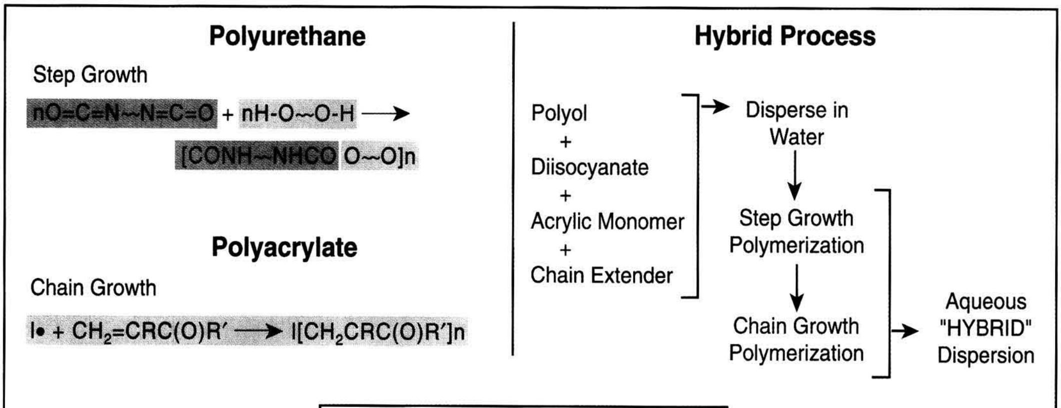

Figure 2—Polymerization processes.

DMA was performed in a tensile dynamic mode using a Rheometrics solids analyzer (RSA II) with a thin film fixture. The films were analyzed in a temperature range from –150° to 250°C. The samples were not preconditioned with regard to humidity prior to the acquisition of data. Data was obtained every 6°C. To ensure isothermal conditions, a one-minute temperature soak time was used. All measurements were made in a dry nitrogen atmosphere.

Coatings from the unpigmented hybrids and the TiO_2 pigmented version (*Table* 4) were inspected using scanning electron microscopy (SEM) and atomic force microscopy (AFM). AFM is a relatively new technique which allows three-dimensional imaging of a surface by using a "scanning probe" with a tip of molecular dimensions. More details on this technique are provided in references 14-16.

AFM was performed using a Digital Instruments Nanoscope III. The one cm square samples were mounted onto steel pucks with double stick tape. After cleaning with a gentle nitrogen purge to remove dust particles, samples were characterized in air. A 0.36 N/m cantilever was used, and a silicone nitride "oxide sharpened" probe tip from Digital Instruments was used to image the coatings. In the imaging experiments, forces of 50 to 80 nN were used. The AFM calibration technique is described in detail in reference 17.

SEM specimens were prepared by applying a one nm coating of platinum on the surface of the coating with an ion beam sputterer. The platinum coating was applied to help minimize electron beam damage to the specimen and also to enhance the secondary electron signal used to form the image. The samples were imaged at 2 kV accelerating voltage in a JEOL JSM-6300F field emission scanning electron microscope. Coating surface views were observed with the hybrid coatings on the metal substrate. Cross-sections were obtained by immersing free-standing films in liquid nitrogen, then quickly snapping the brittle film to produce a fracture surface.

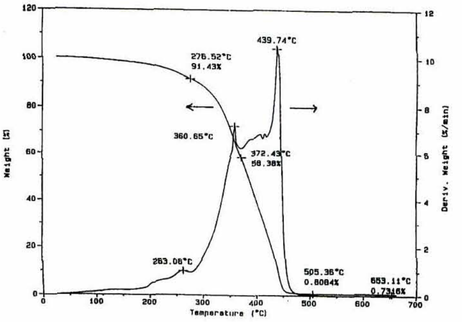

Figure 3—TGA response for H570.

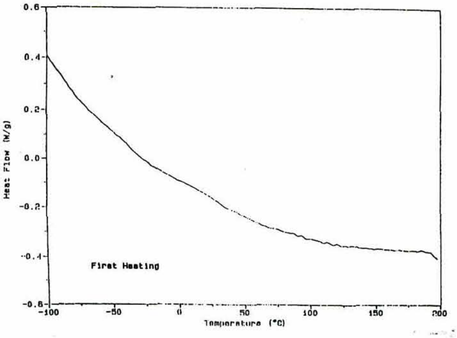

Figure 4—DSC response for H570 (first heating).

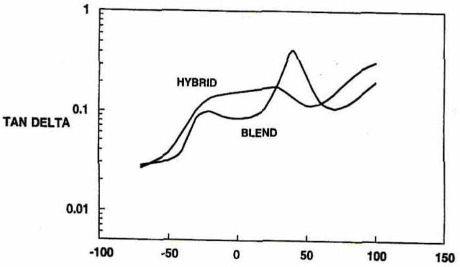

Figure 5—Dynamic mechanical spectroscopy of hybrid polymer.

RESULTS AND DISCUSSION

Thermal Properties

In general, the thermal response of the H560, H570, and H580 hybrids had similar trends in both TGA and DSC. *Figures* 3 and 4 illustrate TGA and DSC results for H570. TGA response in both air and nitrogen (not shown) indicate good thermal stability with no appreciable weight loss until well above 200°C. As expected for this intimate mixture, the DSC curve (*Figure* 4) is stable (although the baseline does curve) with no clear indication of a distinct glass transition temperature. Taking this same DSC sample, quench cooling and reheating resulted in a similar DSC response. This quenching-reheating process was performed to determine if the first heating process caused substantial morphological changes such as segregation of the acrylic and polyurethane chains in the sample and the results indicate that this did not occur.

Figure 5 illustrates the DMA response (tan δ) of the H570 hybrid compared to that of a 50/50 acrylic-poly-

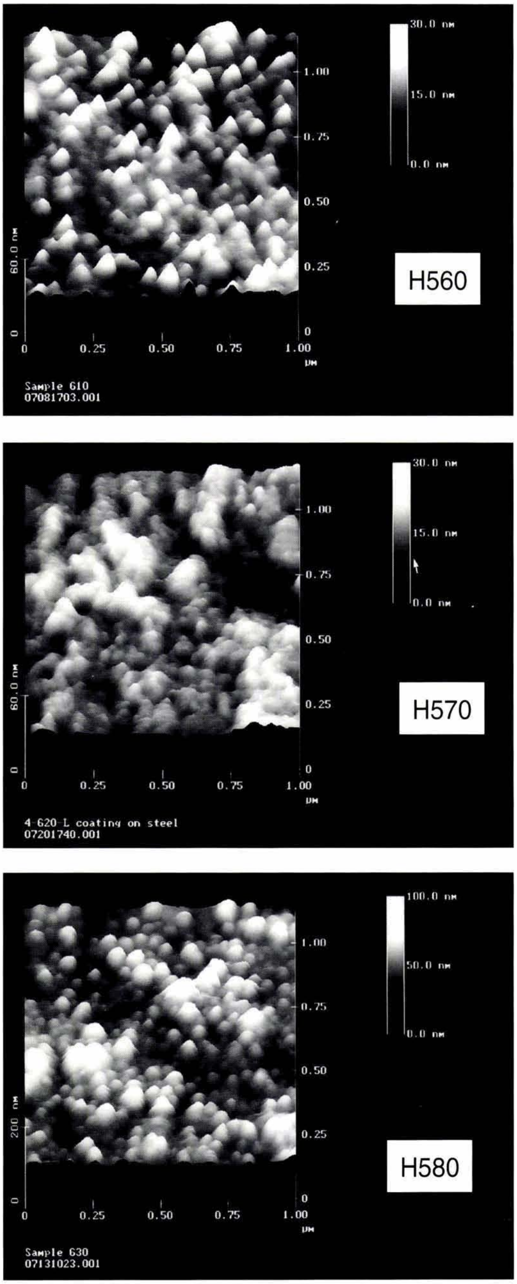

Figure 6—Atomic force microscopy (AFM) of unpigmented coatings.

urethane blend.[11] The physical blend clearly displays two glass transition peaks, indicating two distinct morphological domains, one for the polyurethane and another for the acrylic. In contrast, the hybrid displays one broad glass transition region from –20° to 35°C, and a storage modulus, E′, well above 10^9 dynes/cm^2. These DMA results are indicative of a more homogeneous and mechanically compatible material than a physical blend.

The broad glass transition range in both DSC and DMA, along with an understanding of the polymer synthesis and dispersion procedures, provides strong evidence that the acrylic and polyurethane chains are intimately entangled as opposed to a simple physical blend with larger acrylic-rich and polyurethane-rich domains. This effect with blends has been observed with numerous systems.[18] In addition, the fact that annealing the hybrid specimen caused no discernible changes according to DSC is also supporting evidence. Finally, the coating property data described later in this paper is consistent with this proposed morphology.

Surface Topography

Figures 6 and 7 illustrate a comparison of SEM and AFM images for all three unpigmented hybrid coatings. The main observation from these micrographs is the surface topography which consists of protrusions and depressions less than 100 nm in width. It would appear that the protrusions correlate with individual particles (diameter = 40 to 80 nm) which were dispersed in the aqueous medium prior to application and drying. Analysis of these micrographs indicates varying extents of coalescence (at ambient laboratory conditions, without coalescing aids): H570 > H560 > H580. In order to quantify this effect, average particle height, surface roughness, and surface area were determined from the AFM images (*Table* 6). It is clear from this data that H580 has higher protrusions and a rougher surface as associated with less complete coalescence. The H580 also had more protruding particles per coating surface area (particle density) than both H560 and H570. This is expected since H580 is formed from a harder acrylic polymer, and it typically requires co-solvent or higher temperature to aid coalescence and film formation. As will be illustrated in the presentation and discussion of coating properties, H560 and H570 displayed acceptable film formation. Since H580 is a harder material, addition of 5-10% co-solvent is recommended for improved coalescence and film formation.

Figure 8 is an SEM micrograph of the TiO_2 pigmented H570. The most important observation in this micrograph is that the titanium dioxide particles appear to be well dispersed with good pigment-binder interaction. No cracks are apparent in the matrix or at the matrix-pigment interface. A fracture surface cross-sectional view with SEM agrees with these results.

Clear Coating Properties

Film properties of the unformulated (clear) coatings are listed in *Table* 7. All five clear coatings were transparent and had a 60° gloss of over 90. These optical properties illustrate that all of the coatings had a high quality appearance, indicating homogeneity throughout the coatings and relatively good film formation. In contrast, coatings from many physical blends of polymers have a hazy or milky white appearance as a result of resin incompatibility and different refractive indexes between polymer domains.

Mechanical property results on both steel and aluminum substrates (*Table* 7) indicate that the hybrids have good adhesion and a wide range of flexibility and hardness. With all of the hybrid coatings, the tape test adhesion rating was a 5A (no removal) and the scrape adhesion value (the force required to scrape the coating from the surface) was ≥ 3 kg which typically is adequate for industrial coating applications. The Gardner indirect impact values were all greater than 160 in.-lbs, except for the H580 which was considerably less. Nonetheless, the G.E. impact and mandrel bend flexibility results on aluminum were all impressive, 60% elongation and 0.125 in. mandrel bend, respectively. These mechanical property results illustrate that H580 is harder but more brittle than both H560 and H570. This is understandable considering that the acrylic portion of the H580 is harder than that in H560 and H570. Comparing these results to those obtained for the acrylic (AC1) and polyurethane (PU1) dispersions, the results indicate that the acrylic is moderately hard yet it is very brittle as evidenced by low impact strength and elongation. The polyurethane coating has mechanical properties which are more comparable to those exhibited by the hybrid coatings; it is moderately hard with good impact flexibility. The scrape adhesion values for all of the coatings followed the trend:

$$\mathrm{AC1} < \mathrm{H560} \sim \mathrm{H570} < \mathrm{H580} < \mathrm{PU1}$$

Interestingly, this is the trend that one might expect for film toughness, which is reasonable considering the mode of failure when attempting to scrape a coating from its substrate by using increasing loads (weights). A softer material will be easily gouged and the scraping stylus will cut through to the substrate, while a brittle material will crack and flake off the substrate. Traditionally, coatings with a balance of strength and flexibility (indicative of toughness) do well in this test.

The MEK and toluene solvent resistance of all three hybrid coatings was greater than 100 double rubs (*Table* 7). In fact, even at 200 double rubs, the only evidence of solvent effects was a decrease in gloss (slight marring) of the coatings' surfaces. In contrast, the solvent resistance of both the polyurethane and acrylic coatings was poor. Considering these results with respect to those for the hybrids, it may be somewhat surprising that the hybrids perform noticeably better in solvent resistance since one may expect that the solvent would attack the most susceptible polymer in the hybrid. However, as with mechanical properties, chemical resistance appears to undergo a synergistic effect with the hybrid process.

Pigmented Coating Properties

Results for the pigmented hybrid and acrylic coatings are provided in *Table* 8. The 60° gloss values were 64 for

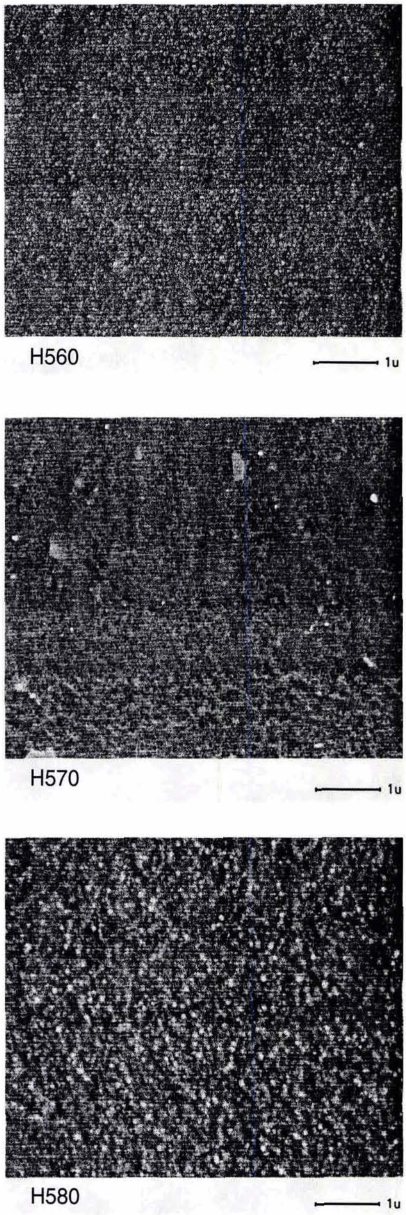

Figure 7—SEM micrographs of unpigmented coatings (x20,000).

Table 6—Summary of AFM Observations

	H560	H570	H580
Average particle height (nm)	10	11	28
Surface roughness	2.7	3.1	7.7
Surface area (%) (100%=flat)	104	103	116

the acrylic and 70-75 for the hybrid topcoats. These values are relatively low for a desired high-gloss finish; however, they are indicative of many waterborne topcoats which rarely have gloss values exceeding 80. It should be noted that pigmenting both the H570 and the acrylic resulted in a substantial reduction of gloss. Although it is well documented that waterborne coatings normally have poorer gloss than their solvent-borne counterparts due to wetting and leveling effects,[19] it was not clear from SEM and AFM why this occurred with the TiO_2 pigmented H570 coating. Braun recently illustrated that even nanometer-range roughness at the coating surface can dramatically decrease gloss.[20,21] It would seem likely that these effects are all interrelated and the cause for gloss reduction in these and other waterborne coatings. It should be noted that the hybrid formulation is considered a "suggested starting point formulation," and it has not been optimized for optical properties. Addition of dispersing aids and use of a grade of titanium dioxide specifically designed for optimum gloss effects in aqueous systems may increase the 60° gloss properties of pigmented hybrid coatings to greater than 80.[22] These formulation optimization efforts currently are underway. Both pigmented coatings had a contrast ratio of > 0.90 and a whiteness index > 80 at a thickness of 50 microns, which is good considering the low titanium dioxide pigment volume concentration (15%) of the hybrid topcoat. (PVC of acrylic topcoat was unknown.)

Concerning mechanical properties of the pigmented coatings, the addition of titanium dioxide at the given concentrations appears to improve hardness without detrimental effects on toughness or flexibility. Although the pendulum hardness of the pigmented H570 is less than that of the clear H570, it is believed that this is simply due to a minor increase in surface friction from pigmentation. The scrape adhesion and pencil hardness of the pigmented material compared with that of the clear coating agree with this explanation. Comparing the hybrid and acrylic topcoats, the mechanical properties are somewhat comparable, both having moderate hardness and good flexibility. The improvement in flexibility of the acrylic topcoat over the clear acrylic may be due to the incorporation of plasticizers or co-solvents for better coalescence. However, the solvent resistance results are indicative of those obtained for the clear coatings with the hybrid clearly displaying better resistance properties than the acrylic.

The accelerated weatherability of the hybrid topcoat was tested by exposing specimens in both xenon arc weatherometer and QUV (UV-B bulbs and condensation) chambers for 1000 hr, respectively. Gloss, color, and G.E. impact were measured before and after the exposures. The retention of these properties is listed in *Table* 8. For both exposures, gloss retention was above 90% and color change (ΔE) was 0.9 and 1.6, respectively. The G.E. impact was 60% elongation prior to exposure in the Weatherometer and 40% after exposure. Since this is a step-function test (i.e., 10, 20, 40, and 60%), the retention of impact elongation is listed as between 67 and 100%. All of the optical, mechanical, and exposure results presented and discussed illustrate that the hybrid materials form moderately hard yet tough, flexible, adherent, weatherable, and solvent-resistant coatings.

Finally, a retain sample of the formulated white topcoat was kept at laboratory conditions and periodically

Table 7—Properties of Clear (Unpigmented) Coatings

	Unformulated Clear				
	H560	H570	H580	AC1	PU1
Properties over Steel					
60° gloss	>90	>90	>90	>90	>90
Drying time (min)					
Dry hard	<30	<30	<30	<30	<30
Tape adhesion (1-5, worst-best)	5	5	5	5	5
Scrape adhesion (Kg)	3	3	5	0.5	5.5
Gardner impact (in. lbs) (indirect)	≥160	≥160	36	60	≥160
Pencil hardness	2B	F	2H	F	B
Pendulum hardness (cycles)	157	165	225	113	103
Solvent resistance (double rubs)					
MEK	>100	>100	>100	<25	<75
Toluene	>100	>100	>100	<25	–100
Properties over Aluminum					
Tape adhesion	5	5	5	5	0
Scrape adhesion (Kg)	3	3	3	1.5	2.5
G.E. impact (% elongation)	≥60	≥60	≥60	0.5	≥60
Mandrel bend (in)	≤0.125	≤0.125	≤0.125	≤0.125	≤0.125

VOC of all coatings ≤165 g/L (1.3 lbs/gal).
Dry film thickness = 50 ± 5 microns.

evaluated for storage stability and especially pigment setting according to ASTM D 869. Ten months after milling, the wet coating was homogeneous with no significant pigment setting or hard compaction, an ASTM D 869 rating of eight. This result also provides evidence of good pigment-vehicle interaction. In many cases, waterborne coatings require a dispersing aid to obtain this type of interaction and acceptable pigment dispersion stability. The coating property results illustrate that the acrylic-polyurethane hybrid dispersions offer unique advantages in the formulation of industrial coatings.

Table 8—Properties of TiO_2 Pigmented Topcoats

	Hybrid	Acrylic
Properties over Steel		
60° gloss	>70	64
Drying time (min)		
Set-to-touch	15	15
Tack free	20	20
Dry hard	30	30
Contrast ratio	>0.90	>0.90
Tape adhesion (1-5, worst-best)	5	5
Scrape adhesion (Kg)	4	2.5
Gardner impact (in. lbs) (indirect)	≥160	≥160
Pencil hardness	H	H
Pendulum hardness (cycles)	140	194
Solvent resistance (double rubs)		
MEK	>100	<25
Toulene	>100	<25
Properties over Aluminum		
Tape adhesion	5	5
Scrape adhesion	3	<2
G.E. impact (% elongation)	≥60	≥60
Mandrel bend (in)	≤0.125	≤0.125
Xenon arc		
Gloss retention (%)	94.1	—
Color change (ΔE)	0.9	—
G.E. impact retention (%)	67-100	—
QUV		
Gloss retention (%)	92.1	—
Color change (ΔE)	1.6	—

SUMMARY AND CONCLUSIONS

Acrylic and polyurethane aqueous dispersions have been used extensively in coatings applications, both providing respective advantages and disadvantages. Generally, the acrylics have moderate properties and are less expensive, while polyurethanes provide better performance properties at a significantly higher cost. Physical blends of acrylics and urethanes have been used to obtain a cost-performance compromise; however, the properties of these blends normally are less than those predicted from the rule of mixtures.

In order to obtain a cost/performance advantage, aqueous acrylic-polyurethane hybrid dispersions have been developed by mixing urethane prepolymers and acrylic monomers, dispersing the mixture in water, and mutually polymerizing the prepolymers and monomers, respectively. This *in situ* polymerization results in a colloidal dispersion of individual particles containing acrylic and polyurethane polymer chains which are intimately entangled. This molecular level mixing is demonstrated by broad glass transition ranges (> 50°C) which are indicative of an interpenetrating network of acrylic and polyurethane polymer chains as opposed to larger individual acrylic- and polyurethane-rich domains.

Coatings from the unpigmented dispersions formed transparent films with good adhesion, flexibility, and hardness. Impact flexibility ranged from 36 to 160 in.-lbs while pencil hardness ranged from 2B to 2H. In general, the flexibility trend was H560 ~ H570 > H580, while coating hardness had the reverse trend. All three coatings displayed fairly good solvent resistance by withstanding 100 double rubs with MEK and toluene, respectively. The titanium dioxide pigmented H570 was harder than the unpigmented version (H vs. F) while still being flexible and tough (> 160 in.-lbs reverse impact). At 2 mils dry film thickness, it had a contrast ratio of greater than 0.90. Finally, 10 months after milling, a retain of this pigmented version had no pigment compacting. Extended exposure studies of these coatings are underway. From the data obtained, the acrylic-polyurethane hybrid dispersions provide the coatings formulator with an attractive alternative in the development of waterborne coatings for industrial applications.

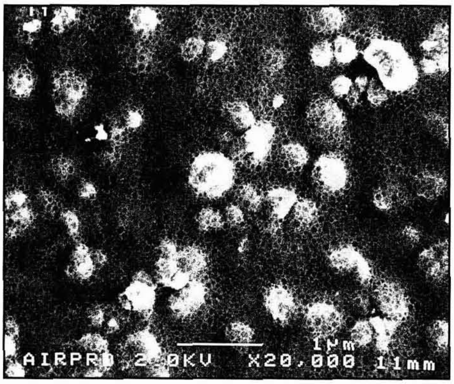

Figure 8—Scanning electron micrograph of titanium dioxide pigmented H570 (x20,000).

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Liquid, Sprayable, "Zero" VOC Coatings Utilizing Cycloaliphatic Epoxies

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Zero VOC, hazardous air pollutant free coatings formulations can be readily prepared from liquid cycloaliphatic epoxies and narrow polydispersity caprolactone polyols. These formulations can be applied by conventional spray equipment and are a viable liquid alternative to powder coatings. Using conventional liquid spray equipment, the capital investment for the installation of a new powder coating line can be avoided. With modification, these coatings can be diluted with water and thickened with conventional cellulosic thickeners used in waterborne coatings. In this study, we discuss the influence of key formulating variables like epoxy/hydroxyl mole ratio, catalyst concentration, polyol molecular weight, and polydispersity on coating properties. Viscosity reduction and sag resistance are also discussed.

INTRODUCTION

Cycloaliphatic epoxies differ from conventional diglycidylether of bisphenol-A resins in several ways: aliphatic backbone; react readily with acids but are essentially not reactive with typical amine/amide type conventional epoxy curing agents, no chlorine; viscosities of 350 cps versus 11,000 cps; and excellent weatherability.

The use of low viscosity cycloaliphatic epoxies has shown dramatic growth in cationic UV coatings. There are many publications on formulating and performance of these 100% solids 'zero' VOC coatings.[1-23] Less well documented is the use of cycloaliphatic epoxies in thermally cured coatings.[19,24-27] In principle, formulating know-how from UV cationic coatings could be applied to thermally cured systems. There are some differences, including the fact that UV coatings are usually not spray applied and thus can tolerate higher application viscosities than sprayed, thermally cured coatings. In baked cationic coatings, water can be used as a zero VOC diluent.

Caprolactone polyols have been shown to be effective reactive diluents for solvent-based[28] coatings and can speed the cure of cationic UV coating formulations. In cationic UV coatings, the OH groups of the polyol both speed cure and impart a certain cure sensitivity to humidity. In thermally cured coatings, there is no cure inhibition by humidity since the humidity inside an oven is very low. The enhanced water sorption brought on by polyol addition allows water to be used as a non VOC diluent in the coating formulation that contains both cycloaliphatic epoxies and polyols. These coatings are essentially high-solids organic coatings diluted with water. Water dilution has two benefits: low viscosity at zero VOC and the ability to use conventional, well-known strategies for imparting sag resistance and rheology control to waterborne coatings. Water uptake is limited due to the partial miscibility of the formulating ingredients with water. Care must be taken to avoid adding too much water causing phase separation.

Raw Materials

Cycloaliphatic Epoxies: A commercially available cycloaliphatic di-epoxy was used. The experimental tri- and tetrafunctional cycloaliphatic epoxies were prepared by a method described elsewhere.[29] Epoxy names are the approximate molecular weights of the unsaturated precursors of the cycloaliphatics epoxies; for example, epoxy 221. The number 221 is the molecular weight of the diene precursor used to make the epoxy. The diene is reacted with peracetic acid.

Caprolactone Polyols: Commercial polyols were used where noted. Experimental 150 equivalent weight di-, tri-, and tetrafunctional polyols were prepared in-house.

Viscosities, equivalent weight, water uptakes, and solids of the raw materials are shown in *Table* 1. Water

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Presented at Waterborne, Higher-Solids, and Powder Coatings Symposium, February 14-16, 1996, New Orleans, LA.

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Table 1—Raw Material Properties

Material	Viscosity, cps @ 25°C	Functionality	Equivalent Wt. Gm/Equiv	Water Uptake wt% 1 phase	Wt % Solids By ASTM 2369
Polyol 201[a]	400	2	270	13	98
Polyol 2XX	255	2	150	56	93
Polyol 303	1687	3	150	—	99
Polyol 421	2262	4	150	—	—
Polyol 301[b]	2250	3	100	33	97.3
Epoxy 221[c]	375	2	135	1.75	98.6
Epoxy 458	63000	3	180	—	—
Epoxy 568	Solid	4	179	—	—

(a) Union Carbide Tone 0201 or equivalent.
(b) Union Carbide Tone 0301 or equivalent.
(c) Union Carbide ERL-4221 or equivalent.

uptake was determined by titrating the material with distilled water until a cloud point (phase separation) was reached.

Starting Point Clear Formulation

In principle, the strong acid catalysts used here will allow the epoxy to readily react with any OH. Narrow polydispersity polyols made by ring opening polymerization generally have lower viscosities at a given molecular weight than condensation polyols. Thus, we used caprolactone polyols to give lower viscosity formulations. A starting point formula is given in *Table* 2. A key formulation parameter is epoxy/hydroxyl mole ratio, R. Coatings were cured 7 min at 121°C @ 0.8 mil DFT. The higher equivalent weight polyol results in softer coatings with R = 2.

Effect of Catalyst Level and R Value (Epoxy/Hydroxyl Mole Ratio) on Cure, Hardness, and Impact

A three variable, blocked, central composite 20 experimental design was run to define the 'cure' envelope. Variables were cure temperature (120°-180°C), catalyst level (0.5 to 2%), and R (epoxy/OH mole ratio, 1.25 to 12) using epoxy 221 and polyol 301. Dry film thicknesses were 0.7 to 0.8 mils. Coating formulation variables and performance results are in *Table* 3.

Table 2—Starting Point Cycloaliphatic Epoxy/ Caprolactone Polyol Coatings

Component	Formulation #1 Wt%	Formulation #2 Wt%
Epoxy 221	72.9	51.3
Polyol 201	—	47.5
Polyol 301	25.9	—
Catalyst[a]	0.9	0.9
Surfactant[b]	0.3	0.3
R	2	2
Hardness	3H	3B
MEK rubs	>200	>200
Impact F/R	72/28	100/52

(a) 3M FC-520 (di-ethyl ammonium triflate solution) or equivalent.
(b) OSi L-7604 or equivalent.

Design software allows the time to cure, t, to be calculated from the fitted formula (the data gave an excellent fit with an 'r-squared' statistic of 0.9949):

$$
\begin{aligned}
\ln(t) = {} & 1.25 - 0.88*[(\mathrm{Temp} - 150)/30] \\
& -0.30*[(\ln(\mathrm{Cat\ level}\ \%) + 0.02)/1.18] \\
& +0.076*[(\ln(R) - 1.35)/1.13] \\
& +0.23*\{[(\mathrm{Temp}-150)/30]*[(\ln(\mathrm{Cat\ level}\%) + 0.02)/1.18]\} \\
& +0.29*[(\mathrm{Temp}-150)/30]^2
\end{aligned}
$$

Figures 1-5 are contour plots of time for cure as a function of catalyst level and cure temperature at different 'R' values (R = epoxy/OH mole ratios). The times to cure are on the contour. Higher catalyst levels and cure temperatures give faster cures, as expected. Higher 'R' values give slightly slower cure rates. If oven cure temperature and residence time is known, a formulator can choose the catalyst level and R value needed to fully cure.

Pencil hardness is mainly a function of epoxy/OH mole ratio (*Figure* 6). Higher R = higher hardness.

Reverse impact resistance is the inverse of hardness: more epoxy, less impact resistance (*Figure* 7). The key variable which controls reverse impact is R, epoxy/OH mole ratio.

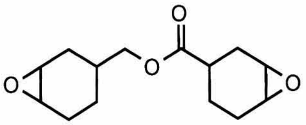
$$
\begin{aligned}
\ln(\text{reverse impact}) = {} & 0.76 - 2.383*[(\ln(R)-1.35)/1.13] \\
& +1.952*[(\ln(R) - 1.35)/1.13]^2
\end{aligned}
$$

Coil Coating Conditions

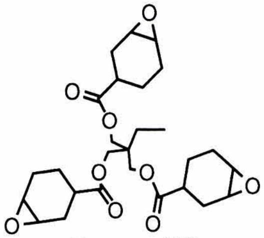
Other lab work suggests that coil coating cure rates can be attained by using >2% catalyst and baking to a peak metal temperature of 200°C (30-45 sec). Higher catalyst levels will speed cure. Triols and tetrols give faster cure with epoxy 221 under coil bake conditions.

Epoxy/Polyol Functionality

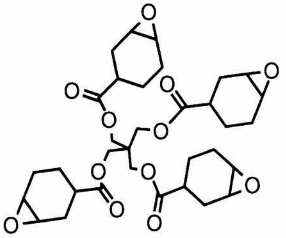
The influence of polyol and epoxy functionality was evaluated with a simple set of designed experiments. From previous work on thermally cured cationic coatings,[19,27] 0.3 to 2% catalyst was known to result in reasonable cure rates at 120°C and above with epoxy/hydroxyl mole ratios, R = 1.5. Design compositions, cure rates and coating properties are shown in *Table* 4. Each polyol had an equivalent weight of 150. Catalyst level was two percent. Dry film thicknesses were 0.7 to 0.8 mils. Coatings were cured at 120°C. Structures of the epoxies are shown in the following:



Epoxy 221



Epoxy 458



Epoxy 568

Shortest cure times (fastest cure rates) were found with the commercial di-epoxide reacted with tri and tetrafunctional polyols. The lowest viscosity was with the diol and diepoxy. Unexpectedly, experimental tri and tetrafunctional epoxies did not speed cure. They also had higher application viscosities. It is probable that the higher viscosities of epoxy 458 and 568 slowed cure due to diffusion effects on cure rate. All further work was carried out with the commercial diepoxy and a commercial diol or triol.

Corrosion Resistance

Since this technology uses a strong acid catalyst, one needs to evaluate the corrosion resistance requirements for metal substrates. *Table* 5 contains 300 hr salt spray data for several epoxy 221/polyol 301/0.5% catalyst clear coatings. Shorter cure times and higher epoxy levels reduce creepback at the scribe in ASTM B-177 salt spray tests. Clear coatings were drawn down to 1.5 mil DFTs on Bonderite 1000.

The use of anticorrosive pigments and additives will improve salt spray resistance.[24] The original formula in reference 24 did not include the acid catalyst and contained products not currently available, so the following modified formulas are suggested.

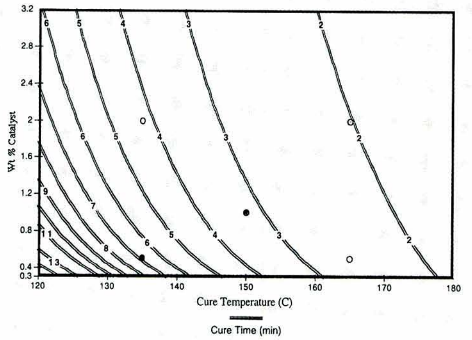


Figure 1—Epoxy/OH = 1.25.

Usually zinc phosphate is used in combination with the iron phosphate. The original authors[24] did not include the zinc in their formulations. We continue to study this issue.

Water Dilution

Model clear formulations were prepared with polyols 201, 301, and di-epoxy 221. These formulations were diluted with water and the viscosities were measured as a function of added water. Results are shown in *Figures* 1 and 2 for epoxy/hydroxyl mole ratios of 2 and 4, respectively. Obviously, water is an effective diluent for these 100% solids organic coatings. Added water had no effect on the cure rates.

Rheology Control of Water Diluted Systems

Cellulosic type thickeners are known to be effective in imparting sag control in waterborne coatings. It was not

Table 3—Three Variable Design on Cure Variables

Temp °C	Cat Wt%	Epoxy/OH	Time[a], min	Hardness	Impact F/R
135	0.5	2.0	5.75	2H	100/32
165	2.0	2.0	2.00	2H	100/40
165	0.5	8.0	2.75	3H	36/0
135	2.0	8.0	4.75	3H	24/0
150	1.0	4.0	3.50	2H	48/0
150	1.0	4.0	3.50	2H	40/2
165	0.5	2.0	2.50	2H	108/24
135	2.0	2.0	4.25	2H	92/24
135	0.5	8.0	7.50	3H	32/0
165	2.0	8.0	2.25	3H	44/0
150	1.0	4.0	3.50	2H	32/2
150	1.0	4.0	3.50	2H	40/2
120	1.0	4.0	11.25	H	44/8
180	1.0	4.0	2.00	3H	44/0
150	0.3	4.0	5.00	3H	48/0
150	3.2	4.0	2.75	2H	52/2
150	1.0	1.25	3.25	F	132/56
150	1.0	12	3.75	3H	28/2
150	1.0	4.0	3.5	2H	40/2
150	1.0	4.0	3.5	2H	48/0

(a) Cure time needed to reach 200+ MEK rubs.

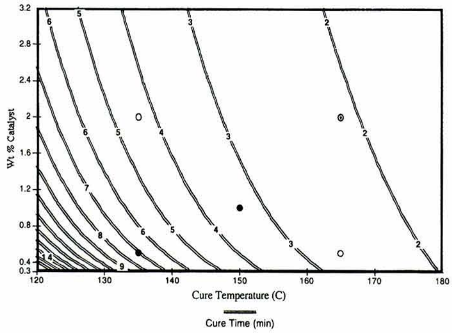


Figure 2—Epoxy/OH = 2.0.

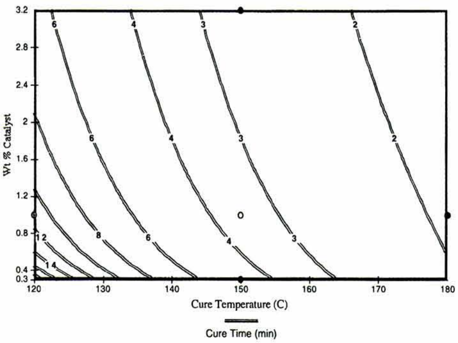


Figure 3—Epoxy/OH = 4.0.

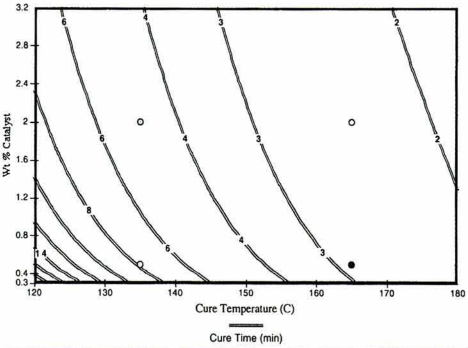


Figure 4—Epoxy/OH = 8.0.

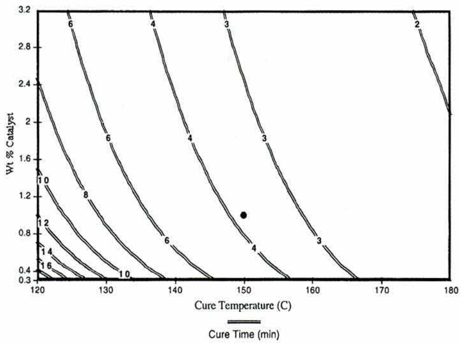


Figure 5—Epoxy/OH = 12.0.

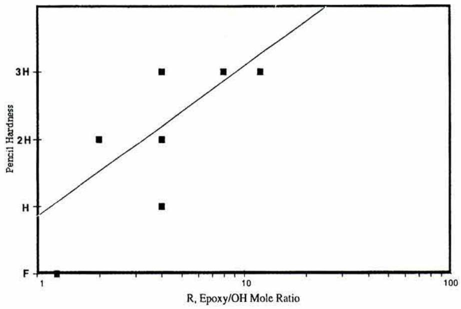


Figure 6—Hardness vs. Epoxy/OH.

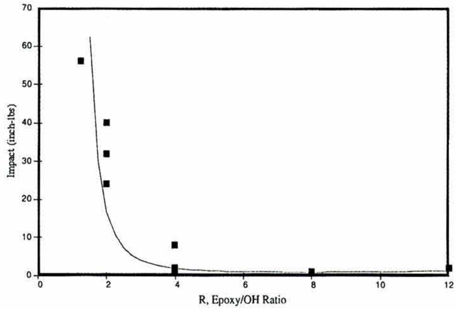


Figure 7—Reverse impact.

obvious that they would be effective in 100% solids, water diluted cycloaliphatic epoxy coatings. Initial work showed that water diluted 100% solids epoxies, thickened with a cellulosic thickener, exhibited shear thinning as measured on a Brookfield type viscometer. A variety of thickeners were evaluated. The thickener specified in *Table* 7 gave sag resistance. Other cellulosics and associative thickeners were not effective in this system. *Table* 7 contains a starting point water reduced, rheology modified formula along with coating performance data. Best coating appearance was observed with a spray gun heated at 40-60°C. Lower application temperatures produced more orange peel in the cured coating.

Lower Cure Temperatures

In the course of this work it was observed that the addition of lithium triflate (3M FC-122)[30] to the formulations discussed previously will reduce cure temperature to below 100°C. 0.25% lithium triflate will act as an effective catalyst, showing 40-50 MEK rubs vs. 0-15 for the blocked triflic acid (FC-520) when both systems are cured 40' @ 100°C in R = 2/triol formulations @ 0.25 to 0.4 mils DFT. Lithium triflate is lower in cost than the blocked acid (FC-520) on a cost/active # basis. The combination of the blocked triflic acid plus triflate is also effective.

Formulating Tips

- For cationic cure, all additives and rheology control agents must not contain basic substances, since bases will stop cationic cure. Basic pigments and amine treated pigments will inhibit cure. Basic rhodamine pigments will inhibit cationic cure. Basic pigments and additives cannot be used in cationically cured coatings. A list of cationic compatible pigments is available from the authors.

- Cure depends on loss of a small quantity of volatile amine blocking agent from the triflate catalyst (FC-520). If the coating is too thick or if the oven is not vented, the

Table 4—Experimental Design

Functionality (name)

Epoxy	Polyol	Cure^a Time Sec	Pencil H	Viscosity CPS	Impact F/R
2 (221)	2 (2XX)	405	H	195	112/72
2 (221)	4 (421)	360	H	660	100/72
4 (568)	2 (2XX)	540	H	Paste^b	88/94
4 (568)	4 (421)	555	H	Paste^b	112/64
3 (458)	3 (303)	450	2H	4150	120/64
3 (458)	2 (2XX)	435	2H	1175	112/56
2 (221)	3 (303)	345	H	540	108/72

(a) Cure time to 200 MEK rubs.
(b) Semi-solid, thinned with solvent for coatings tests.

Table 5—Corrosion Resistance of Clear Coatings

Wt% Polyol	Epoxy/OH (mole ratio)	Cure Time (min)	Creepback (in.)
0	∞	9	0
0	∞	30	1/8
33	1.61	9	3/8
33	1.61	30	5/8
40	1.18	9	3/8
40	1.18	30	3/8

Table 6—Corrosion Resistant Formulations

Ingredient	Formulation #1 Wt%	Formulation #2 Wt%
Epoxy 221	68.85	63.00
Polyol 305	20.40	—
Polyol 201	—	26.75
Ferric Phosphate anti corrosive pigment	10.00	10.00
Coupling agent^a	0.5	—
Catalyst^b	0.25	0.25
Surfactant^c		0.35

(a) Kenrich KR-55 or equivalent.
(a) 3M FC-520 or equivalent.
(b) OSi Silwet L-7500 or equivalent. (PO modified methylpolysiloxane).

Table 7—Sag Resistant Formulation

Ingredients	Wt. of Component in Formulation
Epoxy 221	45.73
Polyol 201	28.65
Catalyst^a	1.13
Water	10.9
Cellulosic thickener^b solution 5% solids in water	4.25=wt of 5% solution in water
Pigment^c	8.06

Performance Parameters	Performance
Hardness	HB
Viscosity	200 cps @ 60°C
Impact F/R	120/108
Sag bar rating	5 mil gap max, no sag when vertical in oven at the cure temperature
Cure time/temp	2.5 min @ 204°C @ 1 mil DFT
R (epoxy/OH)	3
Gloss 60°/20°	84/70

(a) 3M FC-520 (diethylammonium triflate solution) or equivalent.
(b) Union Carbide Cellosize QP-300 or equivalent.
(c) Hoechst-Celanese, 13-3072 NovaPerm Red F2RK-70 ground with BYK P-104-S or equiv. ground for 7': 85% epoxy 221, 14% pigment, 1% P-104-S.

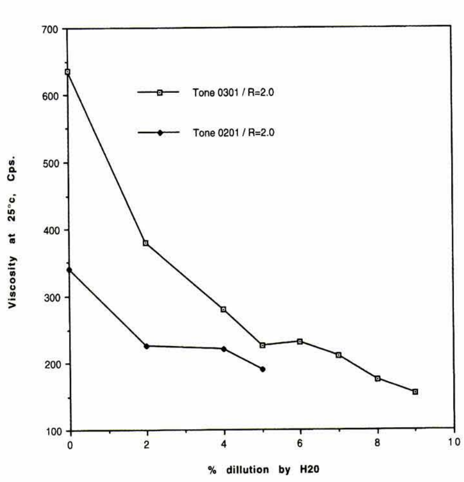


Figure 8—Effect of dilution by water on cycloaliphatic epoxy/polyol clearcoats. Epoxy/hydroxy mole ratio = 2.0/

amine may not completely exit the film and cause cure inhibition. Lithium triflate (FC-122) has no volatile blockers.

- Viscosity increases with increasing polyol branching: diols make lower viscosity coatings than triol and tetrols. More epoxy (higher R values) is needed with diols to get hard coatings.
- High epoxy content (epoxy/hydroxyl mole ratio) increases corrosion resistance (*Table* 5).
- More catalyst increases cure rate but may hurt corrosion resistance.

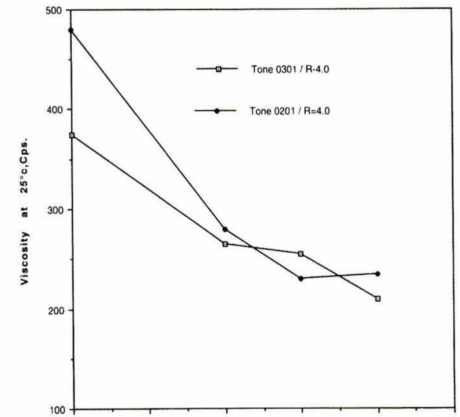


Figure 9—Effect of dilution by water on cycloaliphatic epoxy/polyol clearcoats. Epoxy/hydroxy mole ratio = 4.0.

- Epoxy/hydroxyl mole ratio, R, has a large effect on impact resistance.

CONCLUSIONS

(1) Cycloaliphatic epoxies and caprolactone polyols can be formulated into low viscosity, low to 'zero' VOC coatings.

(2) These coatings can be diluted with water to sprayable viscosities.

(3) Cellulosic type thickeners are effective in imparting sag resistance to water-diluted 100% solids epoxy/polyol formulations.

(4) Cure rates of these systems depend on several variables: epoxy/hydroxyl mole ratio, polyol and epoxy functionality, catalyst level, and cure temperature.

(5) Formulations are readily pigmented.

(6) Since these coatings are cationically cured, basic pigments and substrates will inhibit the cure.

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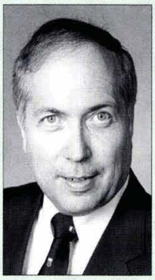
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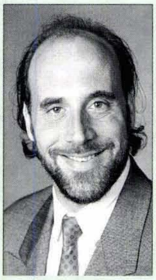
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Use of Castor Oil in the Preparation of Various Oil-Based Binders

O.S. Kabasakal,* F.S. Guner,* A. Arslan,* A. Ergan,* A.T. Erciyes,* and Y. Yagci†—
Istanbul Technical University

Styrenated oil, urethane oil, and oil modified alkyd resin were prepared by using castor oil in a different way. For this purpose, castor oil was initially subjected to an interesterification reaction with linseed oil, and the resulting intermediate was employed in the preparation of oil-based binders. Urethane oil and alkyd resin were obtained through the reactions of the interesterification product with toluene diisocyanate and phthalic anhydride, respectively. For the production of styrenated oil, thermally labile azo groups were inserted into the interesterification product and then this intermediate was reacted with styrene. Styrenated oil showed the best alkali resistance.

INTRODUCTION

Castor oil is one of the unique oils due to its high content of ricinoleic acid. Because of the presence of a hydroxyl group and an olefinic linkage in the ricinoleic acid molecule, castor oil has many reaction possibilities.[1,2] Among these reactions esterification and dehydration find a large number of applications in the manufacture of industrially useful materials. For instance, for the production of non-drying alkyd resin, castor oil is esterified with phthalic anhydride.[3] Secondary esters of castor oil, formed with drying oil fatty acids, were evaluated as materials with drying oil properties.[4] Since castor oil is a non-drying oil and cannot be used by itself in the manufacture of air-curing binders, it is converted to dehydrated castor oil (DCO) which contains a considerable amount of conjugated double bonds. This synthetic oil is produced by catalytic dehydration of castor oil.[5-9] The use of a catalyst favors the dehydration reaction, but the resulting product is dark colored and, additionally, the catalyst must be removed from the product. These are the disadvantages of the conventional catalytic methods of DCO manufacture.

Another reaction applicable for technical purposes is the splitting of secondary esters of castor oil.[10-14] In this splitting (pyrolysis) process, conjugated double bonds are formed on the ricinoleic acid chain. Therefore, the decomposition mixture has potential in the preparation of a synthetic drying oil with conjugated diene. By taking this fact into account, synthetic oils were prepared from the decomposition mixture of castor oil esters formed with fatty acids of sunflower, linseed, and *Ecballium elaterium* seed oils.[15] More recently, we synthesized an oil modified alkyd type resin[16] and new styrenated oils[17] from the splitting mixture of castor oil esters prepared with different oil fatty acids. As part of our continued interest, in the present study, castor oil is evaluated in a different way for the production of various oil-based binders. For this purpose, castor oil was initially subjected to an interesterification reaction with linseed oil and the resulting hydroxyl containing intermediate (IP) was used for the production of styrenated oil, alkyd resin, and urethane oil (*Figure* 1). Film properties were determined and compared with those of the conventional samples of styrenated oil, urethane oil, and alkyd resin.

EXPERIMENTAL

Materials

Commercially purchased linseed oil and castor oil were used. *Table* 1 presents the main characteristics of these oils. 4,4′-azobis(4-cyanopentanoic acid) (ACPA), analytical grade from Fluka, was used as received in the preparation of the corresponding acid chloride (ACPC) by means of phosphorus pentachloride as described previously.[17,20] Styrene and solvents were purified according to conventional drying and distillation procedures.[21]

Preparation of Castor Oil-Linseed Oil Interesterification Intermediate (IP)

Castor oil and linseed oil, in given proportions, were placed in a four-necked flask equipped with a thermom-

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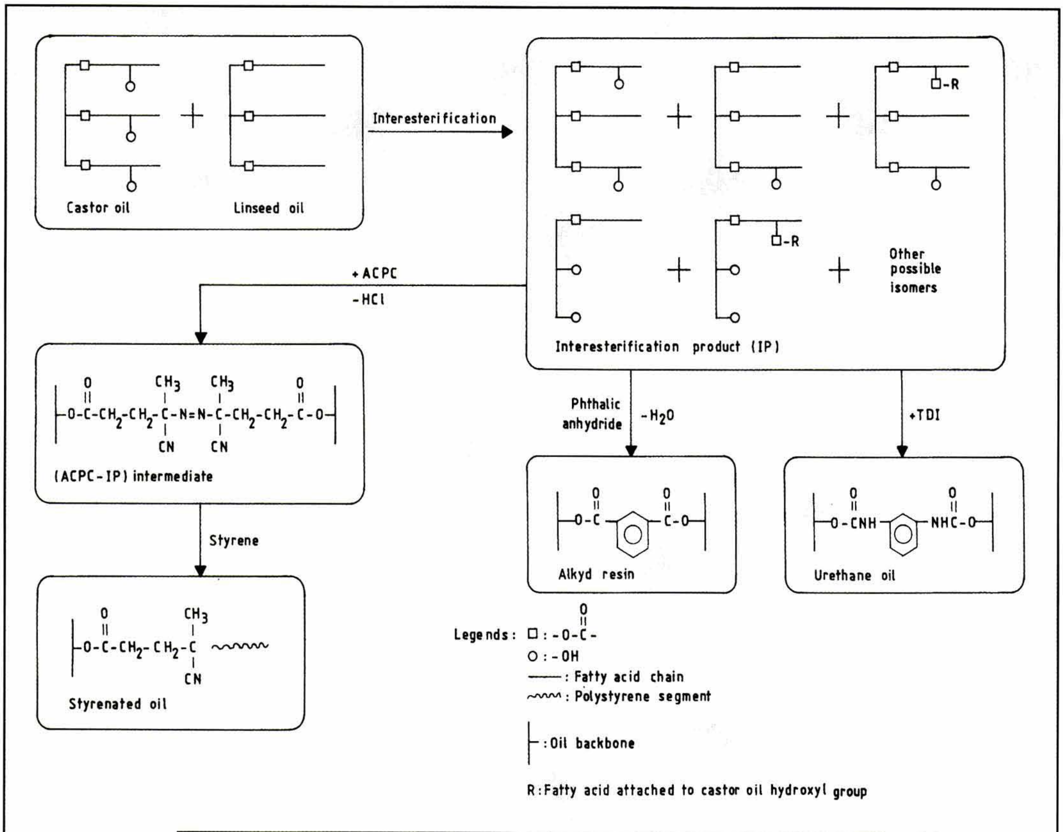

Figure 1—Preparation of styrenated oil, alkyd resin and urethane oil.

eter, an inert gas (nitrogen) inlet tube, a mechanical stirrer, and an air condenser. The mixture was heated to 218°C and $Ca(OH)_2$, 0.1% wt of the mixture, was added. The temperature was raised to 232°C and the reaction was carried out at that temperature for one hour under a nitrogen atmosphere. Acid and hydroxyl values of the resulting product were determined.[18]

Preparation of Styrenated Oil from IP

Interesterification products (IP) obtained with various castor oil:linseed oil ratios were initially reacted with ACPC as described previously.[17,20] Thus, 30 g of ACPC in 60 ml of dichloromethane was added dropwise to a mixture of equivalent amount of IP, as described by hydroxyl value, and pyridine at 0°C. After 30 min the temperature was raised to 35°C and kept constant while stirring for 80 hr. The reaction mixture was then dissolved in diethyl ether and washed successively with 0.1% aqueous sodium hydroxide solution and water and finally dried over sodium sulfate. After filtering and removing the solvent, the product (ACPC-IP) was characterized by IR spectroscopy. Additionally, the hydroxyl and acid values were determined.[18] The average amount of ACPC incorporated to IP was calculated as 53% of the theoretical value.

Prior to heating using a constant temperature bath at 70°C, nitrogen was bubbled through the (ACPC-IP) (30 g), styrene (30 g), and diethyl allylmalonate (10% in volume with respect to styrene) when stated. After eight

Table 1—Some Properties of Oil Specimens Used in this Study[a]

Oil	Refractive Index, n_D^{20}	Acid Value	Saponification Value	Iodine Value[b]	Hydroxyl Value
Linseed oil	1.4811	0.9	191	174.6	—
Castor oil	1.4780	3.3	176.7	83.7	165

(a) Analytical methods were taken from reference 18 unless otherwise stated.
(b) Reference 19.

Table 2—Acid and Hydroxyl Values of IP and ACPC-IP Intermediates

	IP Intermediates based on					(ACPC-IP) Intermediates based on		
Property	70%CO 30% LO	60% CO 40% LO	50% CO 50% LO	40% CO 60% LO	30% CO 70% LO	70% CO 30% LO	60% CO 40% LO	50% CO 50% LO
Acid value	3.23	3.8	2.5	2.8	3.1	Gelation	8.5	2.5
Hydroxyl value	127.34	102	91.3	68	51.2		43.6	37.2

Legends: CO:Castor oil
LO:Linseed oil

hours, the unreacted monomer was removed by vacuum distillation until a clear solid was obtained. The homopolymer portion was removed by precipitating the mixture into methanol. The viscosities of the styrenated oil samples were determined. Additionally, the product was characterized by IR measurement (*Figure* 2).

Preparation of Urethane Oil and Alkyd Resin Based on IP

For the preparation of urethane oil, a given amount of IP was placed into the reaction flask. Dry xylene, 30% by weight based on IP, was added and the contents were heated to 50°C. Toluene diisocyanate (TDI), in equivalent amount to hydroxyl content of IP, was added slowly over a 30-min period. Lead napthenate (24% solution in white spirit) was added in the amount of 0.02% wt of the oil portion. The temperature was set at 90-95°C, and the reaction was continued for another four hours in order to obtain the final product. The free isocyanate content of the product was determined by the wet method using n-butylamine.[22] Under these conditions, 92.25% of the original TDI amount was reacted with IP.

In order to convert the IP to the alkyd type resin, a given amount of IP was reacted with phthalic anhydride in equivalent amount to hydroxyl groups of IP. The reaction was carried out at 232°C for four hours under nitrogen flow. Acid values and the viscosities of the resulting resin samples were determined.

Preparation of Conventional Urethane Oil and Alkyd Resin as Comparative Samples

A conventional alkyd resin sample was prepared according to the formerly reported procedure.[23] The linseed oil (2,000 g) and glycerol (500 g) were heated at 218°C for about two hours then lime (2 g) was added and the temperature raised to 232°C. The heating was continued at this temperature until a withdrawn sample from the reaction mixture gave a clear solution when it was diluted with threefold methanol at room temperature. Phthalic anhydride (1,400 g) and an additional 80 g glycerol were added and the temperature was maintained at 232°C for an additional two hours.

As the basis of comparison, a conventional urethane oil sample was also prepared with the reactant ratios given by Stanton.[24] Thus, 75 g of linseed oil and 6.5 g of glycerol were placed into the reaction flask and heated. When the temperature reached 218°C, 0.075 g CaO was added as catalyst. The temperature then was set at 230°C and maintained. Transesterification reached completion after 0.5 hr as tested by dilution with alcohol.

Partial glyceride mixtures and dry xylene were taken into the reaction flask and heated to 50°C, and TDI, in equivalent amount to hydroxyl content of partial glycerides, was added slowly over a 30-min period. Lead naphthenate, as a 24% solution in white spirit, was added in the amount of 0.02 %wt of the oil portion. The temperature was set at 90-95°C and the reaction was continued for four hours in order to obtain the final product. The free isocyanate content of the product was determined by wet method using n-butylamine.[22]

Determination of Film Properties

Film properties, such as drying time at 25°C,[25] flexibility,[26] adhesion,[27] water resistance,[28] alkali resistance,[28] and acid resistance[28] were determined by using samples thinned with xylene up to 60% solid content. Lead naphthenate, 0.5%, and cobalt naphthenate, 0.05%, as metal based on solid content were added. Driers were added 24 hr before film application. In drying time determinations, a Bird film applicator with a 40 µm aperture was used for film application on the glass plate; dry film thickness being 15 µm. For the other tests, a dipping method was employed. For the flexibility, adhesion, and water resistance tests, tin plate panels were used as a substrate, while glass tubes were used for the alkali and

Table 3—Acid and Viscosity (stokes, 25°C) Values of the Oil Based Binders Prepared in this Study[a]

Product	70% CO 30% LO	60% CO 40% LO	50% CO 50% LO	40% CO 60% LO	30% CO 70% LO
Alkyd resin					
Acid value	—	7.87	6.48	6.1	—
Viscosity	—	4.0	0.5	below 0.5	—
Urethane oil	—	Gelation			
Free isocyanate, %		—	—	—	0.57
Viscosity		—	—	—	4.7
Styrenated oil	Gelation			—	—
Viscosity	—	22.7 (5.88)	0.5 (0.65)		

(a) Values in parentheses belong to samples prepared in the presence of diethyl allylmalonate.

Legends: CO:Castor oil
LO:Linseed oil

Table 4—Some Properties of the Conventional Comparative Samples Based on Linseed Oil[a]

Property	Alkyd Resin	Urethane Oil	Styrenated Oil
Free isocyanate, %	—	0.475	—
Acid value	7.51	—	—
Viscosity, stokes (25°C)	0.5	0.5	0.85

(a) Samples were thinned to 60% solid content in xylene.

acid resistance tests, as explained in the related standard methods. A water resistance test was performed 48 hr after the film application. However, this aging period was 72 hr for other tests.

RESULTS AND DISCUSSION

Figure 1 outlines the strategies applied for the production of the previously mentioned binders. The process starts with interesterification of castor oil with linseed oil. In this reaction, attachment of fatty acid radicals to the hydroxyl groups of castor oil and the migration of the fatty acids between two oil molecules take place simultaneously. Thus, through the redistribution of acid moiety between the two oils gives a hydroxyl containing intermediate (IP). This intermediate was reacted, in the next step, with phthalic anhydride, TDI and ACPC for the preparation of alkyd resin, urethane oil, and ACPC-IP intermediate, respectively. ACPC segments in ACPC-IP serve as a free radical generator when ACPC-IP is heated in the presence of styrene monomer and, by the addition of styrene through these radicals, oil-styrene copolymer is obtained as described previously.[17,20]

Since the previously mentioned binders are air-drying type, their film properties depend mainly on the contents of double bond and hydroxyl groups of the corresponding IP intermediates. Therefore, IP intermediate was prepared by using various castor oil:linseed oil ratios in order to determine the appropriate ratios of oils for each product.

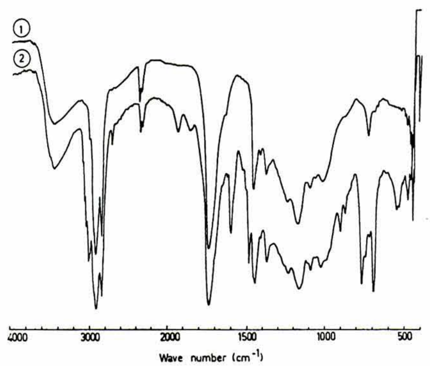

Figure 2—Infrared specta of ACPC-IP intermediate based on the mixture of 60% castor oil and 40% linseed oil (1) and the corresponding styrentated oil (2).

Table 2 contains acid and hydroxyl values of IPs and ACPC-IPs. As shown, free acid contents of the condensation products (ACPC-IP) fell to considerably low values under the applied reaction conditions. Notably, hydroxyl values of the IPs decreased also to a reasonable level, indicating successful incorporation of ACPC. The product (ACPC-IP) was also characterized by IR spectroscopy. For this purpose, nitrile absorption was observed at 2,200 cm^{-1} wavenumber (*Figure* 2). In the case of 70% castor oil, 30% linseed oil mixture, ACPC-IP production could not be completed because of the gelation as a result of high hydroxyl content of the IP. Gelation also occurred in the urethane oil preparation during the reaction of IP with TDI (with the exception of IP based on the mixture of 30% castor oil and 70% linseed oil).

The styrene-oil copolymer structure was assigned by means of IR measurement. The IR spectrum of a typical copolymer sample shows characteristic bands of aromatic group of polystyrene and ester carbonyl at 1,600 cm^{-1} and 1,750 cm^{-1}, respectively (*Figure* 2).

In *Tables* 3 and 4, acid and viscosity values of the new binders and conventional samples are given, respectively.

Table 5 represents the film properties of the prepared resins together with those of the comparative samples. In view of the drying time, new alkyds and urethane oils were not as good as their conventional counterparts and, especially, the films of the former remained tacky. Additionally, with increasing drier amounts they dried in a shorter period, but even in this case drying properties were not better than those of the conventional alkyd resins and urethane oils.

There is no doubt that the oil-styrene copolymer samples achieve their film properties from both oil and polystyrene segments. If the polystyrene segments are too long and in high percentage, the corresponding film samples become more brittle and harder and, therefore, they lose their flexibility and adhesive capability. Due to this fact, various linseed oil:castor oil ratios were applied to prepare the IP intermediates with different hydroxyl contents. It is obvious that the hydroxyl content determines the number of the incorporated polystyrene segments as well as the extent of crosslinking through TDI and phthalic anhydride in the case of urethane oil and alkyd type resin samples, respectively. The increase in crosslinking degree causes more brittleness on the final film sample.

Styrenated oils based on 60% castor oil and 40% linseed oil mixture gave the best film properties. In this regard, allylmalonate was found to be effective in favor of the film formation with better adhesion, flexibility, and alkali resistance. As explained in our previous studies,[17,20] allylmalonate, a degradative chain transfer agent, regulates the chain length of the polystyrene segments and prevents the homopolymer formation. Due to this fact, styrenated oil obtained in the presence of allylmalonate had shorter polystyrene segments as confirmed by their viscosities given in *Table* 3, and, there-

Table 5—Some Film Properties of the Products[a]

Product	Drying Time[b] Set-to-Touch (min)	Adhesion[c]	Flexibility[d] (mm)	Water Resistance[e] (min)	Alkali Resistance[f] (min)	Acid Resistance[g]
Alkyd resin based on IP with:						
60% CO, 40% LO	240	5B	2	36	pr:15	nc
50% CO, 50% LO	240 (220)	5B	2	32	pr:20	nc
40% CO, 60% LO	180 (125)	5B	2	15	pr:18	nc
Conventional Linseed Oil Alkyd	39	5B	2	18	pr:16	nc
Urethane Oil Based on IP with:						
60% CO, 40% LO	Gelation					
50% CO, 50% LO	Gelation					
40% CO, 60% LO	Gelation					
30% CO, 70%, LO	65(47)	5B	2	10.5	pr:41	nc
Conventional Linseed Oil Urethane Oil	20	5B	2	11	pr:224	nc
Styrenated Oil Based on ACPC-IP with:						
70% CO, 30% LO	Gelation					
60% CO, 40% LO	1.5 (3)	3B (5B)	32 (2)	4(33)	pr:1940 (380)	nc
50% CO, 50% LO	75 (100)	5B (5B)	2 (2)	22 (30)	pr: 4 (3)	nc
Conventional Styrenated Linseed Oil	2.5	5B	2	5	pr:60	nc

(a) Values in parentheses belong to samples prepared in the presence of diethyl allylmalonate.
(b) Test was carred out at 25°C and 60% relative humidity. (Ref. 25)
(c) Test Method B was applied (Ref. 27).
(d) Diameter of cylinder which caused no crack on the film. (Ref. 26)
(e) Ref. 28.
(f) Test was carried out at 25°C in 5% NaOH solution. (Ref. 28)
(g) Test was carried out at 25°C in 9% H_2SO_4 solution. (ref. 28)

Legends: CO:Castor oil
LO:Linseed oil
nc:no change
pr:partial removal

fore, their films were more flexible and had better adhesion properties compared to those of the samples prepared without allylmalonate.

It should be emphasized that the styrenated oil prepared by using the castor oil via the proposed way showed the best alkali resistance. In conventional styrenation, polystyrene segments are attached to the fatty acid chains[29-39] and are expected to be far from the ester groups of glycerides. However, in the applied styrenation process, polystyrene segments are joined to oil molecules through the radicals formed by decomposition of azo groups. Therefore, polystryene chains linked this way are closer to originally present ester groups and more likely to prevent them from hydrolysis.

CONCLUSION

Synthetic methods for the production of various castor oil based binders are given and, in particular, styrenation of the oil by the attachment of the initiating azo groups and using a degradative chain transfer agent is shown to be useful in assessing the chain length variation on the flexibility and adhesion of the dried films of styrenated oil samples.

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Film Formation of Vinyl Acrylic Latexes; Effects of Surfactant Type, Water and Latex Particle Size

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Alfred Rudin—University of Waterloo†

The process of film formation from an 85/15 vinyl acetate/butyl acrylate latex was studied with respect to the effects of particle size and surfactant type on minimum film formation temperature (MFFT), glass transition temperature (T_g), drying rates, and optical clarity of the coalesced films.

Water plasticizes this polymer and thus only wet viscoelastic parameters and T_g values are realistic in film formation theories. The polymer is plasticized by ethoxylated alkylphenol nonionic surfactants. The surfactants with shorter ethylene oxide chains are better plasticizers and poorer steric stabilizers than their longer analogs. The type and concentration of stabilizing entities on the latex particle surfaces have very significant effects on the drying and coalescence properties of these latexes. Coalescence is somewhat faster with smaller latex particle sizes but larger particle size products dry at a faster rate than smaller ones in the absence of surfactant effects.

INTRODUCTION

The process of film formation from a polymer latex is often described by a three-step mechanism.[1-4] The stages are successively those in which the latex particles are mobile in the bulk water phase, pack into an ordered array and coalesce, and maturation of the latex film as a result of polymer diffusion across the original particle boundaries. The T_g of the latex must be at or below the film temperature for coalescence to occur.

A number of forces exist during the film formation process. The forces which cause film formation are the polymer-water and polymer-air interfacial tensions and capillary forces, while film formation is resisted by the temperature-dependent elasticity and viscosity of the polymer.[5,6] The polymer-water and polymer-air interfacial forces have been studied by a number of authors to determine the extent to which these forces contribute to the overall coalescence process.[7-9] These forces are said to come into play after the particles are forced together due to water evaporation.

Recently some doubt has been placed on the significance of the water-polymer interfacial tension during coalescence. Dobler[10-12] and co-workers designed experiments which allowed latexes to coalesce in the presence of water but in the absence of evaporating water. They concluded that the forces due to polymer-water interfacial tensions were very small and thus most of the forces in coalescence were exerted during the evaporation of water. They also noted that a considerable resistive force was exerted by stabilizing moieties consisting of poly(methacrylic acid), in this case, and attributed this to a loss of conformational entropy. When the particles were significantly compressed, elastic resistance of the stabilizing moieties was also expected to become a factor. Also, the energy of hydration of the shell was thought to prevent total coalescence of the latex particles in the absence of evaporation. Although forces are also needed to break the steric or electrostatic barrier on latex particles during coalescence, they have been considered but not included in coalescing models.

Capillary forces have also been studied in relation to the coalescing process. Water in the capillaries between particles produces forces which are calculated to contribute to the film formation process in proportion to the air-water interfacial tension and inversely proportional to the size of the capillary formed.[5,6,9,13,14] Agreement among various authors as to the magnitude of capillary forces is lacking. This is because it is difficult to define surface energetics of polymer latexes. Latex complexity

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Table 1—Recipes for Monodisperse Vinyl Acrylic Latexes

Recipe (charge amount in grams)	M1	M2
Deionized water	380.0	380.0
DS10[a]	0.15	0.04
Ammonium persulfate	0.30	0.30
DS10[a]	0.10	0.10
Deionized water	158.0	158.0
Butyl acrylate	63.5	63.5
Vinyl acetate	360.5	360.5
Sodium bicarbonate	0.85	0.85
Deionized water	15.0	15.0
Deionized water	20.0	20.0
Ammonium persulfate	0.52	0.52

(a) Sodium dodecyl benzene sulfonate (Rhône-Poulenc).

as well as nonhomogeneous film formation increases the surface analysis difficulties. Both Sheetz[14] and Okubo[15] report that in improperly stabilized latexes, surface particles coalesce before the bulk material (skinning), increasing the complexity of the mechanism of film formation.

The forces resisting coalescence must also be properly defined. As previously mentioned, stabilizing moieties resist obliteration of particle boundaries. Work by Winnik et al.[16] was aimed at defining the final stages of film formation, the interdiffusion of polymer chains, using energy transfer measurements. They determined that carboxylic acid functionality at the surface of the latex particles can hinder the interparticle polymer diffusion. The viscoelastic properties of the polymer also resist deformation of the particles. The polymer modulus is signficantly reduced at temperatures above the T_g of the material. Bertha and Ikeda[17] studied the coalescence of dried latexes in air and reported that coalescence occurred exothermically at temperatures above the T_g of the polymer.

Eckersley and Rudin[5] have summarized the historical progression of film formation models. These authors proposed a theory in which capillary and interfacial forces act in tandem to promote film coalescence. The interfacial forces may involve dry and/or wet sintering, depending on the details of the drying process. The model was shown to predict the time dependence of coalescence of an acrylic latex system.

Further work by van Tent and te Nijenhuis[18] using transmission spectrophotometry has aided in determining the internal structure of concentrated latex dispersions. Rayleigh scattering equations and multi-layer interference patterns were used to describe the size of the water domains and the time of coalescence of the particles, respectively.

It has been substantially documented that water can plasticize a polymer[4,6,19-24] and thus change its viscoelastic properties and its resistance to coalescence. As a result the dried latex moduli are not necessarily representative of the moduli of the polymer in a wet latex. It is suggested that polar and acidic groups associate[25] causing pseudo crosslinks to form, raising the T_g which is a function of the viscoelastic properties of the latex. Water can plasticize these regions, lowering the T_g. Traditionally, dry latex viscoelastic properties and T_gs have been used in describing latex film forming mechanisms[11,26-28] and as a result, higher forces were ascribed to capillary and interfacial tension effects than were necessary for the coalescence of a latex.

Very recently, Sperry et al.[29] have shed further light on the film formation of latexes. By comparing the MFFT of pre-dried latexes with that of wet latexes they reported that, for given polymer compositions, the capillary forces present during the drying of latex films contribute little if anything to the forces involved with coalescing.

Surfactants can also plasticize latex particles. Bradford and Vanderhoff report that film integration of styrene butadiene copolymer latexes increased with decreasing ethylene oxide (EO) chain length of nonyl phenol ethoxylates.[30,31] They also stated that EO chain lengths of 15 or less were more compatible with the film than longer nonyl phenol EO chains. Snuparek[32] noted that water adsorption of carboxylated butyl methacrylate/butyl acrylate copolymer latexes increased significantly when the nonyl phenol ethyoxylate stabilizer chain length was 20 or more units. He attributed it to decreased compatibility of the more hydrophilic emulsifiers allowing them to more easily adsorb water at the surface of the particle. This decreased compatibility is similar to that observed by Bradford. Vijayendran, Bone, and Sawyer[26] showed that surfactants markedly reduced the MFFT and T_g of vinyl acrylic latexes. They also report that higher hydrophilic lipophilic balance (HLB) nonionic surfactants are better agents at plasticizing, on a weight basis, than lower HLB nonionic surfactants due to their superior compatibility with the relatively polar vinyl acrylic latex. Nonionic surfactants have also been reported to plasticize acrylic latex polymers.[24] The exudation rate of these surfactants from a latex film was determined by Winnik et al.[33] to be enhanced through the use of coalescing aids.

The effect of the particle size of the latex on the film formation process has also been disputed. While some authors have found that increasing the particle size increases the MFFT of the latex,[5,6,25,26] others have not.[34] Theoretical arguments have been put forth to support both sides. Vanderhoff[31] maintained that decreasing the particle size should decrease the MFFT since capillaries formed in the drying process are smaller, therefore increasing the forces on the particles and allowing the particles to coalesce at a higher modulus and thus a lower temperature. Mason,[13] on the other hand, determined that particle size may have no effect since as particles coalesced the capillaries would decrease in size, increasing the force of coalescence. Thus, if materials are not too rigid, the latexes will always form a film, a conclusion which is independent of particle size. Some of the apparent conflict may reflect the use of polydisperse latex samples in most studies.

A number of attempts have been made to explain the phenomenon of film formation and all have met with varying degrees of success. It is agreed that a number of forces contribute to the film formation process but the extent to which each force participates is contested and may, in fact, vary between different latex types. Vinyl acetate based latexes are the largest class of latex polymers used in coatings applications.[35] It is the purpose of this study to further clarify the factors involved in the film formation of vinyl acrylic latexes. These areas include plasticization of the latex by water and surfactants, and the effect of stabilizer surface groups on the film formation process. While studies of this kind have been performed on vinyl acrylic latexes before, this is the first work where the parameters are examined using a series of monodisperse latexes as well as a series of nonyl phenol surfactants.

The effects of surface groups on the film formation process were studied by the addition of surfactants to so-called "surfactant free" latexes. The topics examined are the effect of particle size and surfactant type on the MFFT, T_g, optical clarity, and drying rates of the latex.

The latexes used in this study were composed of 85 wt% vinyl and acetate and 15 wt% butyl acrylate. The stabilizing moieties were generated *in situ* from the reaction of the ammonium persulfate initiator with the monomer. These latexes were manufactured in a number of monodisperse sizes ranging from approximately 200 to 1800 nm.

EXPERIMENTAL

Latex Production Apparatus

The polymerizations were carried out in a one-liter reactor with a four-port glass lid. The reactor was fitted with an overhead condenser. The stirring rate was adjusted so that monomer did not pool on the surface of the reaction mixture (200-400 rpm). The reactor contents were maintained at the appropriate temperature through the use of a thermostatted water bath. Monomers were fed into the reactor using an FMI lab pump, model RP-SY at a prescribed rate. Water soluble initiators were fed into the reactor using a Sage Instruments Model 355 syringe pump.

Production of Monodisperse Latexes[37]

Monodisperse latexes were produced at 42% solids using the following reaction scheme (*Table* 1, M1). The reactor was charged with deionized water, 380.0 g, and surfactant, 0.15 g (DS10, sodium dodecyl benzene sulfonate, 98%, from Rhône Poulenc). The critical micelle concentration (CMC) of DS10 is 0.4 g/L. The CMC is defined as the point where further increases in the amount of surfactant added to water will not significantly decrease the surface tension. This is thought to be the point at which the surfactant begins to aggregate into micelles. The water and surfactant were purged with nitrogen and then heated to 70°C.

A pre-emulsion of monomer in water was prepared as follows: Vinyl acetate, 360.5 g (from Aldrich Chemical Co. Inc., 99+%, inhibited with 3-5 ppm of hydroquinone), and butyl acrylate, 63.5 g (from Aldrich, 99+%, inhibited with 10-50 ppm of methyl ether hydroquinone [MEHQ]), were slowly added to a stirred solution of 0.1 g DS10 in 158.0 g deionized water.

Ammonium persulfate, 0.30 g (from Aldrich, 98+%), was added to the reactor. At this time 30.0 g of the pre-emulsion was also added. The contents of the reactor were then heated to 80°C over the next 20 min.

Sodium bicarbonate, 0.85 g (from Aldrich), dissolved in 15.0 g water was then added to the remaining portion of the pre-emulsion. The pre-emulsion was then added to the reactor over a period of three hours using a lab pump. The emulsion addition rate was increased stepwise every 1/2 hr starting at a rate of 1.2 mL/min to a final rate of 7.0 mL/min. The initiator solution of 0.52 g of ammonium persulfate dissolved in 20.0 g of deionized water was added concurrently with the monomer at a constant rate using a syringe pump. This feed method ensured the production of a homogeneous copolymer and provides conversions of at least 99.75%.

A lightly larger particle size latex was made using less surfactant, 0.04 g, in the pre-charge (*Table* 1, M2).

Seeded Monodisperse Latexes

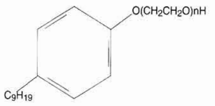
Further increases in particle size were accomplished through seeded reactions as listed in *Table* 2 (M3-M7). The reaction scheme is virtually the same as for the latex described earlier except for the following changes. For reaction M3, the reactor is initially charged with 200.0 g of a seed latex which was manufactured in reaction M2.

Table 2—Seeded Reactions

Charge Amount in Grams	M3	M4	M5	M6	M7
Seed latex	200.0[a]	200.0[b]	300.0[c]	400.0[d]	400.0[e]
Deionized water	100.0	100.0	—	—	—
DS10[f]	0.14	0.14	0.12	0.07	0.07
Deionized water	448.0	448.0	411.0	274.0	274.0
Sodium bicarbonate	0.85	0.85	0.64	0.43	0.43
Butyl acrylate	63.5	63.5	47.6	31.8	31.8
Vinyl acetate	360.5	360.5	270.4	180.3	180.3
Deionized water	25.0	25.0	18.75	13.0	13.0
Ammonium persulfate	0.85	0.85	0.62	0.41	0.41

(a) From M2
(b) From M3
(c) From M4
(d) From M5
(e) From M6
(f) Sodium dodecyl benzene sulfonate (Rhône Poulenc).

Table 3—Nonyl Phenol Ethoxylates Used for Blending with Monodisperse Latexes



Ethylene Oxide Units (n)	Average Molecular Weight	Moles Added per 100g Latex (x10^3)
4	397	5.04
6	485	4.12
9	617	3.24
15	881	2.27
20	1101	1.82
40	1982	1.01

Water is also added (100.0 g). This is purged with N_2 for 30 min and heated to 80°C.

A pre-emulsion of monomer in water was prepared as follows. Vinyl acetate, 360.5 g, and butyl acrylate, 63.5 g, were slowly added to a stirred solution of 0.14 g DS10 and 0.85 g sodium bicarbonate in 458.0 g deionized water. The surfactant, DS10, was below its CMC.

The pre-emulsion was then added to the reactor over a period of three hours using a lab pump. The emulsion addition rate was increased stepwise every 1/2 hr starting at a rate of 1.2 mL/min to a final rate of 12.0 mL/min. The initiator solution of 0.85 g of ammonium persulfate dissolved in 25.0 g of deionized water was added concurrently with the monomer at a constant rate using a syringe pump.

Further reactions (*Table* 2, M4-M7) were performed as for M3 to obtain even larger particles. The amount of seed latex and the amount of monomer added varied to produce the appropriate particle sizes.

A narrower range of particles was produced for the drying rates and optical clarity experiments. The reactions were carried out as mentioned previously with the following exceptions. Reaction M2 was repeated and used as a seed to build larger particles using reaction scheme M5. The latex obtained in this reaction was then used again as a seed for the subsequent reaction all the time using reaction scheme M5. In all cases, a solids concentration of approximately 42% was obtained.

Addition of Surfactants to Latexes

The surfactants used in the study were nonyl phenol ethoxylates (*Table* 3), which are common steric stabilizers for vinyl acrylic latexes used in the manufacture of interior latex paints. The surfactants were added to the latexes by first diluting them in water and subsequently adding them to the latex under agitiation. Agitiation was continued for at least one hour. The final solids content of the latex was 20% with a 4.8% surfactant loading based on polymer, for the T_g and MFFT data, while for drying rates and clarity studies a two percent surfactant loading was used.

The lower ethoxylate surfactants (4EO and 6EO) were only very slightly soluble in water. Therefore they were briefly heated in water to aid in dissolving them. Upon cooling, a fine suspension appeared. This suspension was subsequently added to the latex.

Conversion

The monomer concentration in the vinyl acrylic latexes was determined using a Hewlett Packard 5890 Series II gas chromatograph and recorded on a Hewlett Packard HP 3396A Integrator. Pressures for the air, hydrogen, and helium were 35, 17, and 40 psi, respectively. The oven temperature was 80°C, and the column was a six foot, 10% Carbowax 20M-TPA, Chromsorb W-DMCS, 60-80 mesh column. The detector was a flame ionization detector. Samples were drawn from the reactor during and at the end of specific reactions, by syringe, through a septum. The latex was diluted 1/10 with deionized water and injected directly into the gas chromatograph. The injector port contained a removable glass tube to facilitate cleaning.

Particle Size and Distribution Measurements

The particle size and size distribution of the latexes was measured using an ICI-Joyce Loebl disk centrifuge. The output was recorded by a Brookhaven Instruments DCP-100 data system. Water was used as the spin fluid and the density gradient was produced using methanol. The latexes were diluted to 0.25 to 0.5 wt% in a mixture of 80/20 water/methanol by weight.[38]

The densities of the copolymeric latexes were calculated using a weighted average of the densities of the homopolymers. The rotational speed of the disc was selected so that the particles passed the detector after one minute. For the longer analysis times, the spin fluid was put into the disc and 1 mL of dodecane was added to the top of the spin fluid. This inhibited the evaporation of methanol from the top of the spin fluid and thus prevented the breakdown of the spin fluid gradient, especially on humid days.

Particle sizes below 80 nm are not reliably measured on the disc centrifuge and particles below 40 nm may not even be detected. Smaller particles can be detected however, by the visual observation of the spinning disc soon after the injection of the concentrated latex onto the disc. The larger particles rapidly migrate to the edge of the disc while the small second generation particles form a faint blue ring. The sizes of small particles cannot be measured but this procedure allows for their detection and indication of a second generation of particles in monodisperse latex systems.

Differential Scanning Calorimetry

The T_g of the latexes was analyzed using a DuPont Instruments 910 differential scanning calorimeter. The latexes were dried for 10 days at room temperature to ensure the elimination of any moisture, where required. Each sample was then analyzed twice; the first run was performed to eliminate any thermal history while the second run was used to measure the T_g of the latexes. The scanning range was varied depending on the T_g of

Table 4—Particle Size and Distribution of Latexes Produced from Recipes in Tables 1 and 2 for Stabilizer and Surfactant Effects

Recipe	Particle Size Dn (nm)	Projected (nm)	Polydispersity (Dw/Dn)	Coefficient of Variation (%)
M2	208	—	1.013	6.7
M3	384	379	1.028	9.3
M4	686	699	1.014	6.9
M5	1.26	1043	1.007	5.0
M6	1367	1344	1.007	5.1
M7	1791	1791	1.018	7.9

Dn = number average diameter.
Dw = weight average diameter.

the latex. The scanning rate for all samples was 10°C/min. The T_g was taken to be the onset of the transition.

To determine the T_g of wet latexes as a function of water content, a sample was partially dried overnight in a polyethylene lined petri dish. A portion of the sample was then put into an aluminum pan. The scanning range started at –30°C and ended at 100°C. The 100°C final temperature aided in driving off some of the water. The scans were repeated until all of the water was driven off and a constant T_g was obtained.

Dynamic Mechanical Measurements

A Rheometrics dynamic mechanical spectrometer was used to confirm the T_g measurements of the wet and dry latex films. A known amount of latex (50 g at 42% solids) was allowed to dry in a polyethylene lined petri dish (total surface area for petri dish = 165.1 cm^2). After one day, the incompletely dried film was removed from the dish and cut into rectangular pieces using a die (5.9 cm × 1.25 cm) on a hydraulic press. The film was allowed to fully dry for 10 days. To obtain the T_g of a wet latex a dried specimen was soaked overnight in water.

The dynamic mechanical tests were performed using a torsion rectangular configuration at a constant frequency of 20 Hz and a strain rate of one percent. The temperature was increased from –30° to 65°C.

Minimum Film Forming Temperature

The minimum film forming temperature (MFFT) of the latexes was obtained through the use of an MFFT bar. This bar consisted of a stainless steel plate with slight depressions milled into it to contain the latex. One end was cooled using two 12-volt ceramic thermoelectric cooling modules while the other end remained at room temperature creating a temperature gradient from 0° to 20°C along the bar. The temperature gradient on the bar was measured using eight thermocouples placed at equal intervals along the bar. The bar was covered with a glass plate and nitrogen was passed between the bar and glass cover at a rate of 2 L/min to facilitate drying and to maintain a constant humidity. The latex was applied to the bar and the temperature profile of the bar was monitored during the drying of the latex.[39]

The MFFT of the latex was considered to be the temperature at which the film turned from a clear, well coalesced film, to a cloudy or cracked uncoalesced film. The error in the measurements is ±5%.

Drying Rates of Latexes Using a UV/VIS Spectrometer

The drying rates of the latexes were measured as a function of opacity of the sample. The opacity was monitored by measuring the transmittance of visible light (500 nm) using a Perkin-Elmer UV/VIS spectrometer. A known amount of latex (0.6 g at 42% solids) was applied to a glass slide (7.5 cm × 1.3 cm). This configuration gives a sample coverage of 0.061 g/cm^2. The latex was allowed to air dry in still air conditions until it would not flow when the glass slide was held vertically. A clean glass slide was used as a blank and then the glass slide with the latex was inserted into the UV/VIS spectrometer and the transmittance monitored until a constant transmittance of close to 100% was obtained.

Drying of Latexes Using Gravimetric Analysis

Drying rates were also confirmed using gravimetric analysis. A known quantity of latex (10.0 g) or latex paint (7.6 g) was allowed to dry in a petri dish (total surface area for latex petri dish = 165.1 cm^2 and 124.7 cm^2 for paint petri dish). This configuration also gives a sample coverage of 0.061 g/cm^2. The weight was monitored until a constant weight was obtained. All latexes in a series were dried at the same time to reduce humidity and temperature effects on drying rates between samples. The temperature was 20°C while the humidity was at 40%.

RESULTS AND DISCUSSION

Stabilizer and Surfactant Effects on the T_g and Minimum Film Forming Temperatures of Latexes

The mean particle sizes and distributions of the latexes obtained are listed in *Table* 4. The T_g of the latex films made from these surfactant-free latexes was measured and plotted with respect to the particle size of the latex (*Figure* 1). These measurements were done in order to

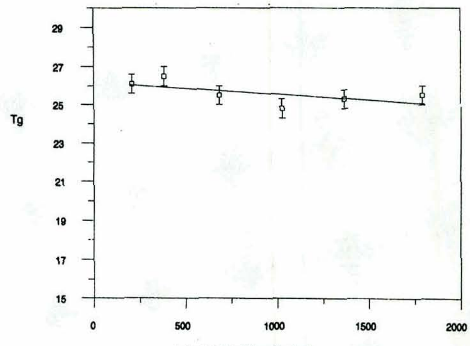


Figure 1—T_g as a function of latex particle size of 85/15 wt% vinyl acetate/butyl acrylate latex films.

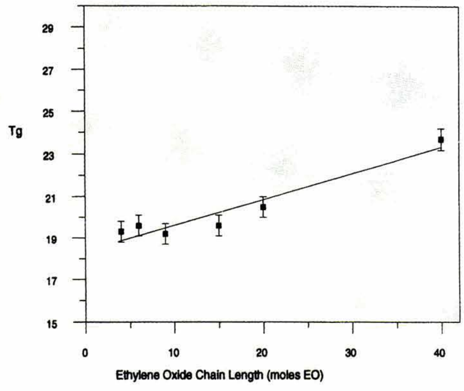


Figure 2—T_g as a function of EO chain length of ethoxylated nonyl phenol surfactants at 4.8 wt% based on polymer.

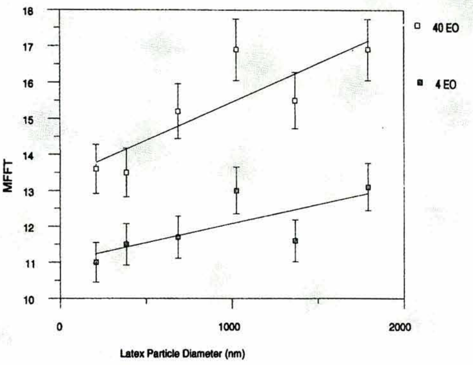


Figure 4—MFFT as a function of nonyl phenol ethylene oxide chain length and latex particle size.

establish a baseline from which all other plasticizing effects were to be compared. As illustrated in *Figure* 3, the T_g of the latex films was approximately 26°C. The T_g is thus not a function of particle size, as expected, since each latex was produced to be homogeneous. (The error bars, representing an error of 1°C, were obtained by finding the error associated with measuring five T_gs of the same sample and then applying this error to all samples.)

In order to determine the effect of nonyl phenol surfactant type on T_g, a 686 nm latex was dosed with a series of nonyl phenol surfactants. Latex films were produced by allowing the latexes to air dry for 10 days at ambient temperatures. DSC measurements were performed to determine the effect of surfactant type on the T_g.

As illustrated in *Figure* 2, the type of surfactant dramatically affects the T_g of the latex film. All of the surfactant types reduced the T_g of the latex. While 40EO decreased the T_g of the latexes by only 3°C, the lower ethoxylated surfactants decreased it by 5° to 7°C. It should be noted that while all surfactant additions were equal on a weight basis they varied significantly on a molar basis. The higher ethoxylates have a much higher molecular weight and therefore fewer moles of surfactant were added than with lower ethoxylates.

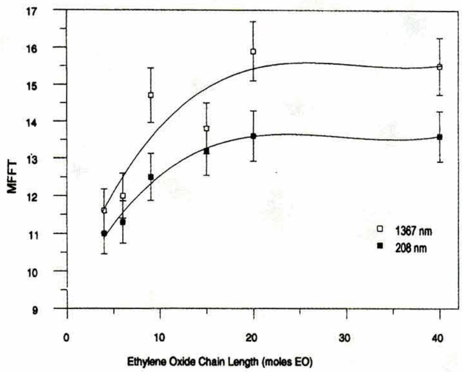


Figure 3—MFFT as a function of EO chain length of ethoxylated nonyl phenol surfactants at 4.8 wt% based on polymer.

Vijayendran's[26] results are in direct conflict with the results presented in this work. While the trend presented in *Figure* 2 indicates better plasticizing with lower ethoxylate chain lengths, Vijayendran's results indicate the opposite. Since he used only two relatively hydrophilic surfactant types (20EO and 50EO) a trend is difficult to establish. His values for the T_g of the latex are further suspect since he used a batch polymerization technique to produce the copolymer latex.[40] This technique will most certainly produce heterogeneous particles and thus more than one T_g or a broad range for the T_g should be reported.[41]

MFFT measurements were performed on two surfactant modified latexes (208 nm and 1367 nm). Surfactants were added as described. *Figure* 3 illustrates the results. (The error bars, representing an error of ±5%, were obtained by finding the error associated with measuring five MFFTs of the same sample and then applying this error to all samples.) For both the large and small latex, the MFFT remains relatively unchanged for 20EO and 40EO. As the EO chain length in the surfactant is decreased, the MFFT drops off sharply. In the present work, as the EO chain length was reduced, the driving force for coalescence increased since it results in an increase in the interfacial energies of the system. At the same time, the T_g and the modulus were reduced, thus lowering the MFFT.

In work done by Eckersley and Rudin[24] on acrylic latexes, they also found that a nonionic ethoxylated alkyl phenol surfactant plasticized a latex of a 49:49:2 poly(methyl methacrylate-co-butyl acrylate-co-methacrylic acid) polymer. However, the MFFT was independent of the nonionic surfactant concentration. This is presumably because of two counteracting efforts. Since only the concentration of surfactant was varied and not the type, the plasticization of the polymer by the surfactant reduced the resistance of the material to flow and coalescence as explained earlier; but with this surfactant, the driving force for coalescence was decreased since the total EO content increased resulting in a reduction in the interfacial energies of the system.

Another series of latex samples were made in which two different types of ethoxylated nonyl phenol surfactants were added to a range of particle sizes (*Figure* 4, error ±5%). Here the effect of particle size can be observed. With both of the surfactant types, MFFT increases with increasing particle size.

Figure 5 illustrates some of the same data as *Figure* 4 but with a complete range of particles to which the complete range of surfactants have been added (error bars have been omitted for 6EO and 20E for clarity). The data are difficult to resolve, but the MFFT data appear to increase with increasing particle size for all surfactant types. This was expected since although surfactants plasticize the latex polymer, they also reduce the aqueous surface tension and polymer/water interfacial energy.

It should be noted that MFFTs of so-called "surfactant free" latexes also increase with particle size. The total surface area of a large particle size latex is less than that of a small particle size latex at equivalent solids concentrations. These latexes contain sulfate ions from the initiator at equivalent solids concentrations. These latexes contain sulfate ions from the initiator at the ends of the polymer chains which act as stabilizers. Since these stabilizers are hydrophilic and the T_g of the polymer is below the reaction temperature during the production of these latexes, the ionic groups can migrate to the surface of the latex particle.[39] Larger particle size latexes will thus have a higher concentration of stabilizing moieties on their surface than smaller ones and thus are expected to resist coalescing to a greater degree. As a result, larger particles will also have lower latex-water interfacial tensions, reducing the forces favoring coalescence and, as a result, produce higher MFFTs.

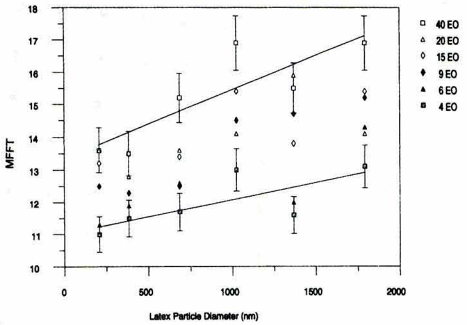


Figure 5—MFFT as a function of nonyl phenol ethylene oxide chain length and latex particle size.

Drying Rates of Latexes

The latex particle size and size distributions for this set of experiments are listed in *Table* 5.

There appears to be a relationship between particle size and the drying rate of latexes. The clarity of a latex film was used as a criterion for the loss of water from a latex film. This was accomplished by monitoring the transmittance of a latex as it dried using a UV/VIS spectrometer at a wavelength of 500 nm. It is realized that the phenomenon measured reflects both the loss of water from between the latex particles and polymer coalescence.

The larger particle size, "surfactant free" latexes dried at a faster rate than smaller particle size latexes (*Figure* 6). It is suggested that the larger particles dried faster since the density of stabilizing entities on the surface of the latex is much greater than on the smaller latex particles, thus increasing the resistance to coalescence and allowing more rapid water evaporation from the latex film.

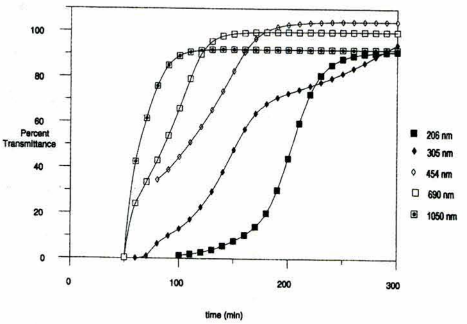


Figure 6—Effect of particle size on drying times of latexes.

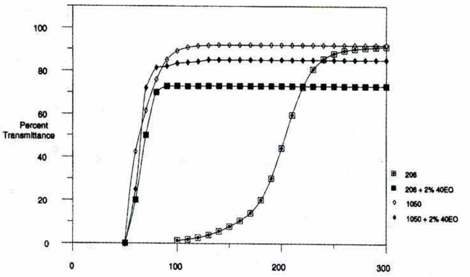


Figure 7—Effect of nonionic surfactant on drying time.

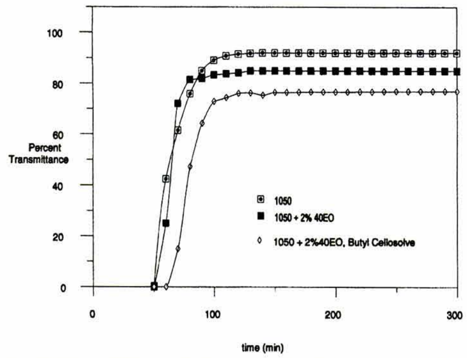


Figure 8—Effect of coalescing agent on drying time.

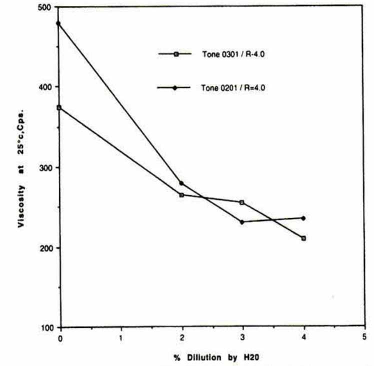


Figure 9—Drying rates as a function of particle size.

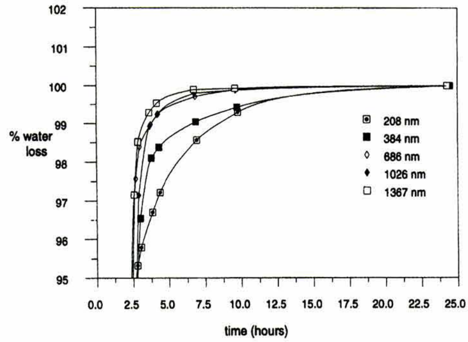


Figure 10—Drying rates as a function of partice size.

To test this hypothesis, the smallest (206 nm) and the largest (1050 nm) particle size latexes were stabilized with two wt%, based on polymer, of a 40EO surfactant and the drying rates were compared with those of their unstablized counterparts (*Figure* 7). The addition of surfactant to the smallest particle size latex increased the drying rate to that of the largest size. The addition of surfactant to the largest particle size latex resulted in no discernible change in the drying rate. Thus, the effect of particle size appears to be a function of stabilizer concentration and not a function of particle size.

The addition of two wt% of a coalescing agent, butyl Cellosolve® (ethylene glycol monobutyl ether acetate from Union Carbide Corp.), did not significantly affect the drying time of the latex (*Figure* 8). This emphasizes the importance of the surface character of the latex particules on the drying rates. The butyl Cellosolve acts as a plasticizing agent, but it only affects the film formation process after the latex particles actually touch. The surfactants act as steric stabilizers, retard coalescence, and facilitate water loss.

Also notable in *Figures* 6-8 are the final transmittance values. As illustrated in *Figure* 6, the largest and the smallest latexes produced the lowest transmittance levels at the end of the drying period while the 454 nm latex produced the highest transmittance. The latexes larger than the 454 nm latex became increasingly hazy as the particle size increased. This is speculated to be due to the increasing size of the interstitial domains in the larger particle size latexes which contain more hydrophilic material. As the domain size increased, the refraction of light at the boundaries increased, causing a hazy film to be produced. The latexes which were smaller than 454 nm produced films with surface irregularities. The concentration of irregularities increased as the particle size of the latex decreased. This produced films with lower final transmittance levels.

In *Figure* 7, where the nonionic surfactant 40EO was added, the transmittance level decreased when compared to the surfactant-free film. This is speculated to be due to surfactant regions or exudations[42,43] causing the film to become hazy and reducing the final transmittance levels. Also in *Figure* 8, the addition of butyl Cellosolve caused the film to become even more hazy. Here the addition of butyl Cellosolve may have actually enhanced the exudation rate of the surfactant, causing the film to become more hazy than the latex film with no coalescing solvent added. This result was also obtained by Winnik et al.[33]

The drying rates of latex films were also measured gravimetrically (*Figure* 9). Initially, the rate of water loss for large and small particles was identical up to 95% total water loss, which corresponds to a solids content of 93.5%. The drying rate during this period in time was 3.04×10^{-4}g·min^{-1}·cm^{-2} which corresponds closely to the values of 2.5-2.9 × 10^{-4}g·min^{-1}·cm^{-2} reported by Vanderhoff et al.[1] While Vanderhoff noticed a drop in the drying rate at about 60-75% solids, which corresponds to a solids concentration at which the particles are just touching, the drying rates for the latexes presented here did not decrease until 93.5 to 95.5% solids, depending on the particle size of the latex.

Table 5—Particle Size and Distribution of Latexes Produced from Recipes in Tables 1 and 2 for Drying Rates and Optical Clarity

Recipe	Particle Size Dn (nm)	Projected (nm)	Polydispersity (Dw/Dn)	Coefficient of Variation (%)
M2	206	—	1.035	10.5
M5[a]	305	313	1.033	10.5
M5[b]	454	464	1.029	9.6
M5[c]	690	690	1.025	8.9
M5[d]	1050	1049	1.010	5.9

(a) 206 nm seed.
(b) 305 nm seed.
(c) 454 nm seed.
(d) 1050 nm seed.

Dn=number average diameter
Dw=weight average diameter

These results fit a two-stage drying model,[44,45] which has also been found to give a good picture of the drying behavior of acrylic latexes.[46] During the first drying stage, evaporation occurs from a water surface that retreats through the film, away from the air boundary, as the drying progresses. The water in the shrinking wet layer in contact with the substrate supplies water to maintain a constant evaporation rate. Total water loss is directly proportional to time until this reservoir of water is depleted. The second falling rate period begins long after the particles have packed into an irreversible array.

The percolation model[44,45] implies that drying is complete before significant degrees of particle coalescence. It has been observed, however, that materials that coalesce more readily form a skin before the film is dry. It seems, therefore, that the newly formed coalesced films are sufficiently porous to allow essentially unimpeded transport of water.[46] The present results, with a different polymer, are consistent with this conclusion, since the addition of a coalescing agent did not affect the temporal development of a transparent film.

Close inspection of the curves at 95 to 100% water loss reveals similar trends to those seen with the UV/VIS spectrometer (*Figure* 10). The smaller particles take a much longer time to lose residual water. As the particle size increases, the residual water is lost more rapidly since the greater concentration of stabilizing moieties on the larger particles provides for better water transport.

Water as a Plasticizer

Another interesting aspect of the film formation of the "surfactant free" latexes is that, surprisingly, the MFFT values fall between the values for the 40EO and 4EO surfactants (*Figur*e 11, error ±5%). It was expected that the MFFT of the "surfactant-free" latex would be higher than that of the surfactant modified latexes since its T_g and, subsequently, its modulus is higher. Since the only other ingredient present was water, it was theorized that water must be plasticizing the latex.

The extent of water plasticization of latex polymers was examined using dynamic mechanical spectroscopy. The rheological behavior of a dry latex film was compared to that of a latex film which was soaked overnight in water (*Figure* 12). A one-percent strain was used since it allowed for the measurements to be done in the linear viscoelastic region. The upper curves for G′, G″, and tan δ indicate the modulus for the wet latex film while the dry films are indicated by the lower curves of each set. The reason G′ is higher for the wet latex is because the water in the wet latex is frozen at lower temperatures. As the temperature increases, the curves cross and G′ wet dips below G′ dry. This occurs since the water in the wet latex starts to melt above 0°C and plasticizes the latex.

The T_g of a partially dried latex was measured using DSC to verify the data obtained using dynamic mechanical spectroscopy. As illustrated in *Figure* 13, water significantly reduced the T_g of the latex. The lowest curve represents a latex with approximately five percent water. The large first order transition starting at approximately 0°C is indicative of the water melting. The second order transition, indicating the T_g of the latex, is at approximately 15°C for the lowest curve. As water is driven off, the size of the first order transition decreases (upper curves). The actual transition shifts to a lower temperature as the latex dries as well. This is probably due to a freezing point depression brought about by the higher concentration of initiator fragments and other ions which are soluble in the aqueous phase.[20]

The T_g of the latex polymer also changes as it dries. It slowly shifts to higher temperatures at lower water concentrations. The third curve from the top represents a latex where there is no discrete water phase (no first order transition indicating the melting of water). The T_g of the polymer has increased, but is still less than that of the completely dried latex (top two curves). Upon further drying, the T_g shifts to its final temperature at 26°C (second curve from the top). This compares well with the room temperature dried latex which has a T_g of 26°C as well (top curve).

The Fox equation[47] can be used to calculate the glass transition temperature (T_g) of the latex (T_g of poly(butyl acrylate) = –54°C, T_g of poly(vinyl acetate) = 32°C).

$$1/T_g = w_1/T_{gl} + w_2/T_{g2} \qquad (1)$$

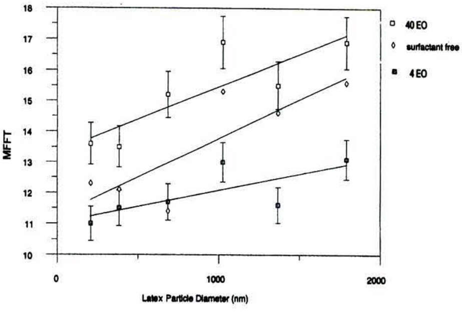


Figure 11—MFFT as a function of latex particle size of surfactant-free latexes and surfactant-free latexes blended with 4.8 wt% nonyl phenol ethoxylated surfactants based on polymer.

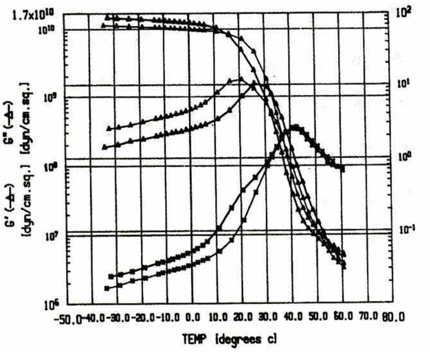


Figure 12—Dynamical mechanical properties of wet and dry vinyl acrylic latex films.

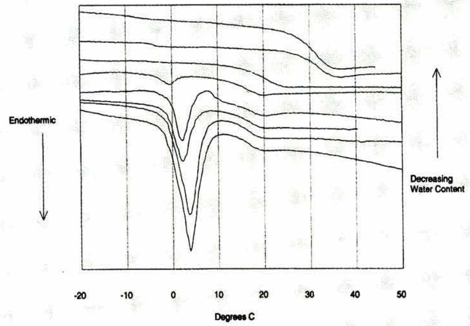


Figure 13—T_g as a function of water concentration in a vinyl acrylic latex.

The values for T_{g1} and T_{g2} are in Kelvin for the homopolymers while T_g is the T_g of the copolymer. The values for w_1 and w_2 are the weight fractions of each polymer in the copolymer. The calculated T_g is 15°C.

Recall that the water plasticized latex has a T_g of 15°C, which equals the calculated T_g, while the dried latex has a T_g of 26°C. The Fox equation is not a noticeably accurate predictor, but one can use the discrepancy noted to speculate, as follows, on the surface character of the latex particles. Apparently the highly polar and ionic portions of the latex which include initiator sulfate ions on the ends of the polymer chains, small amounts of hydrolyzed poly(vinyl acetate) (i.e., poly(vinyl alcohol)) and other products,[48-51] possess a high T_g when dry, and can associate[52] to form pseudo crosslinks raising the average T_g of the material. When water is present, the T_g is lowered since the water-soluble portions are solvated. It is suggested that water plasticization occurs significantly in the surface portions of the latex and to a lesser extent in the underlying polymer.

It is evident that major polymer types used for architectural coatings are plasticized by water. This is shown by earlier work[21,24] with acrylic latexes and more dramatically by this study of vinyl acrylics. Water plasticization should therefore be included in any mechanistic study of coalescence of these latex types.

Combining Water and Surfactant Effects

Upon further examination of the data presented in this paper, one can see that the MFFT of the surfactant-free latex resides between those of the materials containing 4EO and the 40EO surfactants. The coincidence is approximately with the 9EO surfactant modified latex. This is interesting in that all surfactant types reduced the T_g of the latex yet only the latexes modified with surfactants with ethylene oxide lengths below 9EO actually reduced the MFFT of the latex. The explanation is rather simple when one looks at the structure of the surfactants used. The shorter EO surfactants are more hydrophobic than the longer ones and thus migrate further into the latex particle, a thermodynamically favorable process studied and discussed by Bradford.[30] The longer EO surfactants extend further into the aqueous phase increasing the forces needed to cause the particles to come in contact with each other and coalesce.

The higher stabilizing ability of the longer EO surfactants was also evident in the storage stability of the wet latexes. The latexes formulated with 4EO and 6EO surfactants remained stable only one week while the latexes formulated with 20EO and 40EO surfactants were indefinitely stable.

A complementary or alternate reason for obtaining higher MFFTs with longer EO surfactants is that these surfactants are more hydrophilic than the shorter EO surfactants. This decreases the latex-water interfacial tension and thus reduces the force of coalescence, increasing the MFFT.

Thus, water plasticizes vinyl acrylic latexes decreasing T_gs and producing MFFTs which are significantly lower than the dry T_gs. Surfactants can either increase or decrease the MFFT depending on their relative ability to stabilize or plasticize latexes.

CONCLUSIONS

Water plays a large role in the film formation process of vinyl acrylic latexes. While many authors have considered the influence of water on the interfacial forces in latex film formation, not enough emphasis has been placed on its significance as a plasticizing agent. Clearly water plasticizes latexes and only wet viscoelastic moduli or T_gs should be used when modeling the film formation process.

A further influence in the film formation process is the type of stabilizer used. Ethoxylated nonyl phenol surfactants can plasticize polymer latex films. They also influence the MFFT of vinyl acrylic latexes by reducing the MFFT when ethoxylates of less than nine units in length are used. This is thought to be due to a plasticizing effect. While higher ethoxylates (20EO and 40EO) also plasticize latexes, the hydrophilic portion reduces the latex-water interfacial tension and increases the steric barrier to coalescence, thus increasing the MFFT.

Increases in the particle size of latexes increase the concentration of surfactants on the surface of latex particles when surfactants are added on an equal polymer weight basis. A higher steric and ionic barrier to coalescence and a lower latex-water interfacial tension is then produced on larger latex particles, and as a result, the MFFT increases. The type and concentration of stabilizer on the surface of latex particles can alter the MFFT, even in surfactant-free latexes. As a result, particle size effects on the film formation process cannot be assumed without prior knowledge of the surface stabilizing type and concentration.

The vinyl-acrylic latexes used in this study were monodisperse and were made without use of cellulosic stabilizers. These protective colloids are expected to undergo grafting and molecular weight degradation during the emulsion polymerization reaction. The presence of the products of such reactions on the latex particle surfaces will certainly exert an as yet undetermined effect on the coalescence and film properties of "real" vinyl acetate-butyl acrylic copolymer latexes. Drying rates of latexes are dependent on their stability. Vinyl acrylic latexes do not exhibit a reduction in drying rate until approximately 93.5% solids has been reached. The clarity of films produced from vinyl acrylic latexes increases with decreasing particle size to a maximum, and then decreases again. Clarity increase is due to the lowering of the surface stabilizer concentration on the particle surface, reducing surfactant domain size. The subsequent decrease of clarity from a maximum is attributed to the formation of surface defects in the film as it dries.

ACKNOWLEDGMENT

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JCT Spotlight

Introduction to POLYMERS & RESINS

Joseph R. Prane—Consultant*

According to the FSCT Coatings Encyclopedic Dictionary, *the term* resin *is generally applied "to a wide variety of more or less transparent and fusible products, which may be natural or synthetic . . . Higher molecular width synthetic resins are presently more generally referred to as* polymers.*" For coatings technologists, though, the definition is easily expressed in by the author of this article — "polymers are the heart of the coatings formulation." Mr. Prane introduces the topic of polymers and resins in this Spotlight. A more complete discussion can be found in his monograph, "Introduction to Polymers and Resins," which is part of the* FSCT Series on Coatings Technology.

*This Spotlight focuses briefly on this essential ingredient for coatings formulation. In addition, the Spotlight highlights the companies and products that supply resins to the coatings industry.**

** The company and product guides included here were compiled by individual companies' responses to a mail survey. The inclusion of companies and products in this guide should not be construed as an endorsement by the JCT or the Federation of Societies for Coatings Technology. JCT makes every effort to ensure that the information is accurate, but is not responsible for errors or omissions. Names appearing in bold type indicate advertisers in this issue.*

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INTRODUCTION

Importance of Polymeric Materials in the Coatings Industry

Polymers are chain-like molecules of high molecular weight (also called macromolecules); they are comprised of repeating structural units joined by covalent bonds. Polymers are built up from smaller, simpler molecules called monomers. A different monomer, or combination of monomers, is used to make each specific type or family of polymers used in the coatings and allied industries.

The term "resin" is often used to refer to any material in the polymeric state.[1] Originally, the use of the word resin was restricted to natural products, e.g., rosin (derived from pine trees or tall oil). However, it has become common to use the term to include synthetic macromolecules, particularly precursor polymers, such as epoxy resins and novolak phenolics. The latter are prepared from formaldehyde with excess phenol. These precursors are subsequently chemically reacted to produce industrially useful higher polymers.

Two other terms—binder and vehicle—are commonly used to describe the liquid portion of a paint or coatings composition that is used to bind (by dispersion) pigmentary materials, and to carry them in dispersion through subsequent stages of manufacture, storage, application, and performance. Polymers are almost always the major functional ingredient of binders and vehicles; they are present initially in the binder, or are formed during the subsequent drying or curing process.

Polymers are the heart of the coatings formulation. Their properties govern to a great extent the properties and performance of the finished coatings composition, e.g., hardness, strength, elongation, adhesion, chemical resistance, exterior durability, etc. Indeed, the improper choice of polymer and/or curing system can have adverse and drastic effects on the performance of coatings derived therefrom.

Brief History of Natural and Synthetic Polymers

Natural polymeric products, e.g., pitch, milk, egg white, gum arabic, and beeswax were known to the ancient Egyptians and Greeks. In combination with minerals, these products were used to prepare coating compositions for walls, burial chambers, etc. During the Middle Ages, linseed oil (from flax) began to be used by artists in painting.

The monk, Theophilus, in the 11th century, described the preparation ("cooking") of a varnish from linseed oil and a gum called "Fornis" (which may have been rosin or amber).[2] In 1773, in England, varnish compositions were published using copal and amber resins, with linseed, walnut, hempseed, and poppyseed oils, and with turpentine as the solvent. (Copal is a resin or gum derived from fossil exudation of trees. Amber is a form of resin from an extinct variety of pine tree.)

Imports into Europe from the Far East in the 17th century included tables and other wooden objects finished with Oriental lacquer (or Chinese lacquer).[3] This lacquering technique is believed to have been developed in China during the Chou dynasty (1169-255 B.C.). The functional basis for this lacquer is an unsaturated phenol, *Urushiol*, which is an ingredient of the sap of the Chinese tree, *Rhus Vernicifera*.

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* Elkins Park, PA.

This article is exerpted from "Introduction to Polymers and Resins," *FSCT Series on Coatings Technology*, Federation of Societies for Coatings Technology, Philadelphia, PA, 1986.

Until the beginning of the 20th century, man had done little to improve on the natural materials available to him for the production of protective coatings. Starting with the work of Dr. Leo Baekeland with phenolic resins in the early 1900s, the development of synthetic polymers for coatings proceeded rapidly. Much of the progress in synthetic polymers can be attributed to the pioneering work of Staudinger in Germany (1920), Carothers (1929) and Flory (1937) in the U.S.

Table 1 lists chronologically the approximate introduction dates of the most important synthetic polymers for coatings.[4,5] Key polymers listed are phenolics, alkyds, acrylics, epoxies, and urethanes; these polymers form the backbone of the coatings industry.

Table 2 lists most of the polymers currently used in coatings (often in combination with each other). Those which are of natural origin are so identified; the remainder are synthetic polymers. The list is large, but certainly not all-inclusive.

Table 1—Coatings Polymers—Milestone Events

Year	Polymer
1907	Phenol-formaldehyde resins patented
1912	Acrylic resins patented
1913	Rosin-modified phenolic resins
1915-1920	Other modified phenolic resins
1920	Nitrocellulose resins for lacquers
1921-1925	Alkyd resins Maleated rosin varnish grums
1926-1930	Oil soluble phenolic resins
1930	Chlorinated rubber
1930-1935	Urea formuladehyde resins, combined with alkyd resins Vinyl chloride polymers Oil-based emulsions for paints
1935	Polyvinyl butyral (in wash primers)
1940	Melamine formaldehyde resins
1941-1945	Styrenated, acrylated and cyclopentadiene-reacted oils
1944	Silicone resins and polymers
1946-1950	Styrene-butadiene polymers for emulsion paints Polyvinyl acetate for emulsion paints
1947-1950	Epoxy resins
1950	Unsaturated polyester resins
1951-1955	Epoxy/polyamide blends
1951	Acrylic polymers for emulsion paints
1954	Thixotropic alkyd resins
1955	Water soluble/dispersible thermosetting resins, (e.g., alkyds, acrylics)
1956-1960	Urethane oils and alkyds Thermoplastic acrylics—for lacquers Thermosetting acrylics—for enamels Silicone copolymers Powder coatings—fluidized bed patent
1961-1965	Epoxy, acrylic and other resins—anodic electrodeposition Fluoropolymers

TERMINOLOGY

Monomers

A polymer is built by the repetition of many small chemical/structural units linked together by covalent bonds.* The repeating unit is called a mer; therefore polymer = many mers. The monomer is the small molecule used as a starting material for the production of the polymer.

For example, to obtain the polymer poly(ethylene) (more commonly, but imprecisely called polyethylene), the unsaturated monomer ethylene, $CH_2 = CH_2$, is the starting material used. Many monomer units are tied together to form the long chain polymer.

$$—CH_2 — CH_2 — CH_2 — CH_2 — CH_2 —$$

The size of the chain in weight units (relative to H = 1) is the molecular weight or MW. In addition, the subscript n will be used to denote the number of monomer units polymerized and the degree of polymerization.

Table 3 shows examples of other simple polymer, mer, and monomer combinations.

Dimers are monomer molecules formed by the combination of two identical monomers, e.g.,

Table 2—Polymers Used in Coatings

Vegetable and marine oils[a]
Shellac[a]
Oleoresinous varnishes
Alkyd resins
Polyesters
Acrylic resins
Cellulosics
Maleic resins
Phenolic resins
Epoxy resins
Amino resins
Elastomers
Natural resins[a,b]
Pine-derived resins[a]
Petroleum resins[a]
Polyketones
Styrene resins
Vinyl chloride resins
Vinyl acetate resins
Polyvinyl acetals
Polyvinyl ethers
Silicones
Polyurethanes
Fluoropolymers
Polyamides
Polyolefins
Ionomers
Polybutadiene
Polyimides
Polyamide-imides
Polyester-imides

(a) Polymers of natural origin.
(b) For example, congo, kauri, copal, and manila gums.

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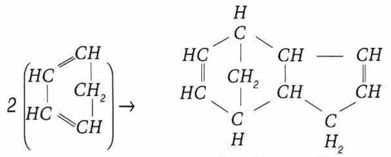
* Further information on the concept of bonds may be found in books on organic chemistry, e.g., *Organic Chemistry*, T.W.G. Solomons, John Wiley, New York (1976).

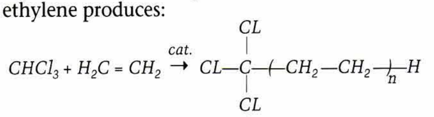


cyclopentadiene (monomer) ***dicyclopentadiene (dimer)***

Similarly, trimers are formed by the combination of three monomers.

Oligomers are low molecular weight (MW) polymers with 5-15 repeating monomer units; MW can range from 1000 to 3000.[6,7] These have become very important in the coatings industry, particularly for high solids and radiation curable coatings. Despite their small size, oligomers are more complex than single monomer combinations. Oligomers are usually end-capped with functional groups which can be further reacted with other functional groups (e.g., isocyanates) to give higher polymers with desirable properties. Common oligomers are based on acrylics, urethanes, polyesters, alkyds, and epoxies.

Telomers are reaction products of unsaturated, polymerizable monomers, e.g., ethylene, with the fragments of another molecule (called telogen) such as benzene, isobutylene, or chloroform. In this catalyzed reaction, the telogen is fragmented by the splitting off of a hydrogen atom. For example, the reaction of chloroform and ethylene produces:



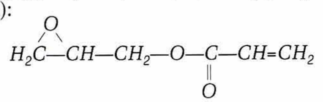
$$CHCl_3 + H_2C = CH_2 \xrightarrow{cat.} CL-\overset{CL}{\underset{CL}{C}}-(CH_2-CH_2)_n-H$$

where $n = 1.5$

telomer

1. Functionality: A functional group on a monomer is the particular arrangement of atoms in a molecule which is capable of undergoing a polymerization reaction. The functionality of a monomer molecule is then the number of functional groups per molecule. Some examples are given in *Table* 4. The concept of functionality is widely used in designing condensation polymers.

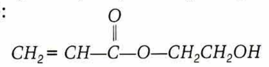
2. Monomers with More than One Functional Group: Ethylene, $CH_2 = CH_2$, has one functional group, — CH = CH —, but a functionality of two (because of the double bond) which allows it to undergo vinyl polymerization. Many monomers are available with more than one functional group, thus opening up the possibility of polymerization or further reaction by a variety of mechanisms. For example, acrylic monomers are available with glycidyl end groups, e.g., glycidyl acrylate (GA) and glycidyl methacrylate (GMA):



glycidyl acrylate

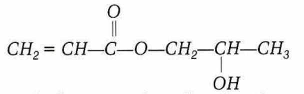
This monomer can be polymerized through the — CH = CH — double bonds, and further reacted, e.g., with polyamines or polyamides, to form cured epoxy structures. Several thermosetting acrylic polymer compositions contain these monomers.

Other difunctional acrylic monomers include the hydroxy alkyl acrylates (HAA) and hydroxyalkyl methacrylates (HAMA):



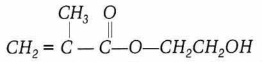
$$CH_2 = CH-\overset{O}{\overset{\|}{C}}-O-CH_2CH_2OH$$

hydroxyethyl acrylate (HEA)



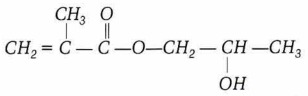
$$CH_2 = CH-\overset{O}{\overset{\|}{C}}-O-CH_2-\underset{OH}{\underset{|}{CH}}-CH_3$$

hydroxypropyl acrylate (HPA)



$$CH_2 = \overset{CH_3}{\overset{|}{C}}-\overset{O}{\overset{\|}{C}}-O-CH_2CH_2OH$$

hydroxyethyl methacrylate (HEMA)

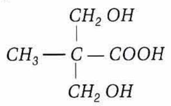


$$CH_2 = \overset{CH_3}{\overset{|}{C}}-\overset{O}{\overset{\|}{C}}-O-CH_2-\underset{OH}{\underset{|}{CH}}-CH_3$$

hydroxypropyl methacrylate (HPMA)

These are used extensively in thermosetting acrylic polymers where the hydroxyl functionality is coupled to melamine formaldehyde resins during bake. They are also used to provide acrylic end-caps to urethane, epoxy, and acrylic oligomers to form bases for radiation curing.

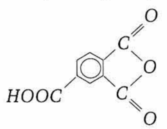
(a) *Dimethylol Propionic Acid* (DMPA)—



$$CH_3-\overset{CH_2OH}{\underset{CH_2OH}{C}}-COOH$$

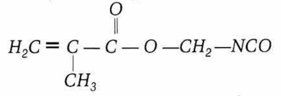
This hydroxy acid can be condensed through the OH groups, with polybasic acids to form alkyd resins or polyesters, leaving the carboxyl group (—COOH) available on the chain for further reaction. Such reaction would include neutralization with ammonia or amines to form water-soluble or dispersible polymers.

(b) *Trimellitic Anhydride* (TMA)—



TMA can also be used to make water-soluble alkyds and polyesters. Although it is trifunctional in acid, the anhydride ring opens more rapidly for condensation reactions, leaving the COOH group available for neutralization.

c) *Isocyanatoethyl Methacrylate* (IEM)[8]—



$$H_2C = \underset{CH_3}{\underset{|}{C}}-\overset{O}{\overset{\|}{C}}-O-CH_2-NCO$$

IEM is a new difunctional monomer with a reactive isocyanate (NCO) group and a vinyl polymerizable double bond. The chemistry of either functionality may be carried on independently without affecting the latent utility of the other group. As such, it has become useful in coatings compositions combining urethane and acrylic chemistry.

Polymers—General

A molecule is usually considered a polymer if it is built up from repeating units and the degree of polymerization, or n, is at least 10. For example, for ethyl acrylate (MW = 100), the polymer of ethyl acrylate at n = 10 would have a MW = 1000. High molecular weight polymers or macromolecules have MW in excess of 10,000; some emulsion polymerized acrylate polymers used in the coatings industry has MW in excess of 1,000,000.*

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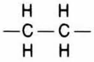
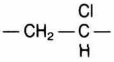
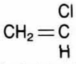
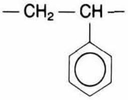
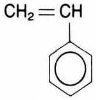
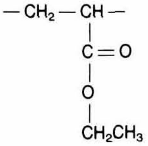
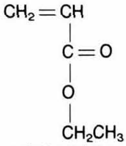
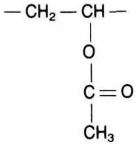
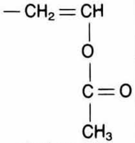
* Some authors prefer to use a value of n=50, since polymer chain entanglement does not occur until an MW greater than 1500 is attained.

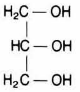
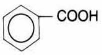
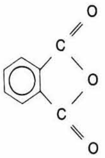
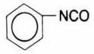
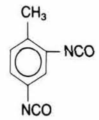
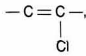
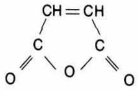
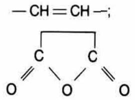
Table 3—Examples of Mers and Monomers in Some Linear Polymers

Polymer	Mer	Monomer
Polyethylene	 $-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-$	$CH_2=CH_2$ ethylene
Polyvinyl chloride	 $-CH_2-\overset{Cl}{\underset{H}{C}}-$	 $CH_2=\overset{Cl}{\underset{H}{C}}$ vinyl chloride
Polystyrene		 styrene
Polyethyl acrylate	 $\begin{array}{ll} -CH_2- & CH- \\ & \vert \\ & C=O \\ & \vert \\ & O \\ & \vert \\ & CH_2CH_3 \end{array}$	 $\begin{array}{ll} CH_2= & CH \\ & \vert \\ & C=O \\ & \vert \\ & O \\ & \vert \\ & CH_2CH_3 \end{array}$ ethyl acrylate
Polyvinyl acetate	 $\begin{array}{ll} -CH_2- & CH- \\ & \vert \\ & O \\ & \vert \\ & C=O \\ & \vert \\ & CH_3 \end{array}$	 $\begin{array}{ll} -CH_2= & CH \\ & \vert \\ & O \\ & \vert \\ & C=O \\ & \vert \\ & CH_3 \end{array}$ vinyl acetate

 = Benzene Ring—Conjugated Unsaturation (O)

= Cyclohexane Ring—Saturated (S)

Table 4—Functionality—Functional Groups

Molecule	Formula	Functional Group	Functionality
Ethanol	CH_3CH_2OH	$-OH$	1
Ethylene glycol	$HOCH_2CH_2OH$	$-OH$	2
Glycerin	 $\begin{array}{l} H_2C-OH \\ \;\vert \\ HC-OH \\ \;\vert \\ H_2C-OH \end{array}$	$-OH$	3
Benzoic acid		$-COOH$	1
Phthalic anhydride		$-COOH$	2
Phenyl isocyanate		$-NCO$	1
Toluene diisocyanate		$-NCO$	2
Vinyl chloride	$CH_2=CHCl$	 $-C=\underset{\underset{Cl}{\vert}}{C}-,$	2
Ethylene	$CH_2=CH_2$	$-CH=CH-$	2
Butadiene	$CH_2=CH-CH=CH_2$	$-CH=CH_2$	4
Maleic anhydride			4

It is important to stress that most polymers used in coatings are not uniform in molecular species composition. They usually consist of a mixture of polymer molecules with different MW.

Three different basic types of polymer architecture have been distinguished:

(1) Linear (or straight chain) polymers. Here, the mers are united by covalent bonds to form chains without branches.

(2) Branched polymers. Mers are linked into chains which contain branch points, from which side chains (built up from additional mers) can grow out.

(3) Network (or crosslinked) polymers. These are originally linear or branched polymers where the chains and/or branches have been joined together by a plurality of chemical crosslinks, e.g., by heat, chemical reagents, or by other means. Network structures are in three-dimensional form.

Figure 1 illustrates these three types of polymers.[9] Since the atoms in the chains are connected in angular configurations (e.g., the C–C bonds), the polymer chains have a certain freedom of motion. Therefore, the polymer chains will not have the stiff, straight shape shown in *Figure* 1a, but will be more like the zig-zag shape shown in *Figure* 1b. In addition, since bond rotation is in three planes (unless restricted, for example, by double bonds or by steric hindrance), the actual configurations are three-dimensional.[10]

Most linear polymers are thermoplastic. Upon raising their temperature, the polymers soften and can flow or deform under gravity or mechanical forces; the original solid state is regained on cooling. Thermoplastic polymers are also soluble in suitable solvents.

In contrast, network polymers, because of the covalent bonds involved in the cohesion of the chains, are not soluble in most solvents, do not flow with temperature increase, and do not deform under moderate mechanical force. In this state, they are often called thermosetting polymers. This latter term is also used for functional oligomers and polymers which are thermoplastic as such,

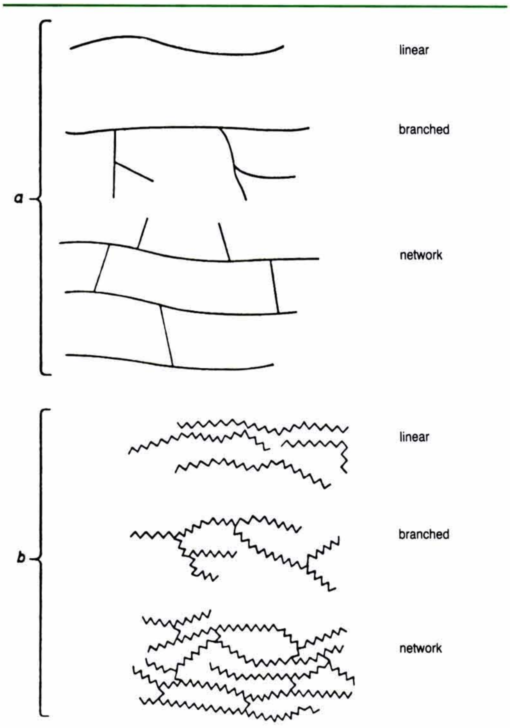


Figure 1—Three basic types of polymers.[9]

but which can be converted to the thermoset form by suitable post-treatment.

In addition to the general characteristics that polymers possess due to their molecular architecture, they will have specific properties depending on the chemical nature of the linkages in the chain, the nature of end groups and branch groups, and the types of curing agents (if any) used in the formulation of the ultimate coating. For example, polymers containing exclusively —*C*—*C*— (e.g., polyolefins) or —*C* —*O* — *C* — (e.g., polyethers) bonds will be generally resistant to hydrolysis or saponification. Polymers containing esters groups, $-\overset{\overset{O}{\|}}{C}-O-C-$, as building units (such as alkyds and polyesters) are susceptible to hydrolysis unless they are further modified. Polymers containing functional groups (such as acrylate, hydroxyl, and isocyanate) can be further reacted by several methods to yield useful coating compositions and films; among these methods are radiation cure or reaction with suitable functional monomers or oligomers.

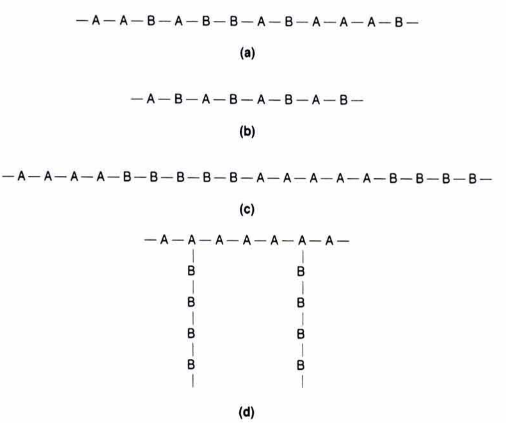


Figure 2—Copolymer Types[11]: (a) random copolymer; (b) alternating copolymer; (c) block copolymer; and (d) graft copolymer.

Homopolymers, Copolymers

Homopolymers consist of repeating structural units of the same kind (disregarding end or terminal units or groups); examples include polyvinyl chloride (PVC) and linear polyethylene.

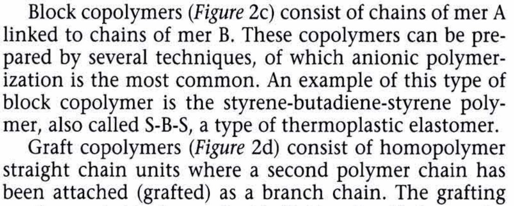
Copolymers are those prepared from two distinct mers or structural units, e.g., the copolymer of vinyl acetate and ethyl acrylate.

Terpolymers are prepared from three mers, e.g., the terpolymer of vinyl acetate, ethylene, and acrylic acid. (Higher species, e.g., tetrapolymers, etc., are possible using four or more mers in their preparation).

Depending on the monomers chosen, their reactivity ratios, and the processing methods used, various distributions of structural units within the polymer chain may be achieved. Several possible copolymer arrangements of two mers, A and B, are shown in *Figure* 2.[11]

Random copolymers (*Figure* 2a) result when the mers combine in no set order. Many commercial polymers of this type are available; these are based mostly on vinyl monomers and/or conjugated dienes, e.g., poly(vinyl chloride-vinyl acetate), styrene-butadiene copolymer.

Truly alternating copolymers (*Figure* 2b) are rare in the coatings industry. The best known example is the copolymer made from the free radical copolymerization of equimolar mixtures of maleic anhydride and styrene. The structure then corresponds to (b) in *Figure* 2:



Block copolymers (*Figure* 2c) consist of chains of mer A linked to chains of mer B. These copolymers can be prepared by several techniques, of which anionic polymerization is the most common. An example of this type of block copolymer is the styrene-butadiene-styrene polymer, also called S-B-S, a type of thermoplastic elastomer.

Graft copolymers (*Figure* 2d) consist of homopolymer straight chain units where a second polymer chain has been attached (grafted) as a branch chain. The grafting can be created by free radical initiation, irradiation, or by chemical means. Several examples of graft copolymers exist in the coatings industry, e.g., styrenated alkyds, epoxy-acrylic graft copolymers.

SUMMARY

In the future, it is unlikely that any radically new monomers will be developed for commercial exploitation. However, new polymerization processes will be forthcoming from worldwide research and development efforts, following such developments as group transfer polymerization and interpenetrating networks, as are discussed further in the monograph, "Introduction to Polymers and Resins."

Semiconductor and computer technology advances will bring further improvements to the many instrumental methods of polymer characterization.

The science of polymers and polymerization has been brought forward to the point where polymers can be designed for specific properties and performance—with molecular architecture that can be predicted and reproduced with precision. The coatings industry has been and will continue to be a major beneficiary of this advanced technology.

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(1) Saunders, K.J., *Organic Polymer Chemistry*, London: Chapman and Hall, 1973, p. 1.

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(3) Nylén, P. and Sunderland, E., *Modern Surface Coatings*. New York: Wiley-Interscience, 1965, pp. 5, 146.

(4) Nylén, *op. cit.*, p. 6.

(5) Craver, *op. cit.*, p. 21.

(6) Boatwright, J.H., "Chicago Society Defines Oligomers," JOURNAL OF COATINGS TECHNOLOGY, *52*, No. 664, 124 (1980).

(7) Noren, G.K., "High-Solids Coatings: Research in Oligomer Engineering," *Polymer News*, *10*, No. 2, 39 (1984).

(8) Thomas, M.R., "Isocyanatoethyl Methacrylate," American Chemical Society, Division of Organic Coatings and Plastics Chemistry, *Preprint Book*, *46*, 506 (March 1982); Regulski, T. and Thomas, M.R., "Isocyanatoethyl Methacrylate II," *48*, 998 (March 1983).

(9) Nylén, *op. cit.*, p. 28.

(10) Saunders, *op. cit.*, p. 28.

(11) *Ibid.*, p. 31.

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In addition to serving as an adjunct Professor of Chemical Engineering at the Polytechnic Institute of New York, Mr. Prane has authored over 30 papers on coatings, sealants, adhesives, elastomer coagents, and statistical methods. He has presented many of these papers at technical meetings in the U.S. and abroad.

Mr. Prane received a B.S. Degree from the City College of New York and a Master's Degree in Chemical Engineering from Columbia University.

He is a member of the Philadelphia Society for Coatings Technology.

RESINS SPOTLIGHT: Source Guide

	ACRYLIC RESINS	ALKYD RESINS	AMINO RESINS	BITUMES	CELLULOSE DERIVATIVES	EPOXY HARDENERS	EPOXY RESINS	ESTER GUMS	HIGH-SOLID RESINS	HYBRID RESINS	HYDROCARBON RESINS	MALEIC RESINS	MELAMINE/ MELAMINE TYPE	MISC. TYPE RESINS	NATURAL
ADM Tronics, Inc.	X														
Akzo Nobel Resins	X	X	X				X	X	X			X	X		
Allied Colloids	X														
American Casein Company		X	X												
Arizona Chemicals												X			
Atomergic Chemetals					X										
BASF Corporation	X					X			X						
Bayer Corporation	X								X						
Cardolite Corporation						X									
CIBA						X	X		X						
Cook Composites and Polymers	X	X				X	X		X	X		X	X		
CYTEC			X						X				X		
Daubert Chemical							X								
The Degen Co.		X													
Dover Chemical Corp.											X				
The Dow Chemical Company	X						X								
Dow Corning Corp.		X													
DSM Resins U.S.			X												
Engineered Polymer Solutions	X	X							X					X	
Etna Products, Inc.															
H.B. Fuller Company	X														
GE Silicones									X						
GE Specialty Chemicals														X	
GEORGIA PACIFIC															
BFGoodrich	X														
Goodyear Tire & Rubber	X										X				
Hoechst Celanese Corp.	X	X	X			X	X						X	X	
Hüls	X					X									
International Specialty Products												X			
S.C. Johnson Polymer	X														
Kenrich Petrochemicals						X					X				
Kraft Chemical Company						X									
Lawter International	X	X							X		X				
Lonza, Inc.						X						X	X	X	

NITROCELLULOSE	OLEORESINOUS VARNISH	PHENOLIC RESINS	POLYAMIDE RESINS	POLYBUTENES	POLYESTER RESINS	POLYETHYLENE RESINS	POLYPROPYLENE RESINS	ROSIN ESTERS	ROSIN SALTS	SILICONE RESINS	STYRENE RESINS	TERPENES	TGIC RESINS	UV CURING RESINS	UREA RESINS	URETHANE LACQUERS	URETHANE/POLYURETHANE	VINYL RESINS	WATER-THINNED
																			X
	X				X			X		X	X				X		X		X
											X								
			X																X
		X						X				X							
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		X				X	X										X		X
					X	X	X			X									
														X				X	
											X								
																	X		
			X		X			X											
			X																

RESINS SPOTLIGHT: Source Guide

	ACRYLIC RESINS	ALKYD RESINS	AMINO RESINS	BITUMES	CELLULOSE DERIVATIVES	EPOXY HARDENERS	EPOXY RESINS	ESTER GUMS	HIGH-SOLID RESINS	HYBRID RESINS	HYDROCARBON RESINS	MALEIC RESINS	MELAMINE/ MELAMINE TYPE	MISC. TYPE RESINS	NATURAL
Lorama Chemicals, Inc.														X	X
Mantrose Haeuser Co.															X
McWhorter Technologies	X	X	X				X		X				X		
Morton International	X								X						
Nacan Products Limited	X														
Neville Chemical Company											X				
Ohio Polychemical	X	X					X		X					X	
Peninsula Polymers	X	X	X			X	X		X	X	X		X		
Petrolite Corp.												X			
Phenoxy Associates							X		X	X				X	
K.J. Quinn & Co., Inc.															
Ranbar Technology Inc.		X					X		X					X	
Reichhold															
Rhone-Poulenc, Inc.														X	
Rohm and Haas Company	X														
Ruco Polymer Corp.														X	
Schenectady Canada Ltd.		X					X		X					X	
Scott Bader Inc.	X														
Sentry/Custom Services Corp.	X		X										X		
Shell Chemical Company	X					X	X		X						
Summit Precision Polymers Corp.														X	
U.S. Polymers, Inc.		X					X	X	X			X			
Union Carbide	X						X								
United Mineral & Chemical							X								
Van Waters & Rogers	X														
Wabash Gilsonite Blends															X
Wacker Silicones Corp.															
Witco Corp.							X								
Zeneca Resins	X														

NITROCELLULOSE	OLEORESINOUS VARNISH	PHENOLIC RESINS	POLYAMIDE RESINS	POLYBUTENES	POLYESTER RESINS	POLYETHYLENE RESINS	POLYPROPYLENE RESINS	ROSiN ESTERS	ROSIN SALTS	SILICONE RESINS	STYRENE RESINS	TERPENES	TGIC RESINS	UV CURING RESINS	UREA RESINS	URETHANE LACQUERS	URETHANE/POLYURETHANE	VINYL RESINS	WATER-THINNED
					X														
											X								
			X		X						X		X		X		X		
					X														X
		X			X					X	X			X					X
										X							X	X	
					X								X				X		
											X							X	
																			X
	X	X			X			X			X								
													X						
																	X		

RESINS: supplier listing

ADM Tronics Unlimited, Inc.
224-S Pegasus Ave.
Northvale, NJ 07647
Phone: (201) 767-6040
Fax: (201) 784-0620
Acrylic Resins
Water-Thinned Resins

Akzo Nobel Resins
1845 Maxwell Street
Troy, MI 48084
Phone: (313) 637-0400
Fax: (313) 649-7367
Acrylic Resins
Alkyd Resins
Amino Resins
Epoxy Resins
Ester Gums
High-Solid Resins
Maleic Resins
Melamine & Melamine Type Resins
Oleoresinous Varnishes
Polyester Resins
Silicone Resins
Styrene Resins
Urea Resins
Urethane & Polyurethane Resins
Water-Thinned Resins

Allied Colloids, Inc.
P.O. Box 820
2301 Whilroy Rd.
Suffolk, VA 23439-0820
Phone: (757) 538-3700
Fax: (757) 538-0204
Dana Field, Sales
Acrylic Resins
Styrene Resins

American Casein Co.
109 Elbow Ln.
Burlington, NJ 08016
Phone: (609) 387-3130
Fax: (609) 387-7204
Robert E. Ball, Technical Sales
Alkyd Resins
Amino Resins
Polyamide Resins
Water-Thinned Resins

Aqualon
1313 Market St.
Wilmington, DE 19894-0001
Phone: (302) 594-6000
Fax: (302) 594-6660

Arizona Chemicals Co.
1001 E. Business Hwy. 98
Panama City, FL 32401
Phone: (904) 785-6700
Fax: (904) 785-2203
J.B. Stanbury
Maleic Resins
Phenolic Resins
Rosin Esters
Terpenes

Ashland Chemical, Inc.
P.O. Box 2219
Columbus, OH 43216
Phone: (614) 790-3333
Fax: (614) 790-3426

Atomergic Chemetals Corp.
222 Sherwood Ave.
Farmingdale, NY 11735-1718
Phone: (516) 694-9000
Fax: (516) 694-9177
M. Samuels, Product Mgr.
Cellulose Derivatives

BASF Corp.
11501 Steele Creek Rd.
Charlotte, NC 28273
Phone: (704) 588-5820
Fax: (704) 587-8157
Wolfgang Boertz, Business Mgr.
Acrylic Resins
Epoxy Hardeners—Chemicals
High-Solid Resins
Styrene Resins
Ultraviolet Curing Resins

Bayer Corporation
100 Bayer Rd.
Pittsburgh, PA 15205-9741
Phone: (412) 777-3845
Fax: (412) 777-2940
D. Barr, Vice President, Automotive; C. Dearth, Vice President, Maintenance & Government; R. Sabatine, Dir., Marketing & Customer Service.; J. Williams, Vice President, Industrial Finishing & Resins
Acrylic Resins
High-Solid Resins
Polyester Resins
Ultraviolet Curing Resins
Urethane & Polyurethane Resins
Urethane Lacquers
Water-Thinned Resins

Cardolite Corp.
500 Doremus Ave.
Newark, NJ 07105
Phone: (201) 344-5015
Fax: (201) 344-1197
Deirdre Igo, Marketing Communications Mgr.; Tony Stortis, President; Paul Mike Nowak, Account Mgr.; Ken Sielski, Account Mgr.; Jim Dae, Technical Director
Epoxy Hardeners-Chemicals

CCP
919 E. 14th Ave.
P.O. Box 419389
Kansas City, MO 64116
Phone: (816) 391-6000
Fax: (816) 391-6337
Mike Kaza, Business Mgr., Coatings Resins; Jane Stadler, Product Mgr.
Acrylic Resins
Alkyd Resins
Epoxy Hardeners-Chemicals
Epoxy Resins
High-Solid Resins
Hybrid Resins
Maleic Resins
Melamine & Melamine Type Resins
Oleoresinous Varnishes
Polyamide Resins
Polyester Resins
Silicone Resins
Styrene Resins
Urethane & Polyurethane Resins
Urethane Lacquers
Vinyl Resins

Ciba/Polymer Division
281 Fields Lane
Brewster, NY 10509
Phone: (914) 785-3315
Fax: (914) 785-3470
Peter Chetcuti, Marketing Mgr.; Gustavo Lescano, Marketing Mgr.; Bob Miller, Marketing Mgr.; Rick Irizarry, Marketing Mgr.
Epoxy Hardeners-Chemicals
Epoxy Resins
High-Solid Resins
Phenolic Resins
Polyamide Resins
TGIC Resins

Cytec Industries, Inc.
Five Carret Mountajn Plaza
W. Paterson, NJ 07424
Phone: (201) 357-3276
Fax: (201) 357-3065
Amino Resins
High-Solic Resins
Melamine & Melamine Type Resins
Urea Resins
Urethane & Polyurethane Resins

Daubert Chemical Co., Inc.
4700 S. Central Ave.
Chicago, IL 60638
Phone: (708) 496-7350
Fax: (708) 496-7367
Mike Dwyer, President
Epoxy Resins

The Degen Co.
200 Kellogg St.
P.O. Box 5240
Jersey City, NJ 07305
Phone: (201) 432-1192
Fax: (201) 432-8483
Gerald Sullivan, Sales Mgr.
Alkyd Resins
Oleoresinous Varnishes

Dover Chemical Corp.
3676 Davis Rd., NW
Dover, OH 44622
Phone: (800) 321-8805
Fax: (330) 364-1579
Dave Schlarb, Marketing Mgr.; Don Stevenson, Vice President, R & D
Hydrocarbon Resins

The Dow Chemical Company
2040 Dow Center
Midland, MI 48630
Phone: (517) 636-1996
Fax: (517) 638-9752
Acrylic Resins
Epoxy Resins
Styrene Resins

Dow Corning Corp.
P.O. Box 0994
Midland, MI 48686-0994
Phone: (517) 496-4000
Fax: (517) 496-4821
Alkyd Resins
Silicone Resins

DSM Resins U.S., Inc.
Augusta Riverfront Ctr-Ste. 580
One 10th St.
Augusta, GA 30901
Phone: (706) 849-6716
Fax: (706) 849-6777
Amino Resins
Phenolic Resins
Polyester Resins
TGIC Resins
Urethane & Polyurethane Resins

Engineered Polymer Solutions, Inc.
1400 N. State St.
Marengo, IL 60152
Phone: (815) 568-4140
Fax: (815) 568-4145
Steve Lindberg, President; Ken Stewart, Operations Mgr.; Bruce Johnson, Technical Director
Acrylic Resins
Alkyd Resins
High-Solid Resins
Misc. Type Resins
Oleoresinous Resins
Polyester Resins
Styrene Resins
Urethane & Polyurethane Resins
Vinyl Resins
Water-Thinned Resins

Etna Products Inc., Specialty Chemicals Division
P.O. Box 630
16824 Park Circle Dr.
Chagrin Falls, OH 44022
Paul S. Beaudry, Sales Mgr.; Mark Messerly, Lab. Mgr.
Polyester Resins

H.B. Fuller Co.
3530 Lexington Ave., N.
St. Paul, MN 55126
Phone: (612) 481-1809
Fax: (612) 481-1828
Tom Kuzara, Industry Mgr.; Stew Anderson, Industry. Mgr.; Tom Shomion, General Mgr.
Acrylic Resins
Vinyl Resins

GE Silicones
260 Hudson River Rd.
Waterford, NY 12188
Phone: (518) 233-3251
Fax: (518) 233-3931
Rob Zillioux, Industry Mgr., Label Systems
High-Solid Resins
Silicone Resins

GE Specialty Chemicals
501 Avery St.
Parkersburg, WV 26102
Phone: (304) 424-5698
Fax: (304) 424-5871
Dan Fox, Blendex Product Mgr.; Gina Ham, Phosphite Product Mgr.
Misc. Type Resins
Phenolic Resins

Georgia-Pacific Resins, Inc.
2883 Miller Rd.
Decatur, GA 30035
Phone: (800) 765-7374
Fax: (800) 395-6885
Rich Stregowski, Marketing Mgr.
Phenolic Resins

BFGoodrich Co., Specialty Chemicals
9911 Brecksville Rd.
Cleveland, OH 44141-3247
Phone: (216) 447-5000
Fax: (216) 447-5770
John J. Falsone, Sr., Marketing Mgr.; Jim F. Papenfuss, Marketing Mgr.
Acrylic Resins
Styrene Resins
Urethane Lacquers
Urethane & Polyurethane Resins
Vinyl Resins
Water-Thinned Resins

The Goodyear Tire & Rubber Co.
1144 E. Market St.
Akron, OH 44316
Phone: (330) 796-6401
Fax: (330) 796-2617
Amy Cullahan, Distributor Liaison
Acrylic Resins
Hydrocarbon Resins
Styrene Resins

Hoechst Celanese Corporation
4331 Chesapeake Dr.
Charlotte, NC 28216-3410
Phone: (704) 559-6737
Fax: (704) 559-6699
Allen Slocki, Technical/Marketing Mgr.; Mike O'Shaughnessy, National Sales Mgr.
Acrylic Resins
Alkyd Resins
Amino Resins
Epoxy Hardeners-Chemicals
Epoxy Resins
Melamine & Melamine Type Resins
Phenolic Resins
Urethane & Polyurethane Resins
Water-Thinned Resins

Hoechst Celanese Specialty Polymers
86 Morris Ave., Bldg. I
Summit, NJ 07901
Phone: (908) 522-7708
Fax: (908) 522-7880
Misc. Type Resins
Polyethylene Resins
Polypropylene Resins

Hüls America Inc.
220 Davidson Ave.
Somerset, NJ 08873
Phone: (908) 560-6800
Acrylic Resins
Epoxy Hardeners—Chemicals
Nylon Resins
Polyester Resins
Polyethylene Resins
Polypropylene Resins
Silicone Resins

International Specialty Products (ISP)
1361 Alps Rd.
Wayne, NJ 07470
Phone: (201) 628-4000
Fax: (201) 628-3825
Van Rhonherimer, Vice President Worldwide Marketing; Sotini Papoulias, Marketing Director; Ellen Werner, Marketing Director; Phil Wolf, R & D Director
Maleic Resins
Ultraviolet Curing Resins
Vinyl Resins

S.C. Johnson Polymer
1525 Howe St.
Racine, WI 53403-2236
Phone: (414) 631-4353
Fax: (414) 631-4079
Acrylic Resins
Styrene Resins

Kenrich Petrochemicals, Inc.
140 E. 22nd Street
P.O Box 32
Bayonne, NJ 07002-0032
Phone: (201) 823-9000
Fax: (201) 823-0691
Epoxy Hardeners-Chemicals
Hydrocarbon Resins

Kraft Chemical Co.
1975 N. Hawthorne Ave.
Melrose Park, IL 60160
Phone: (708) 345-5200
Fax: (708) 345-4005
Ron Weiland, Sales Mgr.
Epoxy Hardeners-Chemicals
Urethane & Polyurethane Resins

Lawter International
990 Skokie Blvd.
Northbrook, IL 60062
Phone: (847) 498-4700
Fax: (847) 498-0066
Dan DeLeagge, General Mgr. Resins; Henry Brooks, General Mgr. Vehicles
Acrylic Resins
Alkyd Resins
High-Solid Resins
Hydrocarbon Resins
Polyamide Resins
Polyester Resins
Rosin Esters

Lonza, Inc.
7-33 Amsterdam St.
Newark, NJ 07105
Phone: (201) 405-0023
Robert J. Narsavage, Mgr. Marketing and Sales
Epoxy Hardeners—Chemicals
Epoxy Resins
Maleic Resins
Melamine & Melamine Type Resins
Misc. Type Resins
Polyamide Resins

RESINS: supplier listing

Lorama Chemicals, Inc.
3643 Boxelder Dr.
Brecksville, OH 44141-2579
Phone: (216) 526-0264
Fax: (216) 526-0246
Pat Amiel, President; Marga Holtzheimer
- Misc. Type Resins
- Natural Resins
- Polysaccharide Resins
- Water-Thinned Resins

Mantrose Haeuser Co., Inc.
1175 Post Rd., E.
Westport, CT 06880
Phone: (203) 454-1800
Fax: (203) 221-7877
Jim Karlson, Tech. Serv. Rep.; Jody Ramik, Tech. Serv. Rep.
- Natural Resins

McWhorter Technologies
400 E. Cottage Place
Carpentersville, IL 60110
Phone: (847) 428-2657
Fax: (847) 428-2653
- Acrylic Resins
- Alkyd Resins
- Amino Resins
- Epoxy Resins
- High-Solid Resins
- Melamine & Melamine Type Resins
- Phenolic Resins
- Polyester Resins
- Styrene Resins
- Ultraviolet Curing Resins
- Vinyl Resins
- Water-Thinned Resins

Morton International
2701 E. 170th St.
Lansing, IL 60648
Phone: (800) 232-6567
Fax: (708) 868-7485
Margaret A. Ciez, Business Mgr.; Raja Ponnaganti, Resin Chemist
- Acrylic Resins
- High-Solid Resins
- Polyester Resins

Nacan Products Ltd.
60 West Dr.
Brampton, ON L6T 4W7
Canada
Phone: (905) 454-4466
Fax: (905) 454-3401
- Acrylic Resins
- Vinyl Resins

Neville Chemical Co.
2800 Neville Rd.
Pittsburgh, PA 15225
Phone: (412) 331-4200
Fax: (412) 777-4234
Joe Bertucci, Technical Coordinator
- Hydrocarbon Resins
- Styrene Resins

Ohio Polychemical Co.
1920 Leonard Ave.
P.O. Box 369004
Columbus, OH 43219
Phone: (614) 253-8511
Fax: (614) 253-6327
Dick Olson, V.P. General Mgr.; Penny Askew, Product Mgr.; Arnie Mohar, Technical Director
- Acrylic Resins
- Alkyd Resins
- Epoxy Resins
- High-Solid Resins
- Misc. Type Resins
- Phenolic Resins
- Polyester Resins
- Silicone Resins
- Styrene Resins
- Urethane & Polyurethane Resins
- Water-Thinned Resins

Peninsula Polymers
9401 Indian Creek Pkwy., Ste. 730
Overland Park, KS 66210
Phone: (913) 498-3777
Fax: (913) 498-3888
- Acrylic Resins
- Alkyd Resins
- Amino Resins
- Epoxy Hardeners-Chemicals
- Epoxy Resins
- High-Solid Resins
- Hybrid Resins
- Hydrocarbon Resins
- Melamine & Melamine Type Resins
- Polyamide Resins
- Polyester Resins
- Styrene Resins
- TGIC Resins
- Urea REsins
- Urethane & Polyurethane Resins

Petrolite Corp., Polymers Div.
6910 E. 14th Street
Tulsa, OK 74112
Phone: (800) 331-5516
Fax: (918) 834-9718
- Maleic Resins
- Polyethylene Resins

Phenoxy Associates
800 Cel River Rd.
Rock Hill, SC 29730
Phone: (803) 328-3825
Fax: (803) 328-3827
Stephen M. Lustig, Commercial Director; Mark Huang, Technical Mgr.
- Epoxy Resins
- High-Solid Resins
- Hybrid Resins
- Misc. Type Resins
- Polyester Resins
- Water-Thinned Resins

K.J. Quinn & Co., Inc.
135 Folly Mill Rd
Seabrook, NH 03874
Phone: (603) 474-7177
Fax: (603) 474-9170
- Urethane & Polyurethane Resins
- Urethane Lacquers

Ranbar Technology, Inc.
1114 Wm. Flinn Hwy.
Glenshaw, PA 15116
Phone: (412) 486-1111
Fax: (412) 487-3313
Raymond Kushner, General Mgr.; Joseph Markovich, Sales Mgr. Resins
- Alkyd Resins
- Epoxy Resins
- High-Solid Resins
- Misc. Type Resins
- Phenolic Resins
- Polyester Resins
- Silicone Resins
- Styrene Resins
- Ultraviolet Curing Resins
- Water-Thinned Resins

Reichhold Chemicals Inc.
2400 Ellis Rd.
Durham, NC 27703
Phone: (919) 990-7500
Fax: (919) 990-7711

Rhône-Poulenc, Inc.
CN 7500
Prospect Plains Rd.
Cranbury, NJ 08512
Phone: (609) 860-3026
Fax: (609) 860-0795
- Misc. Type Resins
- Silicone Resins
- Urethane & Polyurethane Resins
- Vinyl Resins

Rohm and Haas Co.
Independence Mall West
Philadelphia, PA 19105
Phone: (215) 592-3000
Fax: (215) 592-6909
- Acrylic Resins

Ruco Polymer Corp.
New South Rd.
Hicksville, NY 11802
Phone: (516) 931-8100
Fax: (516) 931-8179
Tony Mazzarella, Sales Director; John McLafferty, Vice President Technology
- Misc. Type Resins
- Polyester Resins
- TGIC Resins
- Urethane & Polyurethane Resins

Schenectady International, Inc.
319 Comstock Road
Scarborough, ON M1L 2H3
Canada
Phone: (416) 757-5136
Fax: (416) 757-2468
Rikki Gogua, Product Mgr.
- Alkyd Resins
- Epoxy Resins
- High-Solid Resins
- Misc. Type Resins
- Oleoresinous Varnishes
- Polyester Resins
- Water-Thinned Resins

Scott Bader, Inc.
1592 Georgetown Rd.
P.O. Box 2163
Hudson, OH 44236
Phone: (216) 650-5000
Fax: (216) 528-0184
Bill Fitzgibbons, President; Sue Spurlock, Purchasing/Office Mgr.

Acrylic Resins
Styrene Resins
Vinyl Resins

Sentry/Custom Services Corp.
RR 5, Box 5491
East Stroudsburg, PA 18301
Phone: (717) 421-2574
Fax: (717) 421-2511
David W. Crookall, President; Susan Rightmyer, Operations Mgr.
Acrylic Resins
Amino Resins
Melamine & Melamine Type Resins
Nitrocellulose
Phenolic Resins
Urea REsins
Urethane & Polyurethane Resins
Water-Thinned Resins

Shell Chemical Co.
910 Louisiana
Houston, TX 77002
Phone: (800) USA-SHELL
Fax: (713) 241-1606
Acrylic Resins
Epoxy Hardeners—Chemicals
Epoxy Resins
High-Solid Resins
Water-Thinned Resins

Summit Precision Polymers Corp.
1060 Crestwood Dr.
P.O. Box 99
Mountaintop, PA 18707-0099
Phone: (717) 474-9240
Fax: (717) 474-9250
Terry Fulmer, Marketing & Sales Mgr.
Misc. Type Resins
Polyethylene Resins

U.S. Polymers, Inc.
300 E. Primm St.
St. Louis, MO 63111
Phone: (314) 638-1632
Fax: (314) 638-3100
Rogert Heitland, President
Alkyd Resins
Epoxy Resins
Ester Gums
High-Solid Resins
Maleic Resins
Oleoresinous Varnishes
Phenolic Resins
Polyester Resins
Rosin Esters
Styrene Resins

Union Carbide Corp.
39 Old Ridgebury Rd.
Danbury, CT 06817
Phone: (203) 794-3210
Fax: (203) 794-3170
Acrylic Resins
Epoxy Resins
Polyethylene Resins
Polypropylene Resins
Vinyl Resins

United Mineral & Chemical Corp.
1100 Valley Brook Rd.
Lyndhurst, NJ 07071-3600
Phone: (201) 507-3307
Fax: (201) 507-1506
Sal Morreale, Mgr., Chemical Div.
Epoxy Resins
TGIC Resins

Van Waters & Rogers Inc.
6100 Carillon Point
Kirkland, WA 98033
Phone: (206) 889-3400
Fax: (206) 889-4100
Acrylic Resins
Polybutenes
Polyester Resins

Silicone Resins
Wabash Gilsonite Blends, Inc.
707 E. Fayette Street
P.O. Box 368
Effingham, IL 62401
Phone: (217) 342-9755
Natural Resins

Wacker Silicones Corp.
3301 Sutton Rd.
Adrian, MI 49221-9397
Phone: (517) 264-8500
Fax: (517) 264-8620
Nick Salchert, National Sales Mgr.; Gudrun Windfuhr, Marketing Mgr.
Silicone Resins

Witco Corp.
One American Ln.
Greenwich, CT 06831-2559
Phone: (203) 552-2000
Fax: (203) 552-2010
Epoxy Resins
Urethane & Polyurethane Resins

Zeneca Resins
730 Main St.
Wilmington, MA 01887
Phone: (508) 658-6600
Fax: (508) 657-7978
William Otterbein, Business Mgr., Ind. Coatings; John Kibbee, Business Mgr., Technical Coatings
Acrylic Resins
Urethane & Polyurethane Resins
Vinyl Resins

RESINS: product listing

Acrylic Resins

ADM Tronics Unlimited, Inc.
Akzo Nobel Resins
Allied Colloids, Inc.
BASF Corp.
Bayer Corporation
CCP
Dow Chemical Co.
Engineered Polymer Solutions, Inc.
H.B. Fuller Co.
BFGoodrich Co., Specialty Chemicals
The Goodyear Tire & Rubber Co.
Hoechst Celanese Corporation
Hüls America Inc.
S.C. Johnson Polymer
Lawter International
McWhorter Technologies
Morton International
Nacan Products Ltd.
Ohio Polychemical Co.
Peninsula Polymers
Rohm and Haas Co.
Scott Bader, Inc.
Sentry/Custom Services Corp.
Shell Chemical Co.
Union Carbide Corp.
Van Waters & Rogers Inc.
Zeneca Resins

Polymer Emulsion

ADM Tronics Unlimited, Inc.
Akzo Nobel Resins
Allied Colloids, Inc.
BASF Corp.
CCP
Dow Chemical Co.
Engineered Polymer Solutions, Inc.
H.B. Fuller Co.
BFGoodrich Co., Specialty Chemicals
S.C. Johnson Polymer
McWhorter Technologies
Nacan Products Ltd.
Rohm and Haas Co.
Scott Bader, Inc.
Union Carbide Corp.
Zeneca Resins

Solid

Allied Colloids, Inc.
BFGoodrich Co., Specialty Chemicals
The Goodyear Tire & Rubber Co.
Hoechst Celanese Corporation
S.C. Johnson Polymer
Peninsula Polymers
Van Waters & Rogers Inc.
Zeneca Resins

Solution

Akzo Nobel Resins
Allied Colloids, Inc.
BASF Corp.
Bayer Corporation
CCP
Engineered Polymer Solutions, Inc.
Hoechst Celanese Corporation
S.C. Johnson Polymer
McWhorter Technologies
Morton International
Peninsula Polymers
Rohm and Haas Co.
Union Carbide Corp.
Zeneca Resins

Water-Reducible

ADM Tronics Unlimited, Inc.
Akzo Nobel Resins
CCP
The Goodyear Tire & Rubber Co.
Hoechst Celanese Corporation
S.C. Johnson Polymer
Lawter International
McWhorter Technologies
Ohio Polychemical Co.
Rohm and Haas Co.
Sentry/Custom Services Corp.
Shell Chemical Co.

Misc. Acrylic Resins

BFGoodrich Co., Specialty Chemicals
The Goodyear Tire & Rubber Co.
Lawter International
Ohio Polychemical Co.
Rohm and Haas Co.
Zeneca Resins

Alkyd Resins

Akzo Nobel Resins
American Casein Co.
CCP
The Degen Co.
Dow Corning Corp.
Engineered Polymer Solutions, Inc.
Hoechst Celanese Corporation
Lawter International
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Alkyd & Oil Copolymers

Akzo Nobel Resins
American Casein Co.
CCP
The Degen Co.
Engineered Polymer Solutions, Inc.
Lawter International
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Drying Oil-Modified

Akzo Nobel Resins
CCP
The Degen Co.
Engineered Polymer Solutions, Inc.
McWhorter Technologies
Peninsula Polymers
Schenectady International, Inc.
U.S. Polymers, Inc.

Modified with Other Resins

Akzo Nobel Resins
CCP
The Degen Co.
Dow Corning Corp.
Engineered Polymer Solutions, Inc.
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Nondrying & Semi-Oxidizing, Oil-Modified

Akzo Nobel Resins
CCP
The Degen Co.
Engineered Polymer Solutions, Inc.
McWhorter Technologies
Peninsula Polymers
Schenectady International, Inc.
U.S. Polymers, Inc.

Thixotropic

Akzo Nobel Resins
CCP
Hoechst Celanese Corporation
Lawter International
McWhorter Technologies
Peninsula Polymers
U.S. Polymers, Inc.

Water-Reducible

Akzo Nobel Resins
CCP
Engineered Polymer Solutions, Inc.
Hoechst Celanese Corporation
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Schenectady International, Inc.

Misc. Alkyd Resins

Akzo Nobel Resins
American Casein Co.
CCP
The Degen Co.
Engineered Polymer Solutions, Inc.
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Amino Resins

Akzo Nobel Resins
American Casein Co.
Cytec Industries, Inc.
DSM Resins U.S., Inc.
Hoechst Celanese Corporation
McWhorter Technologies
Peninsula Polymers
Sentry/Custom Services Corp.

Cellulose Derivatives

Atomergic Chemetals Corp.

Epoxy Hardeners-Chemicals

BASF Corp.
Cardolite Corp.
CCP
Ciba/Polymer Division
Hoechst Celanese Corporation
Hüls America Inc.
Kenrich Petrochemicals, Inc.
Kraft Chemical Co.
Lonza, Inc.
Peninsula Polymers
Shell Chemical Co.
Union Carbide Corp.

Epoxy Resins

Akzo Nobel Resins
CCP
Ciba/Polymer Division
Daubert Chemical Co., Inc.
Dow Chemical Co.
Hoechst Celanese Corporation
Lonza, Inc.
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Phenoxy Associates
Ranbar Technology, Inc.
Schenectady International, Inc.
Shell Chemical Co.
U.S. Polymers, Inc.
Union Carbide Corp.
United Mineral & Chemical Corp.
Witco Corp.

Ester

Akzo Nobel Resins
Ciba/Polymer Division
Dow Chemical Co.
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Liquid/Solution

Ciba/Polymer Division
Daubert Chemical Co., Inc.
Dow Chemical Co.
Peninsula Polymers
Schenectady International, Inc.
Shell Chemical Co.
United Mineral & Chemical Corp.

Solid

Ciba/Polymer Division
Dow Chemical Co.
Peninsula Polymers
Shell Chemical Co.
United Mineral & Chemical Corp.

Water-Based

Akzo Nobel Resins
Ciba/Polymer Division
Daubert Chemical Co., Inc.
Dow Chemical Co.
Hoechst Celanese Corporation
Ohio Polychemical Co.
Peninsula Polymers
Schenectady International, Inc.
Shell Chemical Co.
Witco Corp.

Misc. Epoxy Resins

Akzo Nobel Resins
CCP
Ciba/Polymer Division
Dow Chemical Co.
Lonza, Inc.
Ohio Polychemical Co.
Peninsula Polymers
Phenoxy Associates
Schenectady International, Inc.

Ester Gums

Akzo Nobel Resins
U.S. Polymers, Inc.

Solid

Akzo Nobel Resins

Solution

Akzo Nobel Resins
U.S. Polymers, Inc.

High-Solid Resins

Akzo Nobel Resins
BASF Corp.
Bayer Corporation
CCP
Ciba/Polymer Division
Cytec Industries, Inc.
Engineered Polymer Solutions, Inc.
GE Silicones
Lawter International
McWhorter Technologies
Morton International
Ohio Polychemical Co.
Peninsula Polymers
Phenoxy Associates
Ranbar Technology, Inc.
Schenectady International, Inc.
Shell Chemical Co.
Union Carbide Corp.
U.S. Polymers, Inc.

Hybrid Resins

CCP
Peninsula Polymers
Phenoxy Associates

Hydrocarbon Resins

Dover Chemical Corp.
The Goodyear Tire & Rubber Co.
Kenrich Petrochemicals, Inc.
Lawter International
Neville Chemical Co.
Peninsula Polymers

Coumarone-Indene

Neville Chemical Co.

Emulsion

Neville Chemical Co.

Liquid/Solution

The Goodyear Tire & Rubber Co.
Neville Chemical Co.

Solid

The Goodyear Tire & Rubber Co.
Neville Chemical Co.

Terpene

The Goodyear Tire & Rubber Co.

Misc. Hydrocarbon Resin

Dover Chemical Corp.
Kenrich Petrochemicals, Inc.
Lawter International
Neville Chemical Co.

Maleic Resins

Akzo Nobel Resins
Arizona Chemicals Co.
CCP
International Specialty Products (ISP)
Lonza, Inc.
Petrolite Corp., Polymers Div.
U.S. Polymers, Inc.

Solid

Akzo Nobel Resins
Arizona Chemicals Co.
International Specialty Products (ISP)
Lonza, Inc.

Solution

Akzo Nobel Resins
Arizona Chemicals Co.
International Specialty Products (ISP)
U.S. Polymers, Inc.

Melamine & Melamine Type Resins

Akzo Nobel Resins
CCP
Cytec Industries, Inc.
Hoechst Celanese Corporation
Lonza, Inc.
McWhorter Technologies

Peninsula Polymers
Sentry/Custom Services Corp.

Misc. Type Resins

Engineered Polymer Solutions, Inc.
GE Specialty Chemicals
Hoechst Celanese Specialty Polymers
Lonza, Inc.
Lorama Chemicals, Inc.
Ohio Polychemical Co.
Phenoxy Associates
Ranbar Technology, Inc.
Rhône-Poulenc, Inc.
Ruco Polymer Corp.
Schenectady International, Inc.
Summit Precision Polymers Corp.

Natural Resins

Lorama Chemicals, Inc.
Mantrose Haeuser Co., Inc.
Wabash Gilsonite Blends, Inc.

Processed

Lorama Chemicals, Inc.
Mantrose Haeuser Co., Inc.

Solid

Mantrose Haeuser Co., Inc.
Wabash Gilsonite Blends, Inc.

Solution

Lorama Chemicals, Inc.
Mantrose Haeuser Co., Inc.
Wabash Gilsonite Blends, Inc.

Nitrocellulose

Sentry/Custom Services Corp.

Nylon Resins

Hüls America Inc.

Oleoresinous Varnishes

Akzo Nobel Resins
CCP
The Degen Co.
Engineered Polymer Solutions, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Modified Phenolic

CCP
The Degen Co.
Engineered Polymer Solutions, Inc.
Schenectady International, Inc.
U.S. Polymers, Inc.

Phenolic

The Degen Co.
Schenectady International, Inc.

Phenolic Free

The Degen Co.
U.S. Polymers, Inc.

Phenolic Resins

Arizona Chemicals Co.
Ciba/Polymer Division
DSM Resins U.S., Inc.
GE Specialty Chemicals
Georgia-Pacific Resins, Inc.
Hoechst Celanese Corporation
Lawter International
McWhorter Technologies
Ohio Polychemical Co.
Ranbar Technology, Inc.
Sentry/Custom Services Corp.
U.S. Polymers, Inc.

Modified for Powder Coatings

Ciba/Polymer Division

Solid

Arizona Chemicals Co.
Ciba/Polymer Division
GE Specialty Chemicals
Georgia-Pacific Resins, Inc.
Hoechst Celanese Corporation
Lawter International

Solution

Arizona Chemicals Co.
Ciba/Polymer Division
DSM Resins U.S., Inc.
Georgia-Pacific Resins, Inc.
Hoechst Celanese Corporation
McWhorter Technologies
Ohio Polychemical Co.
Ranbar Technology, Inc.
Sentry/Custom Services Corp.
U.S. Polymers, Inc.

Misc. Phenolic Resins

Georgia-Pacific Resins, Inc.
Hoechst Celanese Corporation
Ranbar Technology, Inc.

Polyamide Resins

American Casein Co.
CCP
Ciba/Polymer Division
Lawter International
Lonza, Inc.
Peninsula Polymers

Polybutenes

Van Waters & Rogers Inc.

Polyester Resins

Akzo Nobel Resins
Bayer Corporation
CCP
DSM Resins U.S., Inc.
Engineered Polymer Solutions, Inc.
Etna Products Inc., Specialty Chemicals Division
Hüls America Inc.
Lawter International
McWhorter Technologies
Morton International
Ohio Polychemical Co.
Peninsula Polymers
Phenoxy Associates
Ranbar Technology, Inc.
Ruco Polymer Corp.
Schenectady International, Inc.
U.S. Polymers, Inc.
Van Waters & Rogers Inc.

Drying

CCP
Schenectady International, Inc.
U.S. Polymers, Inc.

Non-Drying

Akzo Nobel Resins
Bayer Corporation
CCP
Engineered Polymer Solutions, Inc.
Ohio Polychemical Co.
Peninsula Polymers
Schenectady International, Inc.
U.S. Polymers, Inc.

Oil-Free

Akzo Nobel Resins
Bayer Corporation
DSM Resins U.S., Inc.
Engineered Polymer Solutions, Inc.
Etna Products Inc., Specialty Chemicals Division
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
U.S. Polymers, Inc.

Saturated

Akzo Nobel Resins
Bayer Corporation
CCP
DSM Resins U.S., Inc.
Engineered Polymer Solutions, Inc.
Etna Products Inc., Specialty Chemicals Division
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Ruco Polymer Corp.
U.S. Polymers, Inc.

Solid

Peninsula Polymers
Ruco Polymer Corp.

Unsaturated

Bayer Corporation

CCP
McWhorter Technologies
Ranbar Technology, Inc.
Van Waters & Rogers Inc.

Water-Reducible

Akzo Nobel Resins
Bayer Corporation
CCP
Etna Products Inc., Specialty Chemicals Division
Lawter International
McWhorter Technologies
Peninsula Polymers
Ranbar Technology, Inc.
Ruco Polymer Corp.
Schenectady International, Inc.

Misc. Polyester Resins

Akzo Nobel Resins
Engineered Polymer Solutions, Inc.
Etna Products Inc., Specialty Chemicals Division
Lawter International
Morton International
Phenoxy Associates
Ranbar Technology, Inc.
Ruco Polymer Corp.
U.S. Polymers, Inc.

Polyethylene Resins

Hoechst Celanese Specialty Polymers
Hüls America Inc.
Petrolite Corp., Polymers Div.
Summit Precision Polymers Corp.
Union Carbide Corp.

Polypropylene Resins

Hoechst Celanese Specialty Polymers
Hüls America Inc.
Union Carbide Corp.

Rosin Esters

Arizona Chemicals Co.
Lawter International
U.S. Polymers, Inc.

Silicone Resins

Akzo Nobel Resins
CCP
Dow Corning Corp.
GE Silicones
Hüls America Inc.
Ohio Polychemical Co.
Ranbar Technology, Inc.
Rhône-Poulenc, Inc.
Van Waters & Rogers Inc.
Wacker Silicones Corp.

Styrene Resins

Akzo Nobel Resins
Allied Colloids, Inc.
BASF Corp.
CCP
Dow Chemical Co.
Engineered Polymer Solutions, Inc.
BFGoodrich Co., Specialty Chemicals
The Goodyear Tire & Rubber Co.
S.C. Johnson Polymer
McWhorter Technologies
Neville Chemical Co.
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
Scott Bader, Inc.
Union Carbide Corp.
U.S. Polymers, Inc.

Styrene & Vinyl Toluene Polymer & Copolymer—Solid

The Goodyear Tire & Rubber Co.
Ranbar Technology, Inc.

Styrene & Vinyl Toluene Polymer & Copolymer—Solution

Akzo Nobel Resins
CCP
Engineered Polymer Solutions, Inc.
McWhorter Technologies
Ohio Polychemical Co.
Peninsula Polymers
Ranbar Technology, Inc.
U.S. Polymers, Inc.

Styrene-Butadiene Emulsions

Akzo Nobel Resins
BASF Corp.
Dow Chemical Co.
BFGoodrich Co., Specialty Chemicals
Union Carbide Corp.

Misc. Styrene Resins

Allied Colloids, Inc.
Dow Chemical Co.
Engineered Polymer Solutions, Inc.
BFGoodrich Co., Specialty Chemicals
The Goodyear Tire & Rubber Co.
S.C. Johnson Polymer
Neville Chemical Co.
Ranbar Technology, Inc.
Scott Bader, Inc.

Terpenes

Arizona Chemicals Co.

TGIC Resins

Ciba/Polymer Division
DSM Resins U.S., Inc.
Peninsula Polymers
Ruco Polymer Corp.
United Mineral & Chemical Corp.

Ultraviolet Curing Resins

BASF Corp.
Bayer Corporation
International Specialty Products (ISP)
McWhorter Technologies
Ranbar Technology, Inc.

Urea Resins

Akzo Nobel Resins
Cytec Industries, Inc.
Peninsula Polymers
Sentry/Custom Services Corp.

Urethane Lacquers

Bayer Corporation
CCP
BFGoodrich Co., Specialty Chemicals
K.J. Quinn & Co., Inc.

Urethane & Polyurethane Resins

Akzo Nobel Resins
Bayer Corporation
CCP
Cytec Industries, Inc.
DSM Resins U.S., Inc.
Engineered Polymer Solutions, Inc.
BFGoodrich Co., Specialty Chemicals
Hoechst Celanese Corporation
Kraft Chemical Co.
Ohio Polychemical Co.
Peninsula Polymers
K.J. Quinn & Co., Inc.
Rhône-Poulenc, Inc.
Ruco Polymer Corp.
Sentry/Custom Services Corp.
Witco Corp.
Zeneca Resins

ASTM Type I—One Package Precured

Akzo Nobel Resins
Engineered Polymer Solutions, Inc.
Ohio Polychemical Co.
Peninsula Polymers
K.J. Quinn & Co., Inc.

ASTM Type II—One-Package Moisture Cured

Bayer Corporation
Engineered Polymer Solutions, Inc.
Peninsula Polymers
K.J. Quinn & Co., Inc.

ASTM Type III—One-Package Heat Cured

Bayer Corporation
Peninsula Polymers
K.J. Quinn & Co., Inc.

ASTM Type IV—Two-Package Catalyst

Bayer Corporation
Peninsula Polymers
K.J. Quinn & Co., Inc.

RESINS: product listing

ASTM Type V—Two-Package Polyol

Bayer Corporation
Peninsula Polymers
K.J. Quinn & Co., Inc.

Waterborne

Akzo Nobel Resins
Bayer Corporation
Cytec Industries, Inc.
BFGoodrich Co., Specialty Chemicals
Hoechst Celanese Corporation
Kraft Chemical Co.
Peninsula Polymers
K.J. Quinn & Co., Inc.
Ruco Polymer Corp.
Sentry/Custom Services Corp.
Witco Corp.
Zeneca Resins

Misc. Urethane & Polyurethane Resins

Akzo Nobel Resins
Bayer Corporation
DSM Resins U.S., Inc.
Engineered Polymer Solutions, Inc.
BFGoodrich Co., Specialty Chemicals
K.J. Quinn & Co., Inc.
Ruco Polymer Corp.
Zeneca Resins

Vinyl Resins

CCP
Engineered Polymer Solutions, Inc.
H.B. Fuller Co.
BFGoodrich Co., Specialty Chemicals
International Specialty Products (ISP)
McWhorter Technologies
Nacan Products Ltd.
Rhône-Poulenc, Inc.
Scott Bader, Inc.
Union Carbide Corp.
Zeneca Resins

Polyvinyl Acetate

Engineered Polymer Solutions, Inc.
H.B. Fuller Co.

Polyvinyl Chloride & Polyvinylidene Chloride

BFGoodrich Co., Specialty Chemicals
Scott Bader, Inc.
Zeneca Resins

Vinyl Acetate Polymer Emulsions

Engineered Polymer Solutions, Inc.
H.B. Fuller Co.
BFGoodrich Co., Specialty Chemicals
McWhorter Technologies
Nacan Products Ltd.

Vinyl Copolymers

CCP
H.B. Fuller Co.
BFGoodrich Co., Specialty Chemicals
International Specialty Products (ISP)
McWhorter Technologies
Nacan Products Ltd.
Rhône-Poulenc, Inc.

Misc. Vinyl Resins

International Specialty Products (ISP)

Water-Thinned Resins

ADM Tronics Unlimited, Inc.
Akzo Nobel Resins
American Casein Co.
Bayer Corporation
BFGoodrich Co., Specialty Chemicals
Engineered Polymer Solutions, Inc.
Hoechst Celanese Corporation
Lorama Chemicals, Inc.
McWhorter Technologies
Ohio Polychemical Co.
Phenoxy Associates
Ranbar Technology, Inc.
Schenectady International, Inc.
Sentry/Custom Services Corp.
Shell Chemical Co.

LOS ANGELES—JUNE

Election Night

Following balloting, Society President Robert Skarvan, of Engineered Polymer Solutions, Inc., announced that James Hall, of ICI Paint, was elected Society Representative, while Joe Reilly, of Rohm & Haas Co. was elected as Secretary.

In addition, President Skarvan reported on a meeting between members of the Golden Gate Society and Los Angeles Society. The two groups discussed running a joint symposium after the Western Coatings Societies' Symposium and Show in Anaheim, CA, on February 18-20, 1997. It was also suggested that in the future, the two Societies may consolidate into one Society with two chapters.

Los Angeles Society member Robert Wendoll, of Dunn-Edwards Paint Co., discussed "ENVIRONMENTAL AFFAIRS CONCERNING THE STATE OF CALIFORNIA."

Mr. Wendoll stated that the Southern California Air Quality Management District (SCAQMD) has asked manufacturers of architectural coatings and paint contractors who use these coatings if they could give up all flat coatings having VOCs over 50 g/l and all non-flats over 100 g/l. SCAQMD made this request since emissions will have to be reduced by 75% over the next 20 years to be in compliance with the EPA's ozone requirements. According to the speaker, these numbers are based on faulty data that underestimate the emissions of automobiles and do not include the emissions of trees and plants. Also, the computer modeling used is not valid. In addition, other studies show that reducing VOCs will not reduce ozone unless nitrogen oxide emissions are also reduced, and in fact the reduction of the nitrogen oxides alone will reduce the ozone levels without the need to reduce the VOC levels. The solvent profiles used in the computer modeling for emissions are not even close to what is really being used in solvent-based or water-based paints today, he said.

VOC limits are established based on surveys that are conducted by AQMD staff, as well as the types of paint used and volume sold. The average of all coatings is used to generate the limits without regard as to how they are used. Over the last 10 years, the legislation that has been passed to lower VOCs has only succeeded in lowering the average content by 37%, but emissions have increased by 16% during that same time period. The AQMD, according to Mr. Wendoll, also has no one who really knows anything about the technical aspects of coatings.

Mr. Wendoll noted that marketing plays more of a role in determining what type of coatings will be made and used than do any legislative efforts. For example, from 1950 to 1975, architectural coatings went from almost 100% solvent-based paint to nearly 75% water-based. This was well in advance of any legislation directed to lower VOCs. As the quality improved and the cost came down, more and more people switched to these water-based products. The same thing is true for zero VOC products. There is no law stating paint with no solvents in them must be used, but odor free paint is a very marketable product.

If legislation forces technology, the results are usually poor quality and performance. In addition, the smaller manufacturers often do not have the resources to develop these coatings and end up disappearing. Mr. Wendoll concluded that, if the small manufacturers go, eventually the large nationals will have to deal with the government alone.

Q. What legal status does the AQMD have to amend their rules? Is making rules more difficult than amending them?

A. The AQMD has every right to amend their rules provided they follow the required procedures. Making a new rule is much more difficult to do because some new area comes under control rather than modifying an existing regulation.

ARTHUR W. LORENZ, *Secretary*

PHILADELPHIA—APRIL

Awards Night

Society President Howard J. Salmon, of Akzo Nobel Coatings, Inc., presented the Past President's Award to Barry Fisher, of Van Horn, Metz & Co.

Also recognized were Neil Shearer, of The 3E Group, for his years of service to the Technical Committee and Marshall Jones for serving as Membership Committee Chair for 10 years.

Don Fritz, Society Honorary Member, received the Ben Franklin Award for his many years of service to the Philadelphia Society.

Neil Shearer presented the Ossie Award to Tim McClelland, of ChemCentral, in recognition of this year's plant tour.

Wayne Kraus, of Hercules Incorporated, acknowledged the efforts of Don Denny, of E.W. Kaufmann Co., Sam Firestone, of S.E. Firestone Associates, Inc., and Brian Gilbert, of E.W. Kaufmann Co., in the planning and success of the Eastern Training Conference and Show.

PATRICIA M. PETERSON, *Secretary*

PHILADELPHIA—JUNE

Officer Elections

Barry Fisher, of Van Horn, Metz & Co. announced the 1996-97 PSCT Board Members. They are: President—Tom Brown, of Consultants Consortium; President-Elect—Patricia M. Peterson, of ARCO Chemical Co.; Secretary—Sue Nielsen, of Best Brothers Paint Mfg. Co., Inc.; Treasurer—Neil Shearer, of The 3E Group; Assistant Treasurer—Marshall Jones; Sr. Member At Large—Brian Gilbert, of E.W. Kaufmann Co.; Sr. Past-President—Barry Fisher, of Van Horn, Metz & Co.; and Jr. Past-President—Howard J. Salmon.

PATRICIA M. PETERSON, *Secretary*

See Page 19 For Preliminary Program Information for the

1996 FSCT International Coatings Expo and Technology

Conference and the FSCT Annual Meeting

October 22-25, 1996, in Chicago, IL

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ACETYLATED CONGO
S.B.P. SPIRITS
SAGGING

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Editor: Stanley LeSota

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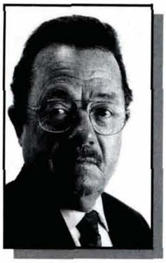


A. Bernes

Al Bernes has joined the sales staff of Dowd and Guild Inc., San Ramon, CA. Mr. Bernes has been involved in the chemical industry in sales and management for both a manufacturer and distributor. Most recently, he was Branch Manager for E.T. Horn Co. Mr. Bernes is a member of the Golden Gate Society.

Cook Composites and Polymers, Kansas City, MO, has announced three new coatings management appointments for its Polymers Division. Accepting new positions are: **Tom Peta**, Eastern Region Sales Manager; **Dave Porter**, Midwest Region Sales Manager; and **Jay Fenstermacher**, Southern Region Sales Manager. Messrs. Peta and Fenstermacher are members of the Baltimore Society, while Mr. Porter is a member of the Chicago Society.

E.C. "Chuck" Steiner, has been appointed by the Asphalt Roofing Manufacturers Association (ARMA), Rockville, MD, as the Chairman of the ARMA Residential Roofing Committee. Mr. Steiner serves as Product Manager for Residential Roofing Products, Celotex Corp., Tampa, FL.

Man-Gill Chemical Co., Cleveland, OH, has appointed **John Zbiegien** to the position of Director of Sales, Forming and Finishing Group, Metalworking Division. Mr. Zbiegien will manage the group's sales activities.

Ronald E. Brandt was named Senior Vice President, Marketing for Lawson-Mardon Wheaton, Inc., Millville, NJ. Lawson-Mardon Wheaton, Inc. was recently acquired by Alusuisse-Lonza Packaging Division.

Brinkmann Instruments, Inc., Westbury, NY, has appointed **Martin N. Farb** to the position of President and Chief Executive Officer. Mr. Farb succeeds **Klaus P. Brinkmann**, who recently retired from the company.

James E. Coleman has joined the staff of the National Association of Printing Ink Manufacturers, Inc., Hasbrouck Heights, NJ. Mr. Coleman will assist Executive Director, **Jimmy Sutphin**, who will retire during the second half of 1997.

New York Society Bestows Annual Awards

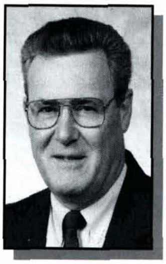
During the 1996 New York Society Awards Night, **Sheila D. Westerveld**, of Standard Coating Corp., Ridgefield, NJ, received the Roy H. Kienle Award. Ms. Westerveld was recognized for her technical achievements and outstanding service to the Society's Technical Committee.

A member of the Society since 1985, Ms. Westerveld has served as Chair of the Technical Committee since 1993. In addition, she co-authored the Society's technical paper "Rheology Modifiers for Low VOC Bake Coatings," which was awarded second place in the APJ/Voss Awards Competition at the 1995 FSCT Annual Meeting. In 1993, Ms. Westerveld was honored with the Technical Achievement Award presented by Women in Coatings.

In recognition of his long and faithful service to the FSCT, New York Society, and the protective coatings industry, **Michael C. Frantz**, Vice President, Sales, for Daniel Products Co., Jersey City, NJ, received the President's Service Award.

Mr. Frantz has been associated with the coatings industry for 30 years. At the present, Mr. Frantz is a member of the FSCT Board of Directors and serves as Society Representative to the Federation. In addition, he was Society President in 1993. Mr. Frantz has served on various Society committees including Bylaws, Program, Long-Range Planning, and Finance. During the 1995 New York Society Symposium, he presented "Recent Advances in Additives and Modifiers for Coatings."

Peter A. Lewis, Coatings Industry Manager for the Pigments Division of Sun Chemical Corp., Cincinnati, OH, served as the PaVaC Speaker. A member of the CDIC Society, Dr. Lewis joined Sun Chemical in 1979. He is recognized as the editor of *The Pigment Handbook*, Vol. 1 and 2.



B. Hobley

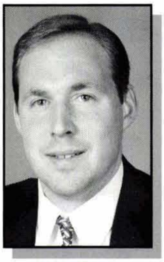
Degussa Corp., Ridgefield Park, NJ, has announced the promotion of **Bruce Hobley** to Marketing Manager for the company's carbon blacks, precipitated silicas, and organosilanes produced for the industrial rubber goods industry. Working within the Carbon Blacks Division, Mr. Hobley will be responsible for the marketing activities pertaining to these specialized products. He is a member of the Toronto Society.

In other news, **Robert M. Yamada** has been promoted to Vice President of Human Resources. In this capacity, Mr. Yamada will supervise all human resource and labor relations functions for the company's Pigment Group.

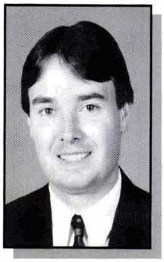
Fusion Systems Corp., Rockville, MD, has appointed **William Asmann** as Director of Operations for the day-to-day operations and management for Fusion UV Curing's Aetek subsidiary in Plainfield, IL. Prior to this position, Mr. Asmann served as Special Project Director for Fusion UV Curing in Rockville.

Frank A. McPherson has announced his retirement as Chairman and Chief Executive Officer of Kerr-McGee Corp., Oklahoma City, OK. Succeeding Mr. McPherson will be **Luke R. Corbett**.

Rick Kristensen has accepted the position of Sales Engineer at LaserMike, Inc., Dayton, OH. He will be responsible for the Ohio and Michigan territories.



M. Mendelsohn



D. Wacker

Raabe Corp., Menomonee Falls, WI, has named **Michael Mendelsohn** to the position of Manager of Color Technology in the company's color match department. Mr. Mendelsohn will oversee the technical application of color matching technology, while serving as a liaison between the company's sales department and the color matching staff.

Also, **Dave Wacker** was promoted to Sales Manager. Mr. Wacker will direct the sales and customer service staff and manage the company's national sales effort.

Daniel Products Co., Inc., Jersey City, NJ, has appointed **Scott T. Becker** as President. Mr. Becker has over 16 years of experience in the pigment industry.

Edward J. Rish has accepted the position of Executive Vice President and General Manager of Freedom Textile Chemical, Charlotte, NC. Mr. Rish will be responsible for all locations and functions of the business.

Obituaries

Neil Patrick Conroy, a member of the Los Angeles Society, died on April 25, 1996. He was 75 years old.

Mr. Conroy began his career in 1948 with the California Flaxseed Co. and later joined the Paul W. Wood Co. In 1962, he co-founded Conroy-McKibben Co., where he served as President until he retired in 1990.

Mr. Conroy is survived by his wife, Pat; seven children; and nine grandchildren.

Milton Zucker, Co-founder and Director of Kalcor Coatings Co., Willoughby, OH, passed away on July 4, 1996. He was 91 years old.

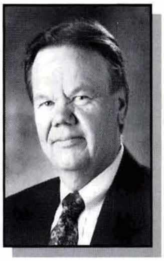
Mr. Zucker's career in the coatings industry began as a Chemist, NC Lac Lab Director, and Chief Patent Council at The Glidden Co. Thereafter, he held positions at Interchemical Corp. and FMC Corp. In 1961, he co-founded Kalcor, where he served as a board member for many years.

Gregory J. Weyers has joined the staff of Crosfield Co., Joliet, IL, as Territory Manager—Surface Coatings. Mr. Weyers will represent Gasil® micronized silica gel products in the Southern and Eastern United States.

BatchMaster Software Corp., Seal Beach, CA, has announced the addition of two new sales and implementation offices for its BatchMaster® product line. **Stuart Gish** of Minnesota Software Solutions, St. Paul, MN, and **Thierry Cools** of Platinum Services Europe, Brussels, Belgium, are now serving clients.

Nancy Donahue has been hired as General Manager of Ark Systems, Johnstown, PA, a Division of Spider Staging Corp., Kent, WA. Ms. Donahue brings experience in the industrial painting business to her new position.

Hüls America Inc., Somerset, NJ, has named **Henry A. Kasprzak** as Vice President of its newly created Coatings Raw Materials Division. Mr. Kasprzak will be responsible for the North American marketing, sales, and technical service-related functions for all coatings raw materials and additives product lines.



H.A. Kasprzak

American Colors Inc.'s, Sandusky, OH, Board of Directors has elected **Bob Bourne** to the office of Vice President of Sales. Mr. Bourne joined the company in 1985 and has held various positions.

Michael W. Johnson has been appointed Product Marketing Manager for Charles Ross & Son Co., Hauppauge, NY. Mr. Johnson will be responsible for new market development, product marketing, and technical support.

Vianova Resins, a business unit of Hoechst Celanese Corp., Charlotte, NC, has named **Michael S. O'Shaughnessy** to the position of National Sales Manager. Mr. O'Shaughnessy has more than 16 years of experience in the resins business focusing on coatings.

Harvey Snelling has joined Deeks and Company, Cincinnati, OH, as Technical Account Manager. Based in Louisville, KY, Mr. Snelling will handle technical coatings and related accounts in Kentucky and Indiana.

UCB Chemicals, Inc./Radcure Business Unit, Smyrna, GA, has promoted **Chris M. Paul** to Sales Representative, Central Region. Based in Overland Park, KS, Mr. Paul will cover Missouri, Kansas, Nebraska, North Dakota, South Dakota, Oklahoma, Arkansas, Texas, Louisiana, and Mississippi.

Books/ Publications

Index

Elsevier Science Inc. (ESI) announces its first edition of a four volume set of the *CAA Regulations and Keyword Index* designed to work with the Clean Air Act (CAA) regulations. This index includes the full text of the CAA implementing regulations—40 *CFR* parts, summaries of each *CFR* part, detailed keyword indexes of the regulations, and a cumulative keyword index of all topics covered by the CAA regulations.

Circle No. 30 on Reader Service Card

Coatings Logbook

NACE International announces the revised and expanded edition of the *NACE Coating Inspector's Logbook*. The logbook includes more forms that are user-friendly and new forms such as a job hazard checklist and a humidity chart. This logbook allows users to keep vital information at their fingertips. It also has tables, comparisons, formulas, conversion tables, and blank pages for notes.

Circle No. 31 on Reader Service Card

Coatings Directory

An updated edition of the *European Coatings Directory* has been published. The European coatings manufacturers and their products are listed in detail and arranged by country. There is also an alphabetical directory of the companies and a suppliers' index. This publication is available in English, French, and German.

Circle No. 32 on Reader Service Card

Research Study

Packaging Research International, Inc., introduces the 1996 edition of *An Analysis of the Market for Intermediate Bulk Containers and 30-55 Gallon Non-bulk Packagings* that examines market usage, current market pricing, trends, and major using segments for intermediate bulk containers and non-bulk packaging.

Circle No. 33 on Reader Service Card

Additives Catalog

A new specialty additives catalog from Daniel Products Co., Inc., is available in Spanish. This catalog focuses on the complete range of performance enhancing specialty additives for inks and coatings. A few of the products described in this 26-page catalog include defoamers, emulsions, UV stabilizers, and micronized waxes.

Circle No. 34 on Reader Service Card

Gas Detection

Bacharach, Inc., offers their new catalog to address gas detection. The instrument types in this catalog range from survey to area sampling to personal monitoring. The company's instruments are designed to aid in many detection applications including confined space entry, leak verification, and personal protection.

Circle No. 35 on Reader Service Card

Equipment

Data Logger

Onset Computer Corp. introduces a temperature logger for HVAC systems, energy surveys, and quality control. The Hobo® Temp is a battery-powered data logger and measures temperatures from -4° to 158°F (-20° to 70°C) and stores 1,800 data points in 2K memory.

Circle No. 36 on Reader Service Card

Gas Detector

National Draeger, Inc., announces the release of a multi-gas instrument that can monitor one to five gases. Multiwarn II can have three sensors, one infrared and/or one catalytic combustion/thermal conductivity. This gas detection system may also have an internal pump that can draw a gas sample up to 100 ft. Sensors and functions may be added as the workplace changes.

Circle No. 37 on Reader Service Card

Pumpheads

Watson-Marlow Inc. introduces 313D OEM pumpheads for transfer, metering, and vacuum applications. This pumphead features a clamping mechanism that makes tube loading easy and ensures that the tubing is loaded properly. The pumpheads can be combined for multi-channel applications and are designed to snap-lock to each other.

Circle No. 38 on Reader Service Card

Laboratory Apparatus

Fluorine Detector

Bruker Spectrospin (Canada) Ltd. introduces its high sensitivity fluorine spectrometer in a table-top version. The NMS Minispec NMR provides non-destructive determination of fluorine in liquids, solids, and polymers without using wet chemistry and by being environmentally friendly. The Minispec NMR has robotics available to automate the analysis procedure.

Circle No. 39 on Reader Service Card

Particulate Respirator

The Moldex 2200 N95 respirator has a polymesh shell that holds its shape and resists collapsing in hot and humid climates. Moldex-Metric, Inc., designs this respirator with a naturally contoured facepiece that contains a molded, bandless nose bridge that maintains a seal and also acts as a platform for safety eyewear. This respirator is certified by NIOSH to provide 95% efficiency for dust and non oil-based mists.

Circle No. 40 on Reader Service Card

Miscellaneous

Vacuum Breaker

Hayward Industrial Products, Inc., introduces an all-plastic, corrosion resistant vacuum breaker. This vacuum breaker allows air to enter tanks and piping systems for draining. When the draining is complete, the breaker resets itself to the closed position. The Hayward breaker operates automatically and is closed when internal pressure is above 1 psi. As the tank or piping system drains, the internal pressure falls and the breaker opens to allow air to enter. When the draining is completed and the internal pressure rises, the vent closes.

Circle No. 41 on Reader Service Card

In-Line Filter/Strainer

Ron-Vik, Inc., introduces a one-inch compact filter/strainer developed to offer the benefits of the original filter in a less spacious and more economical way. The filter is available in both nylon and 20% glass filled molded black polypropylene materials designed to accommodate both polyethylene or wire mesh elements. Standard screen sizes are 20, 40, or 80 type 304 wire mesh, and all replacement parts are the same as the filter/strainer line parts.

Circle No. 42 on Reader Service Card

Dumping Station

Flexicon Corp. introduces a manual dumping station to collect dust created by dumping powder and bulk solid materials from boxes, drums, bags, and other containers. This dumping station has a high velocity vacuum fan that pulls airborne dust through two five-micron filters. The dust is returned to a hopper equipped with a flanged outlet that may be connected to a blender, conveyor, or other process equipment. Filters are accessed by removing the interior baffle and replacing it using quick-disconnect fittings.

Circle No. 43 on Reader Service Card

pH and ORP Control Systems

Dynatec Systems, Inc., introduces their pH and oxidation/reduction potential (ORP) control systems for controlling and treating wash water from paint manufacturing processes. The standard control system has a flow capacity from 5 to 200 gal/min and is designed to be self regulating. These control systems are were developed for a variety of uses, can be configured to adjust pH in one or two directions, and can be combined with ORP control on the same skid.

Circle No. 44 on Reader Service Card

Filtered Bag Dump

Wm. W. Meyer & Sons, Inc., announces their new Meyer Filtered Dump Bag Work Stations designed to draw away dust from operators in the immediate work environment. This dust drawing process is accomplished with an exhaust blower drawing ambient air over and through the loading grate while bags and drums are unloaded, and the dust is drawn into multiple filters, cleaned, and reintroduced into the system. The cartridges are cleaned by shooting staggered high pressure air into the cartridges to ensure a continuously monitored environment.

Circle No. 45 on Reader Service Card

Paints/ Coatings

Ceramic Paint

Zinc No-Stick has been developed by ORPAC, Inc., to prevent zinc adherence or sticking to surfaces. This product is a ceramic paint totally non-wetted by molten zinc to prevent galvanizing in unwanted regions. This ceramic paint is packaged in water- or solvent-based versions and is applied like housepaint.

Circle No. 46 on Reader Service Card

No-VOC Dispersion

Reichhold-RBH Pigment Dispersions introduces a no-VOC dispersion line for inplant tinting of waterborne coatings. This new system consists of 13 glycol-free colorants to provide color development and strength. These no-VOC pigment dispersions are also compatible in most aqueous vehicle systems.

Circle No. 47 on Reader Service Card

Salt Fog Corrosion

Butrol® 9104, developed by Buckman Laboratories, is an active pigment that does not contain zinc, lead, barium, chromates, nor SARA 313 components. Butrol 9104 was used in a study according to ASTM B-117 and may be formulated into a range of environmentally friendly coatings for maintenance, industrial, and consumer use.

Circle No. 48 on Reader Service Card

Rheological Additives

RHEOX, Inc., introduces two new rheological additives for low VOC and zero VOC waterborne systems, Rheolate 420 and Rheolate 2001. Rheolate 420 yields high thickening efficiency in the medium shear range and imparts pigment suspension and sag resistance with reportedly good leveling properties. Rheolate 2001 is a fine particle size, liquid antisettling agent used in water-reducible coating and ink systems.

Circle No. 49 on Reader Service Card

Raw Materials

Surface Cleaner

Lincoln Automotive announces a product that reportedly contains and picks up oils, lubricants, and hazardous materials without leaving a residue. Chem Oil-A-Way is a non-toxic, inorganic compound that can be sprinkled on the spill, scrubbed in with a broom, and then swept up. After using this sorbent on a spill, it may be screened to remove the saturated lumps and reused for the next spill.

Circle No. 50 on Reader Service Card

Polymer Pellet Sampler

ASI announces an FTIR accessory for the analysis of polymer beads. The Polymer Pellet Sampler is an ATR-based device that uses diamond composite technology to analyze polymer bead samples. The sampler provides 6,000 to 400 wavenumber measurement range, enables pellets to be pressed to be in even contact with the diamond sampling surface, and is equipped with a trough to pour pellets and move them without spilling.

Circle No. 51 on Reader Service Card

Catheter Bonding Adhesives

The new line of catheter bonding adhesives introduced by Dymax Corporation reportedly provides solvent-free assembly solutions for catheter substrates and designs. This catheter bonding adhesive bonds to a variety of plastics, glass, and metals. It is solvent-free, USP Class VI tested and approved, and FDA, EPA, and OSHA compliant.

Circle No. 52 on Reader Service Card

Microspheres

Particle size ceramic white Zeeospheres microspheres have been developed by Zeelan Industries, Inc., a subsidiary of 3M Co. The white Zeeospheres are similar to the company's gray Zeeospheres in that they can be used as fillers in paints, plastics, adhesives, and similar polymer compounds. The white microspheres reportedly offer low resin demand, low viscosity, abrasion resistance, and improved particle packing for corrosion resistance.

Circle No. 53 on Reader Service Card

Sealants/ Caulks

Caulk

CorMax® PSC is a polysulfide-based caulk specifically designed to seal joints and chime angles of petro/chemical or wastewater holding tanks, sumps, or trenches. DuPont High Performance Coatings Div. developed this caulk to be resistant to crude oils, certain acids and solvents, and fuels. CorMax® PSC is self-leveling, cures under water, is impact resistant and flexible, and contains no VOCs.

Circle No. 54 on Reader Service Card

Testing Equipment

Leak Test System

A new leak test system from Balzers Instruments, the LTS 212, is an automatic leak test system for all sizes of pressurized spray cans with a one-inch opening. To test for leaks, the cans are filled with an air/helium mixture and are tested to a leak tightness of 10^{-4} mbar l/s. It is possible to test down to 10^{-8} mbar l/s with reduced throughput. This leak test system has two independent chambers to simultaneously test two cans.

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JOURNAL OF COATINGS TECHNOLOGY

Reader Service Card
September 1996 Issue

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- BB ☐ Manufacturers of Raw Materials
- CC ☐ Manufacturers of Equipment and Containers
- DD ☐ Sales Agents for Raw Materials and Equipment
- EE ☐ Government Agency
- FF ☐ Research/Testing/Consulting
- GG ☐ Educational Institution/ Library
- HH ☐ Paint Consumer
- JJ ☐ Other

Your Position
(Check One Block)

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- MM ☐ Quality Control
- NN ☐ Research & Development
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- QQ ☐ Sales & Marketing
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004	024	044	064	084	104	124	144	164	184	204	224	244	264	284
005	025	045	065	085	105	125	145	165	185	205	225	245	265	285
006	026	046	066	086	106	126	146	166	186	206	226	246	266	286
007	027	047	067	087	107	127	147	167	187	207	227	247	267	287
008	028	048	068	088	108	128	148	168	188	208	228	248	268	288
009	029	049	069	089	109	129	149	169	189	209	229	249	269	289
010	030	050	070	090	110	130	150	170	190	210	230	250	270	290
011	031	051	071	091	111	131	151	171	191	211	231	251	271	291
012	032	052	072	092	112	132	152	172	192	212	232	252	272	292
013	033	053	073	093	113	133	153	173	193	213	233	253	273	293
014	034	054	074	094	114	134	154	174	194	214	234	254	274	294
015	035	055	075	095	115	135	155	175	195	215	235	255	275	295
016	036	056	076	096	116	136	156	176	196	216	236	256	276	296
017	037	057	077	097	117	137	157	177	197	217	237	257	277	297
018	038	058	078	098	118	138	158	178	198	218	238	258	278	298
019	039	059	079	099	119	139	159	179	199	219	239	259	279	299
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FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (610) 940-0777, FAX: (610) 940-0292.

1996

(Oct. 22-24)—International Coatings Technology Conference. Chicago Hilton and Towers and McCormick Place North, Chicago, IL.

(Oct. 23-25)—International Coatings Expo (Formerly Annual Meeting and Paint Industries' Show). McCormick Place North, Chicago, IL.

1997

(Nov. 3-5)—International Coatings Technology Conference and Expo (Formerly Annual Meeting and Paint Industries' Show). Georgia World Congress Center, Atlanta, GA.

SPECIAL SOCIETY MEETINGS

1997

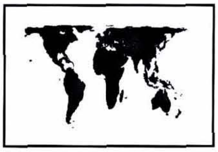
(Feb. 5-7)—24th Annual International Waterborne, High-Solids, and Powder Coatings Symposium. Sponsored by the Southern Society and The University of Southern Mississippi (USM). New Orleans, LA. (Robson F. Storey or Shelby F. Thames, Co-Organizers, WBHS&PC Symposium, Dept. of Polymer Science, USM, Box 10076, Hattiesburg, MS 39406-0076).

(Feb. 18-20)—Western Coatings Societies' 23rd Biennial Symposium and Show. Sponsored by the Golden Gate, Los Angeles, Pacific Northwest, and Rocky Mountain Societies. Disneyland Hotel and Convention Center, Anaheim, CA. (Bruce Cotton, Pluess-Staufer (California), Inc., P.O. Box 825, Lucerne Valley, CA 92356; (619) 248-7306; or Ron Elliott, J.R. Elliott Enterprises, Inc., 300 Thor Pl., Brea, CA 92621; (714) 529-0711).

(May 8-10)—50th Annual Spring Symposium. Sponsored by the Pacific Northwest Society. Panamerican Hotel, Vancouver, British Columbia. (Yvon Poitras, Horizon Chemicals Ltd., 10311 Cornerbrook Crescent, Richmond, BC, Canada, V7E 4H5; (604) 271-6772).

(May 12-14)—Southern Society Annual Meeting. King and Prince Beach and Golf Resort, St. Simons Island, GA. (Eve Irvine, J.M. Huber Corp., One Huber Rd., Macon, GA 31298; (912) 750-5433).

OTHER ORGANIZATIONS



1996—North America

(Sept. 23-27)—"Introduction to Paint Formulation." Short Course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 1870 Miner Circle, Rolla, MO 65409).

(Sept. 30-Oct.1)—Florida Plastics Summit. Sponsored by The Society of the Plastics Industry (SPI), Inc. Clarion Plaza Hotel, Orlando, FL. (SPI, 1275 K St., N.W., Ste. 400, Washington, D.C. 20005).

(Oct. 1)—Rheology Seminar. Sponsored by Brookfield Engineering Laboratories, Inc. San Francisco, CA. (Barbara Cunningham, Brookfield Engineering Laboratories, Inc., Dept. NR-119, 240 Cushing St., Stoughton, MA 02072).

(Oct. 3)—Rheology Seminar. Sponsored by Brookfield Engineering Laboratories, Inc. Denver, CO. (Barbara Cunningham, Brookfield Engineering Laboratories, Inc., Dept. NR-119, 240 Cushing St., Stoughton, MA 02072).

(Oct. 2-3)—Fifth Annual Advanced Radiation (UV/EB) Curing Marketing/Technology Seminar. Sponsored by Armbruster Associates, Inc. Marriott Hotel, Newark Airport, Newark, NJ. (David C. Armbruster, Armbruster Associates, Inc., 43 Stockton Rd., Summit, NJ 07901).

(Oct. 6-11)—ISA/96. Technical Conference and Exhibition sponsored by the International Society for Color Measurement. McCormick Place North, Chicago, IL. (ISA, 67 Alexander Dr., P.O. Box 12277, Research Triangle Park, NC 27709).

(Oct. 7-9)—"Basic Coatings for Sales, Marketing, and General Personnel." Short Course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 1870 Miner Circle, Rolla, MO 65409).

(Oct. 8-11)—International Process Safety Managment Conference & Workshop. Sponsored by American Institute of Chemical Engineers. Airport Marriott Orlando, Orlando, FL. (AIChE*xpress* Service Center, 345 E. 47th St., New York, NY 10017-2395).

(Oct. 8-11)—"Response Surface Methods for Process Optimization." Sponsored by Stat-Ease Inc. Minneapolis, MN. (Rich Burnham, Stat-Ease Inc., Hennepin Square, Ste. 191, 2021 E. Hennepin Ave., Minneapolis, MN 55413-2723).

(Oct. 14)—Coatings Care™ Symposium. Sponsored by the National Paint & Coatings Association (NPCA). Mitretek Systems, McLean, VA. (Cheryl Matthews, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005-5597).

(Oct. 14-17)—15th International Congress on the Applications of Lasers and Electro-Optics. Sponsored by the Laser Institute of America. Radisson Plaza Hotel at Town Center, Southfield, MI. (Daryl Flynn, Laser Institute of America, 12424 Research Pkwy., Ste. 125, Orlando, FL 32826).

(Oct. 14-18)—43rd National Symposium of the American Vacuum Society. Pennsylvania Convention Center, Philadelphia, PA. (American Vacuum Society, 120 Wall St., 32nd Flr., New York, NY 10005).

(Oct. 16-18)—"Ceramic and Glass Solutions for New and Improved Products." Course cosponsored by The New York State College of Ceramics at Alfred University and the New York State Center for Advanced Ceramic Technology. Alfred University, Alfred, NY. (Marlene Wightman, New York State College of Ceramics, Alfred University, Alfred, NY 14802).

(Oct. 16-19)—Joint Fall Meeting of the Basic Science, Nuclear, and Environmental Technology and Cements Division. Sponsored by The American Ceramic Society. San Antonio, TX. (The American Ceramic Society, 735 Ceramic Place, Westerville, OH 43081-8720).

(Oct. 20-23)—"Polyurethanes Expo '96." Technical Conference & Exposition sponsored by The Society of the Plastics Industry, Inc., (SPI). Bally's Las Vegas Casino and Hotel, Las Vegas, NV. (SPI, Polyurethane Division, 355 Lexington Ave., New York, NY 10017).

(Oct. 23-25)—109th Annual Meeting of the National Paint and Coatings Association (NPCA). Palmer House (Hilton), Chicago, IL. (Cheryl Matthews, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005-5597).

(Oct. 23-25)—"Spray Finishing Technology Workshop." Sponsored by Bowling Green State University (BGSU) and ITW DeVilbiss. ITW DeVilbiss Training Center, Maumee (Toledo), OH. (Richard A. Kruppa, College of Technology, BGSU, Bowling Green, OH 43403).

(Oct. 24-25)—"Set-Up Reduction—How to Apply Innovative Just-In-Time Techniques to Shrink Lot Sizes, Slash Lead Times, and Maximize Competitiveness." Sponsored by The Saddle Island Institute. University Park Hotel, Salt Lake City, UT. (Betsy Tyson, The Saddle Island Institute, 100 State St., Boston, MA 02109).

(Oct. 27-Nov. 1)—84th Congress & Exposition. Sponsored by the National Safety Council. Orange County Convention Center, Orlando, FL. (Michael J. Taylor, National Safety Council, 1121 Spring Lake Dr., Itasca, IL 60143-3201).

(Oct. 28-29)—"Set-Up Reduction—How to Apply Innovative Just-In-Time Techniques to Shrink Lot Sizes, Slash Lead Times, and Maximize Competitiveness." Sponsored by The Saddle Island Institute. Radisson Plaza Hotel at Kalamazoo Center, Kalamazoo, MI. (Betsy Tyson, The Saddle Island Institute, 100 State St., Boston, MA 02109).

(Oct. 28-30)—"The Fundamentals of Corrosion and Its Control." Sponsored by LaQue Corrosion Services. Holiday Inn SunSpree Resort, Wrightsville Beach, NC. (S. Darden, LaQue Corrosion Services, P.O. Box 656, Wrightsville Beach, NC 28480).

(Oct. 29-31)—Fabtech West Conference & Exposition. Sponsored by the Society of Manufacturing Engineers (SME). San Jose Convention Center, San Jose, CA. (SME, One SME Drive, P.O. Box 930, Dearborn, MI 48121-0930).

(Nov. 1-3)—"Fall Decor '96: Paint and Decorating Show." Sponsored by the National Decorating Products Association (NDPA). Minneapolis Convention Center, Minneapolis, MN. (Teri Flotron, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Nov. 3-6)—1996 International Conference. Sponsored by the Adhesive and Sealant Council, Inc. Fairmont Atop Nob Hill, San Francisco, CA. (Kathy Oates Domenick, Director, Education and Training, The Adhesive and Sealant Council, Inc., 1627 K St., N.W., Ste. 1000, Washington, D.C. 20006).

(Nov. 4-6)—"Particle Size Analysis." Training course sponsored by Horiba Instruments, Irvine, CA. (Geneen Spence, Horiba Instruments, 17671 Armstrong Ave., Irvine, CA 92714).

(Nov. 6-7)—"Paint Volatile Organic Compounds (VOCs)." Training course sponsored by the American Society for Testing and Materials (ASTM). Los Angeles, CA. (Kristina Falkenstein, ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959).

(Nov. 6-8)—ARMA Executive Committee Meeting and Board of Directors Meeting. Sponsored by Asphalt Roofing Manufacturers Association (ARMA). Tucson, AZ. (ARMA, 6000 Executive Blvd., Ste. 201, Rockville, MD 20852-3803).

(Nov. 10-13)—"Organic Coatings Science and Technology." Sponsored by the State University of New York, Institute of Materials Science and the Division of Polymeric Materials: Science and Engineering of the American Chemical Society (ACS). Westin Resort, Hilton Head Island, SC. (Angelos V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Nov. 10-15)—Annual Meeting of the American Institute of Chemical Engineers. Sponsored by American Institute of Chemical Engineers. Palmer House Hilton, Chicago, IL. (AIChE*xpress* Service Center, 345 E. 47th St., New York, NY 10017-2395).

(Nov. 12-14)—Autofact Conference & Exposition. Sponsored by the Society of Manufacturing Engineers (SME). Cobo Center, Detroit, MI. (SME, One SME Drive, P.O. Box 930, Dearborn, MI 48121-0930).

(Nov. 17-21)—SSPC '96. 1996 International Conference and Exhibition. Charlotte, NC. (Dee Boyle, SSPC, 40 24th St., 6th Floor, Pittsburgh, PA 15222-4643).

(Nov. 19-22)—"The Fourth Color Imaging Conference: Color Science, Systems, and Applications." Sponsored by the Society for Imaging Science & Technology (IS&T) and the Society for Information Display (SID). The Radisson Resort, Scottsdale, AZ. (IS&T, 7003 Kilworth Lane, Springfield, VA 22151; or SID, 1526 Brookhollow Dr., Ste. 82, Santa Ana, CA 92705).

(Nov. 25-26)—Thomas Show. Sponsored by Thomas Scientific. Renaissance Harborplace Hotel, Baltimore, MD. (Thomas Scientific, 99 High Hill Rd. at I-295, Swedesboro, NJ 08085-0099).

1997—North America

(Jan. 21-24)—"Environmentally Compliant Coatings." Short course sponsored by North Dakota State University (NDSU). Crowne Plaza Resort, Hilton Head Island, SC. (Debbie Shasky, Program Coordinator, NDSU, Dept. of Polymers and Coatings, 54 Dunbar Hall, Fargo, ND 58105).

(Jan. 28)—PCI Technical Subcommittee on Test Methods and ASTM D01.51 on Powder Coatings. Sponsored by the American Society for Testing and Materials (ASTM). Embassy Suites, Ft. Lauderdale, FL. (Jeffrey Hagerlin, O'Brien Powder Products, 9800 Genard Rd., Houston, TX 77041-7624).

(Feb. 14-15)—"Spring Decor '97: Paint & Decorating Show." Sponsored by the National Decorating Products Association (NDPA). Charlotte Convention Center, Charlotte, NC. (Teri Flotron, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Feb. 22-24)—"Interiors Decor Showcase '97." Sponsored by the National Decorating Products Association (NDPA). Toronto Congress Centre, Toronto, Ontario, Canada. (Teri Flotron, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Feb. 24-26)—"Basic Coatings for Sales, Marketing, and General Personnel." Short Course sponsored by University of Missouri-Rolla (UMR), St. Louis, MO. (UMR Coatings Institute, 1870 Miner Circle, Rolla, MO 65409).

(Mar. 1-2)—"Degradation and Stabilization of Polymers." Sponsored by the State University of New York. Hilton Head Island, SC. (Angelos V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 2-5)—SSPC 1997 Compliance in Industrial Paint Conference. Sheraton Stamford Hotel, Stamford, CT. (Dee Boyle, SSPC, 40 24th St., 6th Floor, Pittsburgh, PA 15222-4643; (412) 281-2331).

(Mar. 10-12)—"Block and Graft Copolymer Blends." Sponsored by the State University of New York. Hilton Head Island, SC. (Angelos V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 10-12)—"Introduction to Polymer Colloids/Emulsion Polymers." Sponsored by the State University of New York. Hilton Head Island, SC. (Angelos V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 10-13)—"Pigment Dispersions." Sponsored by the State University of New York. Hilton Head Island, SC. (Angelos V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Apr. 7-10)—12th Annual Advanced Composites Conference and Exposition. Sponsored by The Engineering Society (ESD) and SAE International. Westin Hotel, Renaissance Center, Detroit, MI. (Wael Berrached, ESD, 29355 Northwestern Hwy., Ste. 200, Southfield, MI 48034).

(Apr. 7-11)—"Basic Composition of Coatings." Short Course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 1870 Miner Circle, Rolla, MO 65409).

(Apr. 8-10)—Sixth Annual Advanced Coatings Technology Conference & Exposition. Sponsored by The Engineering Society (ESD) and SAE International. Westin Hotel, Renaissance Center, Detroit, MI. (Wael Berrached, ESD, 29355 Northwestern Hwy., Ste. 200, Southfield, MI 48034).

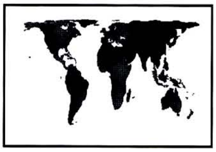
(Apr. 21-24)—"Introduction to Paint Formulation." Short Course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 1870 Miner Circle, Rolla, MO 65409).

(May 5-7)—"Adhesive and Coating Adhesion." Sponsored by the State University of New York. Orlando, FL. (Angelos V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(May 19-23)—"Physical Testing of Paints & Coatings." Short Course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 1870 Miner Circle, Rolla, MO 65409-0010).

(June 2-13)—Summer Coatings Course. Sponsored by North Dakota State University (NDSU). Fargo, ND. (Debbie Shasky, Program Coordinator, NDSU, Dept. of Polymers and Coatings, 54 Dunbar Hall, Fargo, ND 58105).

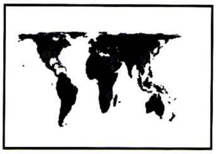
1997—Asia



(Mar. 9-11)—India International Coatings Show '97. Sponsored by FMJ International Publications Ltd. World Trade Centre, Bombay, India. (Jane Malcolm-Coe, PR & Publicity Dept., FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS, England).

(Oct. 22-24)—"New Developments in Colour Material Science and Technology." 70th Anniversary Conference on Colour Materials Tokyo sponsored by the Japan Society of Colour Material. Arcadia Ichigaya (Shigaku Kaikan), Tokyo, Japan. (Shuichi Hamada, Japan Society of Colour Material, Kitamura Bldg. 5F, 9-12, 2-chome, Iwamoto-cho, Chiyoda-ku, Tokyo 101, Japan).

1996—Europe



(Oct. 7-9)—Central European Coatings Show. Exhibition and Conference sponsored by FMJ International. Katowice, Poland. (Jane Malcolm-Coe, FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS, England).

(Oct. 21-22)—"World Congress PET '96." Sponsored by Maack Business Services. Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/Zürich, Switzerland).

(Nov. 4-5)—The Sixth Annual Conference on Textile Coating and Laminating. Sponsored by the *Journal of Coated Fabrics*. Dusseldorf Hilton Hotel, Dusseldorf, Germany. (Programme Division: Technomic Publishing AG, Missionstrasse 44, Ch-4055 Basel, Switzerland).

(Nov. 11-13)—"Waterborne, High-Solids, & Radcure Technologies." Sponsored by Paint Research Association. Frankfurt, Germany. (Conference Secretary, Paint Research Association, 8 Waldegrave Rd., Teddington, Middlesex, TW11 8LD England).

Advertisers' Index

Humbug from Hillman

A few months ago, I wrote of Frank Borrelle's excitement with his new computer. After several weeks of frustration, he writes, "Our oldest son is pressing me to go On-Line, the E-Mail, followed by Celestial Correspondence and Subterranean Smoke. I keep telling him that I am still learning how to perfect the shut down of this confounded computer and you don't do that by simply pressing a button."

Frank included a copy of *Time Out*. Canada's No-News Magazine brought to him by Past-President Clarke Boyce. Here are some crazy excerpts:

➥ What do you give a man who has everything? . . . A burglar alarm!

➥"Daddy, you'll love my new boyfriend. He's so nice and polite."

"But does he have any money?"

"Honestly, you men are all alike. He asked me the same question about you."

➥ After taking his dad through his small apartment, the son looked at his dad and asked, "So, how do you like my room as a whole?"

"As a hole, it's O.K, but as a room, no."

➥ Notice in a local paper: To the bank robbers who broke into our First Avenue branch: "We offer complete banking services at all of our banking offices. Next time you have a financial problem, let one of our trained loan officers assist you."

➥ There's nothing like your first horseback ride to make you feel better off.

➥ Receptionist: "Would you like the $35 room or the $50 room?

Traveler: "What's the difference?"

Receptionist: "With the $50 room you get free TV."

➥ The consultant was showing the young medical student a set of X-rays. "As you will observe," said the consultant, "one hip seems to be higher than the other. What do you expect to find wrong with the patient?"

"I would expect him to walk with a limp."

"Good, and so what would you do under the circumstances?"

"I suppose I'd walk with a limp too."

* * *

I wasn't surprised to learn from my zany friend, Dick Stewart, that he has had retirement "forced" upon him. A further explanation of the event can be explained by his comment, "My father was a workaholic. Thank God this only happens every second generation."

With his usual nuttiness, Dick included a story that he attributed to Frank Borrelle. However, since I have already mentioned Frank in this issue, I will make Dick the culprit.

It seems that Dick bought a house. It was right next to a railroad track. He rented it out to a newly wed couple.

A few days after the couple moved in, Dick went around to make sure they were settled and didn't want for anything.

The lady of the house was most upset and yelled at Dick, "You told me that this was a good house. Every time a train goes by the whole house shakes. I can't get a night's sleep because those damn trains shake me right out of bed."

"It's a good house," Dick replied. "Don't you think that you are exaggerating just a little?"

"No, I am not," she retorted. "Look there's a train due any minute. I will lie down on the bed and you can see what happens. Better still, why don't you lie next to me and you can feel what happens."

Dick agreed and just got himself comfortable on the bed when the door opened. It was her husband and, of course, he wanted to know just what the hell was going on.

"You're not going to believe this," Dick said, "We're waiting for a train."

Dick once wrote me that he went into a clothing store to buy a tie. As the clerk was wrapping up the purchase, Dick said he had changed his mind and wondered if he could swap the tie for a pair of socks.

"No problem," the clerk said and wrapped up the pair of socks.

Dick, then, picked up the socks and started to leave the store.

"Just a minute," the clerk said. "You didn't pay for the socks."

"I know," Dick said. "I swapped the tie for the socks."

"Yes," the clerk argued. "But you didn't pay for the tie."

"Why should I pay for the tie," Dick asked. "I didn't keep it."

* * *

Dave Platt is such a slow learner that it has been some time since I've had occasion to report on the things he has learned. In case anyone cares, it took all this time for him to come up with these "brilliant" observations!

➥ I've learned that couples without children always know how you should raise yours.

➥ I've learned that when I drop a slice of bread it always lands with the jelly side down.

➥ I've learned that children and grandparents are natural allies.

➥ I've learned that if you give a pig and a boy everything they want, you'll get a good pig and a bad boy.

Taxes and prices are rising.
And it's becoming increasingly clear:
You not only can't take it with you,
You can't even keep it while here.

"How embarrassing!" said one fellow to another.

"The party invitation said 'Black Tie Only.' But when I got there, everyone was wearing suits, too."

—The Lion

—Herb Hillman, Humbug's Nest,
P.O. Box 135, Whitingham, VT 05361.

Supplement to the November 1996 issue of the

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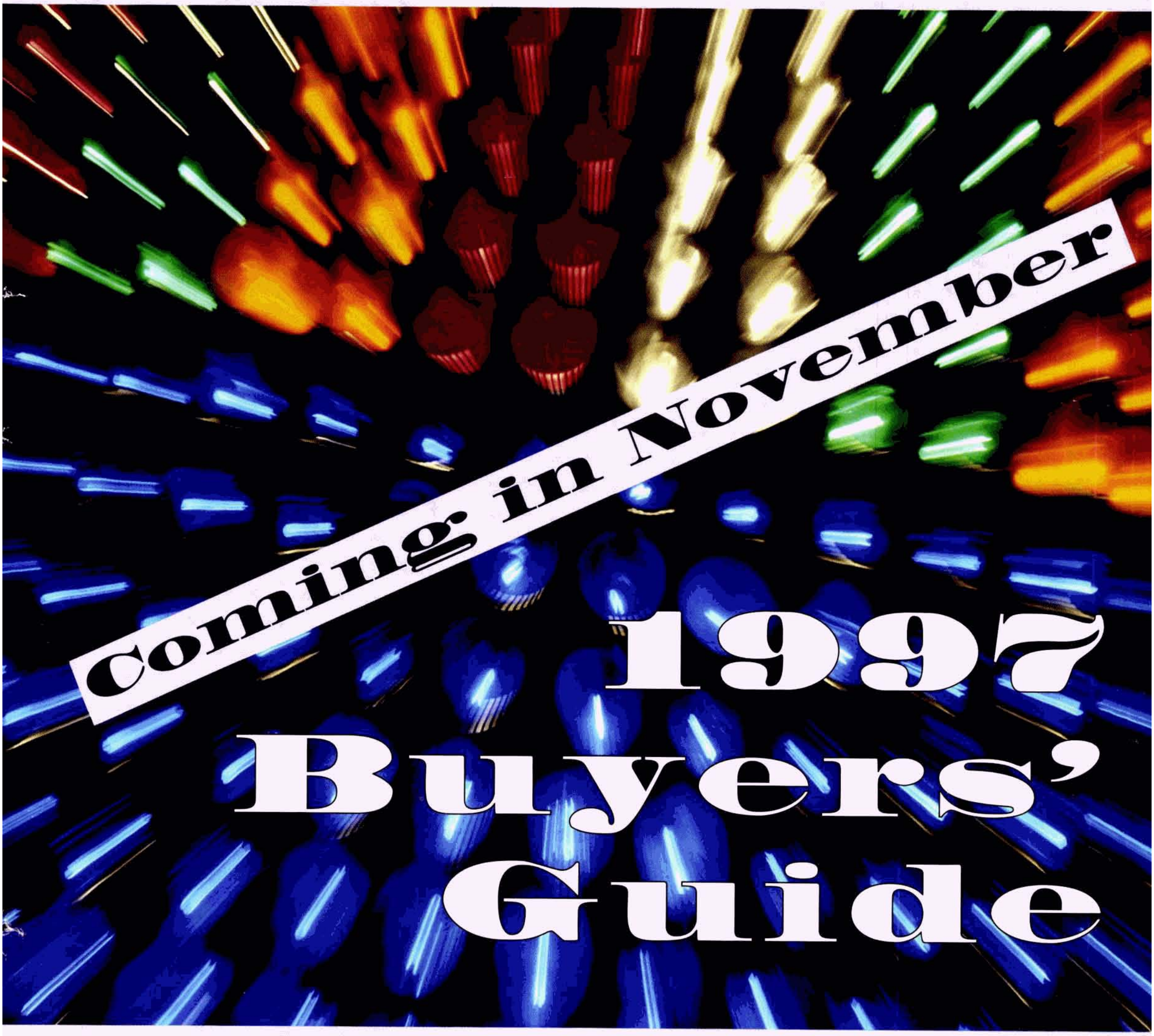

The 1997 JCT Buyers' Guide will be published as a supplement to the November 1996 issue of the Journal of Coatings Technology. Anyone wishing to participate should contact JCT, 492 Norristown Rd., Blue Bell, PA 19422; Phone: (610) 940-0777; Fax: (610) 940-0292.

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