

**Prediction of
Coating Failure Over
Sheet Molding
Compound (SMC):
*Solvent Permeation Studies***



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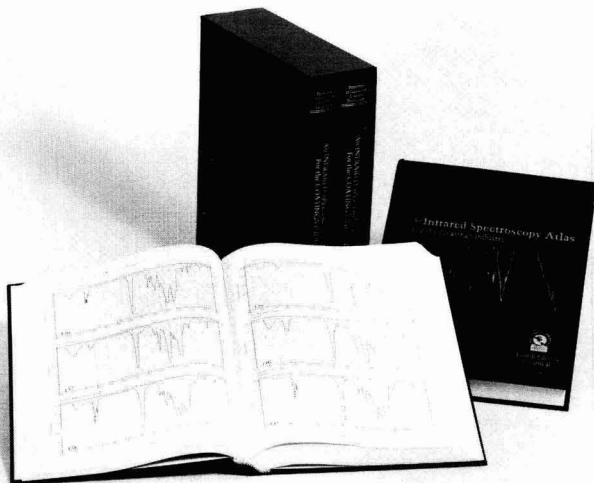
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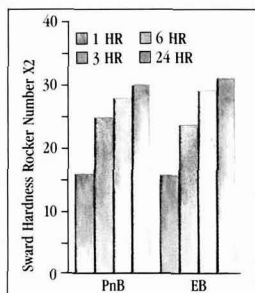


Figure 1 - Hardness Development Rates in Typical Acrylic-Based Latex

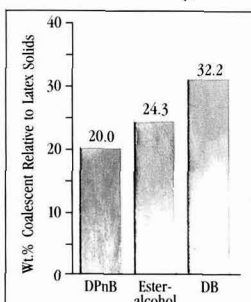


Figure 2 - Coalescent Levels Required for 50°F MFFT in Typical Acrylic-Based Latex

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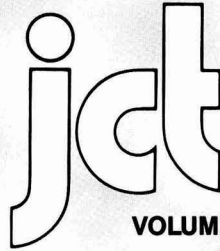


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Comment

Why Federation?

As the Federation of Societies for Coatings Technology moves into its second year in the new Blue Bell, Pennsylvania Headquarters building, it is fitting that we once again look at this remarkable organization to see just where it fits into the great scheme of things.

This organization is somewhat unique in the industry, in that it is a "bottom up" rather than a "top down" structure, with Headquarters the coordinator of the many functions of the local Societies, rather than being the prime mover of the entire organization from which all power flows. The power of the Federation is resident in the local Societies, whose duly elected representatives sit as the Board of Directors. If local Societies have a Manufacturing Committee, the Federation has a Manufacturing Committee to aid the local groups, not direct them in their activities. Likewise for the Technical (called Advisory) Committee, Educational (called Coordinating) Committee, and Environmental Affairs Committee. As the Societies have Honorary Members, so can the Society nominate one of its members to Federation Honorary Membership. For organizational purposes, there is a local Society need for each Federation function.

This structure differs from many other trade and professional organizations, many of whom bestow national awards of one type or another on members of local societies. For the Federation, this type of honor would result from a local Society creating such an award, and other local Societies seeing the merit of it, do likewise, until the need for a Federation award as another step of a local Society award would be apparent.

Such is the strength of the Federation, a union of independent local Societies, and such also is its weakness when swift action at a national level seems called for. About the best we can do is recognize the Federation for what it is, and glory in its ability to make the individual important.



William F. Holmes
FSCT President

Abstracts of Papers in This Issue

PREDICTION OF COATING FAILURE OVER SHEET MOLDING COMPOUND (SMC): SOLVENT PERMEATION STUDIES—R.A. Ryntz, W.R. Jones, and A. Czarnecki

Journal of Coatings Technology, 64, No. 807, 29 (Apr. 1992)

The major failures attributed to coating appearance as applied over sheet molding compound (SMC) are those due to solvent popping or solvent blow-through from the substrate through the coating. Evidence has been reported by G.D. Cheever, of General Motors, which indicates solvent penetration of coating solvents into the porous substrate, which later erupts through the cured coating upon heating, thereby affording a cratered-like appearance.

Our studies relate the tendency of solvents to diffuse through a variety of coating types to the solvent blow-through resistance of the cured coating/SMC composite. Relationships are derived which correlate the ability of a coating to inhibit the solvent blow-through failure on SMC to solvent permeation resistance of a coating formulation into the SMC/coating composite. With this predictive relationship, acceptable finishes can be qualified on SMC by the coating formulation utilized.

T_g-TEMPERATURE PROPERTY (T_gTP) DIAGRAM FOR THERMOSETTING SYSTEMS: ANOMALOUS BEHAVIOR OF PHYSICAL PROPERTIES VS EXTENT OF CURE—X. Wang and J.K. Gillham

Journal of Coatings Technology, 64, No. 807, 37 (Apr. 1992)

The relationships between the isothermal physical properties in the glassy state of amorphous thermosetting cross-linked polymers and chemical conversion are anomalous and complex. In this manuscript, a generalized framework for correlating the basic physical properties of a high-glass transition temperature (T_g) thermosetting amine/epoxy system vs extent of cure at isothermal temperatures from above T_g to deep in the glassy state is reported in terms of the T_g-Temperature Property (T_gTP) Diagram which is introduced with this report. The framework arises from consideration of the isothermal shear modulus and the isothermal physical aging rate vs extent of cure, both of which display maxima and minima throughout a wide range of temperatures below T_g. Use of T_g as a direct measure of conversion results in linearization of the anomalous maxima and minima of the physical properties vs extent of cure in the T_gTP Diagram. The anomalous behavior is related to specific phenomena, such as the glass transition (vitrification) and the glassy-state β-transition (T_β) which change with conversion, and also gelation. The different behavior of the material vs extent of cure corresponds to different

regions. Such simple diagrams are intellectually useful for understanding the properties of materials for both under-cured materials (with change of conversion) and fully cured materials (with change of stoichiometric ratio).

UTILIZATION OF HYDROXYL TERMINATED POLYBUTADIENE IN AIR DRY RUST INHIBITIVE PRIMERS—J.J. Salitros

Journal of Coatings Technology, 64, No. 807, 47 (Apr. 1992)

Hydroxyl terminated polybutadiene (HTPB) has been utilized for its reactivity with isocyanate resins to produce sealants and waterproofing membranes with excellent hydrophobic properties. Resistance to chemical solutions in water is excellent and surpasses most other resins. Resistance of the HTPB modified polyurethanes to most solvents is not good, as evidenced by swelling of the films.

Unsaturations in the HTPB backbone is responsive to oxidative crosslinking with the use of driers routinely used for promoting the drying of thin film alkyd resin coatings. Air-dry primers were formulated using pigments designed for rust inhibition. These primers containing HTPB and rust inhibitive pigments were applied to different metal substrates and subject to salt fog testing. Thin films of HTPB based primers have excellent resistance to aqueous chemical solutions and organic solvents.

HTPB based primers were used under various topcoats to determine primer recoatability and intercoat adhesion. HTPB based primers are suitable for use under alkyds, chlorinated rubber enamels, and high gloss two-component urethane topcoats.

PIGMENT STABILIZATION THROUGH MIXED ASSOCIATIVE THICKENER INTERACTIONS—D.J. Lundberg and J.E. Glass

Journal of Coatings Technology, 64, No. 807, 53 (Apr. 1992)

The role of associative thickeners in the development of latex coating film gloss is examined. The classical explanation relating film gloss to flow and leveling through low viscosities at low shear rates is found invalid in associative thickener formulations. Increases in gloss arise from improved stabilization of titanium dioxide (TiO₂) particles. This requires two separate interactions: (1) the efficient adsorption of hydrophobe-modified maleic acid alternating copolymer on the surface of TiO₂, through hydrogen bonding or an acid-base interaction, and (2) interactions of the hydrophobes of this copolymer with the hydrophobes of ethoxylated urethane (HEUR) thickeners. This interaction provides greater electrosteric stabilization to the pigment, improved thickening efficiency of the pigment paste and coating formulation, and higher film gloss.

Resúmenes de Artículos en este Número

PREDICCIÓN DEL DESGASTE DEL RECUBRIMIENTO SOBRE UNA LÁMINA MOLDEADA (SMC): ESTUDIOS DE PERMEACIÓN A SOLVENTES—R.A. Ryntz, W.R. Jones, and A. Czarnecki

Journal of Coatings Technology, 64, No. 807, 29 (Apr. 1992)

El mayor desgaste atribuido a la apariencia del recubrimiento cuando se aplica sobre una lámina moldeada (SMC) se debe al paso de solvente o al flujo del mismo a través del sustrato del recubrimiento. La evidencia reportada por G.D. Cheever indica que la penetración del solvente del recubrimiento dentro de los poros del sustrato, trae como consecuencia una erupción del mismo a través del recubrimiento ya curado provocando la apariencia de cráteres.

Nuestros estudios describen la tendencia del solvente a difundirse a través de una variedad de recubrimientos para entender la resistencia del recubrimiento ya curado/SCM a la exploración del solvente. Las interrelaciones se derivan de correlacionar la habilidad del recubrimiento para inhibir la explosión del solvente a través del desgaste en la SMC y la resistencia de la formulación del recubrimiento a la permeación del solvente en un sistema SMC/recubrimiento. Con esta relación de predicción, se pueden tener acabados aceptables sobre SMC con el adecuado uso del recubrimiento.

DIAGRAMA DE PROPIEDAD TEMPERATURA- T_g (T_g TP) PARA SISTEMAS TERMOFIJOS: COMPORTAMIENTO ANOMALO DE LAS PROPIEDADES FISICAS VS. LA EXTENSION DEL CURADO—X. Wang and J.K. Gillham

Journal of Coatings Technology, 64, No. 807, 37 (Apr. 1992)

Las relaciones entre las propiedades físicas isotérmicas en el estado vítreo de polímeros termofijos amorfos reticulados y la conversión química son complejas y anómalas. En este escrito, se reporta un sistema general para correlacionar las propiedades físicas básicas de un sistema termofijo amino/epoxy de alta T_g vs. la extensión de curado a temperaturas isotérmicas por arriba de T_g y hacia el estado vítreo en términos del Diagrama de Propiedades Temperatura- T_g (T_g TP) que se describe en este reporte. El sistema parte de considerar el módulo de corte isotérmico y la velocidad de envejecimiento físico isotérmico vs. la extensión en el curado, los dos muestran un máximo y un mínimo a través de un rango muy amplio de temperaturas por abajo de T_g . Usando la T_g como una medida directa de la conversión los resultados se ven en una linealización de las anomalías en el máximo y el mínimo de las propiedades físicas vs. la extensión del curado en el Diagrama T_g TP. El comportamiento anómalo se relaciona como un fenómeno específico, tal como la transición vítrea (vitrificación) y el estado vítreo con transición (T_g) que cambia con la conversión y también la gelación. El comportamiento diferente del material contra la extensión del curado corresponde a regiones diferentes. Estos simples diagramas son muy útiles académicamente para

entender las propiedades de los materiales tanto los no curados (con cambio en la conversión) como para los completamente curados (con cambio en el rango estequiométrico).

USO DE POLIBUTADIENO TERMINADO POR HIDROXILO EN PRIMARIOS DE SECADO AL AIRE INHIBIDORES DE OXIDACION—J.J. Salitros

Journal of Coatings Technology, 64, No. 807, 47 (Apr. 1992)

Polibutadieno terminado por hidroxilo (HTPB) se ha utilizado por su reactividad con resinas de isocianato para producir selladores y membranas impermeables con excelentes propiedades hidrofóbicas. La resistencia a soluciones químicas diluidas es excelente y supera por mucho otras resinas. La resistencia de los poliuretanos modificados con HTPB a los solventes no es muy buena y como evidencia esta el hinchamiento de las películas.

La insaturación en la estructura del HTPB es la responsable de una reticulación oxidativa con el uso de secadores utilizados para mejorar el secado de la película delgada en recubrimientos alquidáticos. Se formularon primarios de secado al aire usando pigmentos diseñados para inhibir la oxidación. Estos primarios conteniendo HTPB y pigmentos inhibidores de oxidación se aplicaron sobre diferentes sustratos metálicos y se sometieron a pruebas de niebla salina. Las películas delgadas de los primarios base HTPB tuvieron una excelente resistencia las soluciones químicas acuosas y solventes orgánicos.

Los primarios base HTPB se usaron bajo diferentes aplicaciones y acabados para determinar la habilidad del repintado y la adhesión entre cada capa. Los primarios base HTPB son fáciles de utilizar en alquidales, esmaltes de hule clorado y acabados de uretano (dos componentes) de alto brillo.

INTERACCIONES DEL MEZCLADO DE ADELGAZADORES AGLOMERADOS A TRAVEZ DE LA ESTABILIZACION DEL PIGMENTO—D.J. Lundberg and J.E. Glass

Journal of Coatings Technology, 64, No. 807, 53 (Apr. 1992)

Se examina el papel de los adelgazadores aglomerados en el desarrollo del brillo en películas de recubrimiento de latex. Se encontró que la clásica explicación donde el flujo y el nivel de brillo de la película se relacionan a bajas viscosidades y bajas velocidades de corte no es válida para formulaciones de adelgazadores aglomerados. El incrementar el brillo, implica mejorar la estabilización de las partículas de dióxido de titanio. Esto requiere dos interacciones separadas: (1) La eficiente adsorción del ácido maleico modificado hidrofóbico alternando con el copolímero en la superficie del dióxido de titanio, mediante enlaces de hidrógeno o interacciones acidobase, y (2) Interacciones que proporcionan una mayor estabilidad electrostática al pigmento, mejor la eficiencia adelgazante de la pasta del pigmento y la formulación del recubrimiento, y da mayor brillo a la película.

Dr. John L. Gardon, Vice President/R&D for Akzo, To Present Mattiello Lecture at 1992 Annual Meeting

The Federation of Societies for Coatings Technology is pleased to announce that Dr. John L. Gardon, Vice President of Research and Development for Akzo Coatings, Inc., Detroit, MI, will present the Joseph J. Mattiello Memorial Lecture during its 70th Annual Meeting, to be held at McCormick Place North, Chicago, IL, on October 21-23.

Dr. Gardon's lecture will be given on Friday, October 23.

The lecture commemorates the contributions of Dr. Mattiello, who was instrumental in expanding the application of the sciences in the decorative and protective coatings fields. Dr. Mattiello served as President of the Federation in 1943-44. He was Vice President and Technical Director of Hilo Varnish Corp., in Brooklyn, NY, when he died in 1948.

The lecturer is chosen from among those who have made outstanding contributions to science and is selected to present a paper on a phase of chemistry, engineering, human relationships, or other sciences fundamental to paint, varnish, lacquer, or related protective or decorative coatings.

Education

John Gardon received his Chemical Engineering Degree at the Swiss Federal Institute of Technology, Zurich, in 1951, and his Ph.D. at the McGill University/Pulp & Paper Research Institute of Canada, Montreal, in 1955. His five publications from this research concerned polyelectrolytic properties of lignin sul-

fonates, polymer fractionation by dialysis and ultrafiltration, and correction of osmometry for imperfect semipermeability.

Career Highlights

For three years, Dr. Gardon was employed by the Canadian International Paper Company. There he developed lignin-based dispersants and thermosetting binders, resulting in two patents and two publications.

Following this, he began his ten-year employment with Rohm and Haas as a Senior Chemist in the Textile Finishes Laboratory. Later, he became a Group Leader in coatings, a Research Associate, and lastly the Manager of the Leather Finishes Laboratory. In two publications, he established quantitative correlations between crosslink density and wash-and-wear properties of cotton. He obtained the Roon Award for his correction of the solubility parameter concept for polarity. In five papers, he established correlations between solubility parameters, critical surface tensions, ultimate strength of polymers and metals, and of adhesive bonds. His interest in adhesion led to two papers concerning a continuum analysis of peel strength. Ten of Dr. Gardon's papers provided a detailed, theoretical analysis of emulsion polymerization and extensive experimental data. He extended the Smith-Ewart theory for quantitative prediction of particle sizes, molecular weights, and kinetics. He showed how radicals can accumulate in particles under certain conditions. He also extensively studied emulsion copolymerization and the swelling of latex particles by monomers. The author of five patents on textile and leather finishing and on nonaqueous dispersion, he participated in the development of many commercially successful products, including latexes, nonaqueous dispersions, leather and textile finishes, and binders for nonwoven fabrics.

Subsequently, Dr. Gardon became employed by the M&T Chemicals subsidiary of American Can/Elf Aquitaine. For five years, he was Director of Corporate Research and for five years Director of Research of the Coatings and Ink Division. He continued his work on emulsion polymerization and published a patent on core/shell morphology of latexes. Dr. Gardon took charge of American Can's cationic UV cure project

and co-authored one patent in this field. He was instrumental in developing the first commercial UV curable ink and end-varnishes for beer and beverage cans. His group pioneered the use of latexes in industrial baking finishes for business machines and automotive interior coatings. He was instrumental in establishing M&T Chemicals in the powder coatings business by bringing in licensed technology and being one of the first to use twin screw extruders.

For the next six years, Dr. Gardon was Vice President of Research for Sherwin-Williams Co., first in the Chemical Coatings Division, later in Corporate Research. By this time, his present focus on nonpolluting coatings dominated his interest. On this topic he co-edited a textbook. He provided technical guidance for developing commercially successful high solids and aqueous and industrial coatings, electrocoatings, and for pioneering novel chemical approaches for car refinishes. His group developed new associative thickeners and microvoid trade sales coatings.

Joining Akzo Coatings Inc. in 1986 as Vice President, R&D, Dr. Gardon remains a scientifically involved manager. He is principal inventor of a new acid-etch resistant automotive coating. His interests now include new crosslinking mechanisms, latexes for wood finishes, aerospace coatings, car refinish coatings for plastics, and coil coatings.

Professional Activities

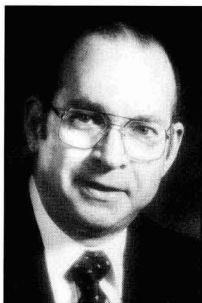
Currently Chairman of the Scientific Committee of the NPCA and Alternate Counselor of ACS, Dr. Gardon was Chairman of the ACS Polymeric Materials Science & Engineering Division and of a Gordon Research Conference of the Science of Adhesion. He established the Sherwin-Williams Student Award of the PMSE. Earlier, he established the Group Life Insurance Plan for the Philadelphia Section of the ACS; the national plan was patterned after this. He served many years as a Trustee of the Paint Research Institute. Dr. Gardon organized ACS symposia on nonpolluting coatings and on emulsion polymerization. He was the

(Continued on page 12)



Dr. Thomas J. Miranda Retires as JCT Technical Editor; Succeeded by Dr. Robert F. Brady, of U.S. Naval Research Labs

The Federation has announced that Dr. Thomas J. Miranda, of Consolidated Research, Inc., Mt. Prospect, IL, has retired as Technical Editor of the *JOURNAL OF COATINGS TECHNOLOGY*, a position he held since 1972. In addition to serving as Technical Editor, Dr. Miranda was Chairman of the FSCT Publications Committee, and a member of the JCT's Editorial Review Board for the past 16 years. He has served as Co-Editor of the *Federation Series on Coatings Technology* since 1986 and will continue in that capacity. Dr. Miranda was most recently affiliated with Whirlpool Corp., Benton Harbor, MI, where he served as Staff Scientist until his retirement this year.



Thomas J. Miranda

Robert F. Brady, Jr., Head of the Coatings Section of the U.S. Naval Research Laboratory, Washington, D.C., will succeed Dr. Miranda both as Technical Editor of the JCT and as Chairman of the Federation's Publications Committee.

Thomas Miranda was born in Ewa, Hawaii. He attended San Jose State College, receiving the A.B. Degree in 1951 and the M.A. Degree in 1953. In 1955, he entered the University of Notre Dame and held the W.R. Grace Fellowship. Dr. Miranda received the Ph.D. Degree in Organic Chemistry in 1959 and was awarded an M.B.A. Degree from Indiana University in 1979.

Dr. Miranda joined Whirlpool in 1969 as Senior Research Material Scientist and rose to the position of Staff Scientist. Prior to joining Whirlpool, Dr. Miranda was Director of Research for the O'Brien Corporation and has also taught at San Jose State University, Indiana University, and the University of Notre Dame. Dr. Miranda has authored more than 50 publications and holds a number of patents ranging from coating composition to resins to rocket fuel.

Dr. Miranda's extensive contributions to the advancement of the FSCT were recognized in 1980, when he was named recipient of the George Baugh Heckel Award. In 1984,

Dr. Miranda presented the Mattiello Memorial Lecture entitled, "Reading the Signals of Society: Technology Push or Market Pull," at the Federation's Annual Meeting. In addition, he has received the FSCT Trigg Award and the Elisha Gray Award from the Whirlpool Chapter of Sigma Xi for his outstanding scientific accomplishments. A Past-President of the Chicago Society, he was honored with their Outstanding Service Award in 1977.

Dr. Miranda has served on the Advisory Board of the Organic Coatings and Polymer Chemistry Division of the American Chemical Society and on the Industrial Engineering Chemistry Product R & D Journal of the ACS.

He and his wife, Carol, have five children and live in Granger, IN.

Dr. Robert F. Brady, Jr. was born in Washington, D.C. He attended the University of Virginia where he received the B.S. (1964) and Ph.D. (1967) Degrees in Chemistry.

Following graduate school, he joined the National Bureau of Standards, where he conducted and directed research in carbohydrate chemistry and in clinical standard reference materials. He moved to the headquarters laboratory of the U.S. Customs Service in 1972 where he developed new instrumental analytical methods for the detection and identification of alkaloid and terpenes. In 1975, he became Chief of the Paint and Adhesives Branch in the U.S. General Services Administration, where he directed standardization and testing programs which supported procurements of paints, brushes, sealants, adhesives, and related materials.

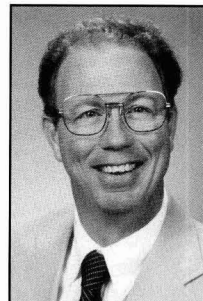
In 1982, Dr. Brady assumed his present position as Head of the Coatings Section of the U.S. Naval Research Laboratory. He directs and conducts basic research in polymer chemistry and coatings science, formulates and tests advanced marine coatings, and develops and validates test methods for coatings. His present interests include control of volume change during polymerization, coatings based on fluorinated resins, high-solids epoxy and polyurethane coatings, nontoxic antifouling coatings, and non-skid coatings for aircraft carriers.

For one year beginning in July 1990, he was a visiting scientist in the Defence Materials Research Laboratory, in Melbourne, Australia, where he worked on the formulation of coatings with tailored infrared properties.

Dr. Brady is a Past-President of the Chemical Society of Washington (1982) and of the Washington Paint Technical Group (1979-80). A former Contributing Editor of the *Journal of Protective Coatings & Linings* (1986-90), he has published more than 20 papers in chemical research, and holds three patents. Dr. Brady is a member of the Baltimore Society for Coatings Technology, American Chemical Society, Steel Structures Painting Council, and Gallows Birds.

He received the Man of the Year Award from the Washington Paint Technical Group in 1979, and a Certificate of Appreciation from ASTM Committee D-1 in 1983.

Dr. Brady married the former Sharon Ann Callison of Arlington, VA in 1965. They are the parents of three children.



Robert F. Brady

L.A. Society Contributes \$15,000 in Educational Funds

In the February 1992 issue of the JCT (Vol. 64, No. 805, p 12), a report listed the results of a survey of Constituent Societies to determine the amount of scholarship funding provided in 1990. Not included in this report were the contributions of the Los Angeles Society. The Society provided over \$15,000 in funding for educational programs during 1990. This brings the total of Constituent Society support of such programs to \$64,000.

1992 Membership Directory Available from Federation

The 1992 Annual Membership Directory (Year Book) of the Federation of Societies for Coatings Technology has been published.

Listed in the 328-page directory are the names, companies, addresses, and telephone numbers of the 7300 Federation members by Society affiliation. The publication also provides an alphabetical index of members and includes informative details on FSCT Officers, the Board of Directors, and Committee Members and Duties. In addition, Federation By-Laws, Articles of Incorporation, Awards, and Constituent Society Meetings are included.

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

Dr. John Gardon to Present Mattiello Lecture at 1992 Annual Meeting

(Continued from page 10)

principal organizer of the Workshop on the Science of Organic Coatings at Kent State University in 1978. He has served on several academic advisory boards, editorial boards of technical publications and on various committees of the Federation, ACS, SME, and of the Industrial Research Institute.

Dr. Gardon is the editor of four textbooks and has authored eight textbook chapters, 29 papers, and 15 patents.

* * *

Paint Industries' Show

With over six months to go before the 1992 Paint Show, exhibit space has been expanded to almost 100,000 sq. ft. to ac-

commodate anticipated increased participation by supplier companies. Currently, 250 companies have reserved almost 88,000 sq. ft. of exhibit space, making the 1992 Paint Show the largest ever sponsored by the Federation (see preliminary floor plan on pages 14-15 and current list of exhibitors on page 16—Ed.).

To be held in conjunction with the Federation's Annual Meeting, on October 21-23, at McCormick Place North Hall, the 57th Paint Show will feature the products and services of supplier companies to the international coatings industry.

Exhibit hours will be 10:00 a.m. to 5:30 p.m. on Wednesday, Oct. 21; 9:00 a.m. to 5:30 p.m., on Thursday, Oct. 22; and 9:00 a.m. to 12:00 noon, on Friday, Oct. 23.

Program Committee

Program Committee Chairman John A. Lanning, of Courtaulds/Porter Paints, Louisville, KY, and his committee are developing a schedule of presentations (see accompanying story—Ed.). Assisting on the committee are: Clifford Schoff (Vice-Chairman), PPG Industries, Inc., Allison Park, PA; G. Dale Cheever, GM Corp., Research Laboratory, Warren, MI; Richard J. Himics, Daniel Products Co., Jersey City, NJ; Louis Holzknicht, Devoe Coatings Co., Louisville, KY; Ronda Miles, Union Carbide Corp., Garland, TX; Rose Ryntz, Akzo Coatings America, Inc., Troy, MI; and Roger Woodhull, California Products Corp., Cambridge, MA.

Registration Fees

Advance registration forms and information will be sent to all members in April. Advance fees are \$65 for members and \$80 for nonmembers. The fee for spouses' activities is \$50 in advance. Retired members and their spouses may register at the special advance-only fee of \$25 each.

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

Hotel Reservations

Seven hotels have reserved blocks of rooms for the Federation event. The Chicago Hilton and Towers will serve as the headquarters hotel. Other hotels include Essex Inn on Grant Park, Executive Plaza Hotel, Hyatt Regency, McCormick Center Hotel, Palmer House, and Stouffer Riviere Hotel. All hotel reservations will be processed through the Chicago Housing Bureau. Hotel reservation forms and information will be available in April.

Airline Information

The Federation's Travel Desk has negotiated reduced rates on United and USAir to Chicago featuring up to 40% discounts. For transportation arrangements, call:

1-800-448-FSCT or 215-628-2549

Mention "Paint Show 92."

An agent will make your reservations, write your tickets using your credit card number, and mail the tickets directly to you.

In addition, the official carriers may be contacted directly. Be sure to reference the file numbers as follow:

USAir 1-800-334-8644
Reference Gold File #62330000
United* 1-800-521-4041
Reference Meeting Code: 533GU

*seven day advance purchase required.

Certain restrictions may apply.

ANNUAL MEETING PROGRAM

The 1992 Annual Meeting Program is in the process of being completed, with the final steps being taken by the Program Committee to ensure a timely and informative event.

The theme for the 1992 event is "New Directions for a Changing World." The theme emphasizes that the coatings industry's future depends on changing existing business strategies in formulating products, responding to regulatory and safety demands, and managing resources. New directions would include adopting merging and emerging technologies to drive innovation, developing environmentally friendly products and processes, and embracing total quality systems to effectively compete in a global market.

Several session themes have already been selected for the program. These sessions are being developed by various FSCT committees. The titles are as follows:

"Advanced Topics"—Professional Development Committee

"Employee Involvement—Overcoming the Obstacles to Empowerment"—Manufacturing Committee

"Formulation Factors for the Design of Corrosion-Resistant Direct-to-Metal (DTM) Coatings"—Corrosion Committee

"Waste Minimization"—Environmental Affairs Committee

"Merging/Emerging Technologies"—Program Committee

"Material Quality"—Program Committee.

In addition to the above sessions, the 1992 Annual Meeting Program will also include the Mattiello Memorial Lecture,

two sessions for the presentation of Roon Award Papers, and an additional two sessions devoted to papers submitted by authors for the event. These papers include topics such as: Powder Coatings, Waterborne Paint Systems, Pigments for High Performance Coatings, Corrosion Inhibitors, Low VOC Coatings, Wood Finishing, Paint Filtration, Recycling, Epoxy Resins, EB Curing Systems, Adhesion Promoters, and Odor Emissions.

The 1992 Annual Meeting will also include a new feature, a Poster Session. The purpose of this activity is to allow individuals who are actively involved in coatings research to display posters of their work and make a brief presentation on the project.

The poster session will provide a noncommercial arena for new ideas, new techniques, preliminary results, and other significant work that is not ready for publication. Cash prizes of \$300, \$200, and \$100 will be awarded to the top three entries. The posters will be judged on the following criteria: originality/novelty, scientific content, and quality of display.

The Poster Session will be held on Thursday, October 22, 1992, with the display of posters from 9:00 a.m. until 5:00 p.m. and presentations from 11:00 a.m. to 2:00 p.m. Participation in the event is subject to the discretion of the 1992 Annual Meeting Program Committee.

For more information on the Poster Session, contact Clifford Schoff, PPG Industries, 4325 Rosanna Dr., P.O. Box 9, Pittsburgh, PA 15101, (412) 487-4500.

**“UNDERSTANDING CORROSION PROTECTION” SEMINAR
REGISTRATION FORM**

May 19-20, 1992 • Sheraton Boston Hotel and Towers, Boston, MA

Registration fees: \$175 (FSCT members); \$225 (non-members)

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

NICKNAME (For Registration Badge) _____

FULL NAME _____

JOB TITLE _____

COMPANY _____ PHONE _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Name of Federation Society
Of Which You Are a Member _____

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

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

**IF YOU REQUIRE HOUSING AT SHERATON BOSTON HOTEL AND TOWERS
COMPLETE FORM BELOW**

**HOUSING FORM
Sheraton Boston Hotel and Towers**

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Arrival Date _____ Before 6 pm
 Late* Departure Date _____

Please reserve: Single _____ \$130.00 (per night)

Double/Twin _____ \$145.00 (per night)

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

Note: Reservations must be made no later than April 15 to guarantee availability and rates.

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

GENERAL INFORMATION

ELECTRICAL:

120 VOLT SINGLE PHASE, 208 AND 480 VOLT
THREE PHASE AVAILABLE THROUGHOUT.

PLUMBING:

□ - INDICATES WATER, DRAIN AND COMPRESSED AIR

CEILING HEIGHT:

4'0" MINIMUM

FLOOR LOAD:

400 POUNDS PER SQUARE FOOT

FHC: INDICATES FIRE HOSE CABINET WHICH MUST
BE VISIBLE AND ACCESSIBLE AT ALL TIMES.

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UNLESS OTHERWISE INDICATED

MAR 2, 1992

RESTAURANT

**1992 PAINT
INDUSTRIES SHOW**
OCTOBER 21-23, 1992
McCORMICK PLACE
53 LEVEL
CHICAGO, ILLINOIS

UNITED EXPOSITION
SERVICE AREA

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LADIES

MEN

FREIGHT
DOOR

LADIES

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ISLE 20

1992 PAINT INDUSTRIES' SHOW

Current List of Exhibitors

Aceto Corp.
Advanced Coatings Technologies
Advanced Software Designs
Agglo Recovery, Inc.
Air Products & Chemicals, Inc.
Ajinomoto U.S.A., Inc.
Akzo Chemicals
Alcan-Toyo America, Inc.
Alcoa Industrial Chemicals
Ambrose Co.
ACS/C&E News
ACS/Industry Relations
American Cyanamid Co.
American Iron & Steel Institute
Amoco Chemical Co.
ANGUS Chemical Co.
Anker Labels USA, Inc.
Aqualon Co.
Arco Chemical Co.
Ashland Chemical, Inc. IC&S Div.
Atlas Electric Devices Co.
Aztec Catalyst Co.

B&P Environmental Resources
B.A.G. Corp.
BASF Corp.
T.J. Bell, Inc./Erichsen Instruments
Blackmer Pump, Dover Resources
Bohlin Reologi, Inc.
Brookfield Engineering Labs., Inc.
Brookhaven Instruments Corp.
Buckman Laboratories, Inc.
Buhler, Inc.
Bulk Lift International, Inc.
Burgess Pigment Co.
BYK-Chemie USA
BYK-Gardner, Inc.

C B Mills, Inc.
CR Minerals Corp.
Cabot Corp., Cab-O-Sil & Special
Blacks Div.
Calgon Corp., Div. of Merck & Co.
Cappelle, Inc.
The Carborundum Co.
Cardolite Corp.
Cargill, Inc.
Carri-Med Americas, Inc.
Carroll Scientific, Inc.
Celite Corp.
Chemical Marketing Reporter
Chemical Week
CIBA-GEIGY Corp.
Coatings Magazine
Color Corp. of America
Colortec Associates
Columbian Chemicals Co.
Consolidated Research, Inc.
Cookson Pigments, Inc.
Coulter Corp.
Cray Valley Products International
Crossfield Chemicals, Inc.
Cuno Process Filtration Products
Cyprus Industrial Minerals Co.

D/L Laboratories
DSA Consulting, Inc.
Daniel Products Co.
Dantco Mixers Corp.
Datacolor International
Day-Glo Color Corp.

Defelsko Corp.
Degussa Corp.
University of Detroit Mercy
Distil-Kleen, Inc.
Dominion Colour Corp.
Dow Chemical USA
Dow Corning Corp.
Draiswerke, Inc.
Drew Industrial Div.
Dry Branch Kaolin Co.
Du Pont Co.

ECC International
EM Industries, Inc.
Eagle Picher Minerals, Inc.
Eagle Zinc Co.
Eastern Michigan University
Eastman Chemical Co.
Ebonex Corp.
Eiger Machinery, Inc.
Elektro-Physik USA, Inc.
Elf Atochem
Elmar Worldwide
Engelhard Corp.
Epworth Manufacturing Co., Inc.
Etna Products Inc.
Exxon Chemical Co.

FMC Corp., Food & Pharmaceuti-
cal Prod. Div.
Fawcett Co., Inc.
**Federation of Societies for
Coatings Technology**
Filter Specialists, Inc.
Fischer Technology, Inc.
Fluid Management Ltd. Partners
Freeman Polymers
H.B. Fuller Co.

Paul N. Gardner Co., Inc.
B.F. Goodrich Co., Spec. Polym. &
Chem. Div.
Goodyear Tire & Rubber Co.,
W.R. Grace & Co., Davison
Chemical Div.
Guer-Tin Bros. Polymers

Halox Pigments, Div. of Hammond
Lead Products
Harcros Pigments, Inc.
Henkel Corp.
Heraeus DSET Laboratories, Inc.
Heucotech Ltd.
Hilton-Davis Co.
Hitax Corp. of America
Hockmeyer Equipment Corp.
Hoechst Celanese Corp., Waxes &
Pigments Div.
Hoechst Celanese Corp., Waxes &
Lubricants Group
Horiba Instruments, Inc.
J.M. Huber Corp.
Huls America, Inc.
Hunterlab

ICI Americas, Inc.
ICI Resins U.S.
ISP Filters, Inc.
Ideal Manufacturing & Sales
Industrial Finishing Magazine
Interfibe Corp.

International Compliance Center
International Resources, Inc.
International Specialty Products

S.C. Johnson Polymer

K-T Feldspar Corp.
Kemira, Inc.
Kenrich Petrochemicals, Inc.
Kent State University
King Industries, Inc.
KRONOS, Inc.

Lawter International
Leeds & Northrup, Microtrac Div.
Lightnin
Liquid Controls Corp.
The Lubrizol Corp.

3M, Industrial Chemical Prod. Div.
Macbeth, Div. of Kollmorgen Corp.
Malvern Instruments
Malvern Minerals Co.
Matec Applied Sciences
McWhorter, Inc.
The Mearl Corp.
Michelman, Inc.
Micro Powders, Inc.
Micromeritics Instrument Corp.
Miles Inc.
Millipore Corp.
MiniFibers, Inc.
Minolta Corp.
Mississippi Lime Co.
University of Missouri-Rolla
Modern Paint & Coatings
Morehouse Cowles, Inc.
Morton International/Universal
Color Dispersions
Mountain Minerals Co., Ltd.
Myers Engineering

NYCO Minerals, Inc.
Nacan Products Ltd.
Netzsch Incorporated
Neupak, Inc.
Neville Chemical Co.
New Way Packaging Machinery,
Inc.
Nicolet Instrument Corp.
Nippon Shokubai Co., Ltd.
North Dakota State University

Obron Atlantic Corp.
Ohio Polychemical Co.
Olin Chemicals
ORTECH International

PPG Industries, Inc., Silica Products
PPG Industries, Inc., Specialty
Chemicals
PQ Corp.
Pacific Micro Software Engineering
Paint & Coatings Industry
Magazine
Peninsula Polymers
Pen Kern, Inc.
Pfizer Specialty Minerals
Philips Container Co.
Pico Chemical Corp.
Plastican, Inc.
Polar Minerals
Pollution Control Industries

Poly-Resyn, Inc.
Premier Mill Corp.
Progressive Recovery, Inc.
Pyosa, S.A. de C.V.

The Q-Panel Co.
Quantachrome Corp.

Raabe Corp.
Reichhold Chemicals, Inc.
RHEOX, Inc.
Rhône-Poulenc Inc.
Rohm and Haas Co.
Rosedale Products, Inc.
Charles Ross and Son Co.

Sandoz Chemicals Corp.
Sannacor Industries, Inc.
Sartomer Co. Inc.
Schold Machine Corp.
SCM Chemicals
Scott-Bader
Semi-Bulk Systems, Inc.
Serac, Inc.
Shamrock Technologies, Inc.
Shell Chemical Co.
Sherwin-Williams Chemicals Co.
Shimadzu Scientific Instruments
Silberline Manufacturing Co.
Sino-American Minerals, Inc.
Sloss Industries Corp.
South Florida Test Service, Inc.
Southern Clay Products, Inc.
University of Southern Mississippi
Spartan Color Corp.
Startex Chemical Co.
Steel Structures Painting Council
Sub-Tropical Testing Service
Sun Chemical Corp.
Systech Environmental Corp.

Tego Chemie Service USA
Texaco Chemical Co.
Thiele Engineering Co.
Toxide, Inc.
Troy Corp.

U.S. Borax
U.S. Silica Co.
Unimin Specialty Minerals Inc.
Union Carbide Corp.
Union Process, Inc.
United Catalysts, Inc., Rheo. &
Perf. Minerals Group
United Mineral & Chemical Corp.
United States Testing Co., Inc.

Van Waters & Rogers
R.T. Vanderbilt Co., Inc.
Velsicol Chemical Corp.
Versa-Matic Tool, Inc.
Viking Pump, Inc., a Unit of IDEX
Vorti-Siv., Div. of M&M Industries

Wacker Silicones Corp.
Warren-Rupp, Inc., a Unit of IDEX
Wilden Pump & Engineering Co.
Witco Corp.

X-Rite, Inc.

Zeelan Industries, Inc.

Regulatory UPDATE

APRIL 1992

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. and edited by members of the FSCT Environmental Affairs Committee.

Department of Transportation Research and Special Programs Administration February 27, 1992—57 FR 6696

Marine Pollutants; Extension of Comment Period Action: Notice

On January 31, 1992, the Research and Special Programs Administration (RSPA) announced a notice of proposed rulemaking to amend the Hazardous Materials Regulations by adding requirements for the transportation of marine pollutants in all modes of transportation. The comment deadline was initially set for March 2, 1992. However, because several industry representatives requested a comment-extension so the proposals could be more thoroughly evaluated, RSPA has extended the deadline to May 4, 1992.

Comments should be submitted in quintuplicate to the Dockets Unit, RSPA, U.S. Department of Transportation, Washington, D.C. 20590. Please identify the comments with the docket number (HM-211) and the notice number (92-2). For further information, contact John Gale, Office of Hazardous Materials Standards, RSPA, (202) 366-4488; or Lt. Cmdr. Phillip Olenik, Office of Marine Safety, Security and Environmental Protection, U.S. Coast Guard, Washington, D.C., (202) 267-1577.

Environmental Protection Agency March 3, 1992—57 FR 7636

Definition of Hazardous Waste; "Mixture" and "Derived-From" Rules

Action: Notice of proposed rulemaking

In May 1980, the U.S. Environmental Protection Agency (EPA) set forth provisions for managing hazardous waste under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The definition of "hazardous waste" included hazardous wastes that were mixed with other solid wastes. Those portions of the rule are known as the "mixture" and "derived-from" rules. EPA promulgated the "mixture" rule so hazardous waste generators couldn't mix hazardous waste with non-hazardous waste and claim it was no longer hazardous. The "derived-from" rule was initiated so owners and operators of treatment, storage, and disposal facilities wouldn't be able to evade regulation by minimally treating the waste and then claiming the residue was no longer hazardous.

In December 1991, the United States Circuit Court of Appeals for the District of Columbia, ruled that EPA did not give the regulated community sufficient notice or adequate

time to comment on the "mixture" and "derived-from" rules. The Court then voided the rules and remanded them back to the Agency.

On March 3, as part of the Administrative Procedure Act, EPA simultaneously removed and reissued the rules on an interim basis to allow for an acceptable comment period. EPA has requested comments on the rules and any other means of regulating waste mixtures and residues. EPA has said it will propose options for revising the rules by April 28, 1992. Final regulations will be issued by April 28, 1993.

The comment deadline is April 2, 1992. Comments post-marked after this date may or may not be considered. An original and two copies of comments should be sent to U.S. EPA, RCRA Docket (OS-304), 401 M Street, S.W., Washington, D.C. 20460. Please mark the comments with docket number F-92-MDFP-FFFFF. For further information, contact the RCRA/Superfund Hotline at (800) 424-9346. For technical information, contact Marilyn Goode, Office of Solid Waste at (202) 260-8551.

Department of Labor Occupational Safety and Health Administration February 24, 1992—57 FR 6356

Process Safety Management of Highly Hazardous Chemicals

Action: Final rule

As mandated by the Clean Air Act in 1990, the Occupational Safety and Health Administration (OSHA) has published a final rule governing the processing of highly hazardous chemicals. The rule, which affects petrochemical and chemical companies and other industries that transport or mix chemicals, becomes effective on May 26, 1992.

Under the rule, companies will have to systematically analyze potential hazards for every phase of their chemical processes and develop ways to prevent chemical releases or explosions. A hazard analysis must be completed over a five-year period for each chemical process with 25% completed by May 1, 1994; 50% by May 1, 1995; 75% by May 1, 1996; and finished by May 1, 1997. The rule also mandates that OSHA require contractors to train their workers in various chemical processes to ensure the safety of both contract workers and those directly employed by the company.

For further information, contact James F. Foster, OSHA, Office of Information, Room N3647, 200 Constitution Avenue, N.W., Washington, D.C. 20210, (202) 523-8151.

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

**Environmental Protection Agency
February 5, 1992—57 FR 4448
Small Business Stationary Source; Technical
and Environmental Compliance Assistance
Program (SBAP)**

Action: Final guidelines; Notice of availability

The EPA has released guidelines to help small businesses comply with requirements mandated by the 1990 Clean Air Act Amendments.

The Clean Air Act requires states to revise, by November 15, 1992, their state implementation plans to include provisions for technical assistance and compliance information for small businesses. At the very least, the program must include a state ombudsman, a small business assistance program, and a state compliance advisory panel.

In order to qualify for assistance, companies have to meet the small business definition under the Small Business Act. Businesses also must be independently owned and operated and not dominant in their field; must employ not more than 100 people; and must not emit more than 50 tons per year of any one pollutant, or not more than 75 tons of a combination of pollutants regulated under the Clean Air Act. Certain restrictions and exemptions may apply.

The guidelines are available from the U.S. EPA, OAQPS, ROB (MD-15), Research Triangle Park, NC 27711. Please refer to the Guidelines for Implementation of Section 507 of the 1990 Clean Air Act Amendments. For further information, contact Jacqueline Shelton, U.S. EPA, Research Triangle Park, NC 27711, (919) 541-0898.

**Environmental Protection Agency
February 4, 1992—57 FR 4316
Rules of Practice Governing the Administrative
Assessment of Civil Penalties under the
Clean Air Act**

Action: Final rule

Under the Clean Air Act Amendments of 1990, the Administrator of the EPA is authorized to assess administrative penalties for specific violations of the Act. On February 4, EPA published a final policy for use of its Consolidated Rules of Practice to assess those penalties. Use of the consolidated rules will allow EPA to implement uniform hearing procedures and lessen the burden on the regulated community.

Under the rule, anyone violating the Clean Air Act will be subject to the same penalties as those who commit other environmental crimes. EPA has the authority to assess civil penalties of up to \$25,000 a day per violation with a cap of \$200,000, and it must initiate the administrative action within 12 months of the violation. The rule also provides that companies have 30 days after notification by EPA of the intent to assess a penalty to respond and request a hearing. EPA may also issue subpoenas for witnesses or documents as evidence.

For further information, contact Scott A. Throwe, Office of Air and Radiation, Stationary Source Compliance Division (EN-34100), U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460, (703) 308-8699.

**Environmental Protection Agency
February 3, 1992—57 FR 3941
Definition of Volatile Organic Compounds
with Regard to State Implementation Plans
Under the Clean Air Act**

Action: Final rule

The EPA has issued a final rule exempting certain chemicals that do not contribute to the formation of ozone from the definition of volatile organic compounds (VOCs) for the purposes of the Clean Air Act Controls.

The definition, which exempts about 20 substances, is particularly important for states developing plans to attain ambient air quality standards for ozone under the Federal law. EPA approval would not be required for states wanting to regulate the exempted VOCs as part of their state implementation plans (SIPs). However, states cannot include the exempted compounds in their emission inventories or list them as being controlled in their ozone control strategies.

For further information, contact Kent Berry, U.S. EPA, OAQPS, Air Quality Management Division (MD-15), Research Triangle Park, NC 27711, (919) 541-5505.

Lead—On March 5, the House Energy and Commerce Subcommittee on Transportation and Hazardous Materials postponed the markup of H.R. 3554, the Lead Exposure Reduction Act. The bill, which is the companion bill to Sen. Reid's (D-NV), was introduced in October 1991.

Reportedly, the markup was postponed because of a disagreement on some unresolved issues—including the phase-out of certain lead-containing industrial paint, and worker training provisions. The proposal, sponsored by Rep. Al Swift (D-WA), Chairman of the subcommittee, is an amendment to the Toxic Substances Control Act. It would limit the use of lead in certain products and certain types of packaging, and it would require EPA to issue rules on lead paint abatement and abatement certification.

The subcommittee has committed to reporting the bill before the Easter recess, but at press time, the markup had not been rescheduled. Sen. Reid's bill has been reported out of the full Environment and Public Works Committee and is waiting to be scheduled for floor action.

"Take-Home-Toxics"—The Workers' Family Protection Act, S. 353, commonly known as "Take-Home-Toxics," passed the Senate on February 19. The legislation, introduced by Sen. James Jeffords (R-VT), is a study bill that focuses on the toxic chemicals that workers carry home on their clothing and inadvertently contaminate family members. The legislation came about following constituent complaints that their families were being contaminated by lead, mercury, and "carcinogenic chemicals" that were being tracked home from the workplace.

The legislation requires that several agencies work together to compile data on the extent of incidents in which workers unwittingly contaminate their homes. The National Institute for Occupational Safety and Health, the lead agency, would be required to conduct the study along with the Department of Labor, EPA, and the Agency for Toxic Substances and Disease Registry 18 months after enactment of the bill.

The study would consist of reviewing previous incidents of home contamination; evaluating current regulations or voluntary industry programs that may deal with the prevention of home contamination; and identifying guidelines for state and Federal agencies responding to these claims. The Secretary of Labor would then review the compiled data, and within four years, make a determination as to whether further regulations are needed to enforce those standards.

Further provisions include the establishment of a task force that would be responsible for developing a strategy for investigating future home contamination occurrences. The task force would consist of workers, industry representatives, scientists, industrial hygienists, and government officials.

There has been no action on the House companion bill (H.R. 845—Ballenger, R-NC) since it was introduced last year.

OSHA Reform—Committees in both Houses of Congress have scheduled hearings on OSHA reform legislation.

The Senate Labor and Human Resources Committee will hold the first of four hearings on March 17 with the focus on whistleblower protection and expanded OSHA coverage. Remaining hearings have been confirmed but the times and dates are tentative.

On February 26, the House Education and Labor Committee held hearings on two provisions of the bill: the requirement that employers establish safety and health programs and a provision requiring joint labor-management safety and health committees. The committee will continue hearings on April 1 or 2 covering OSHA standards; April 8 or 9 on enforcement; and April 28 and 29 for an overview of the bill. Markup of the legislation has not been scheduled but is expected in May.

The Comprehensive Occupational Safety and Health Reform Act (S. 1622 and H.R. 3160) is sponsored by Sen. Edward Kennedy (D-MA), Sen. Howard Metzenbaum (D-OH), Rep. William Ford (D-MI), and Rep. Joseph Gaydos (D-PA). The bill shifts the focus of the current Act to encourage employers and employees to play an active part in identifying hazards in the work place before an injury or illness occurs. The legislation includes provisions that require employees to develop and maintain health and safety programs to "reduce or eliminate hazards and prevent injuries and illness to employees." Employers with 11 or more employees would also be required to establish joint committees with an equal number of employee and employer representatives. The committee would be authorized to review the companies'

health and safety programs, conduct inspections, and make advisory recommendations to the employer.

Further provisions include expanded authority for OSHA, including the elimination of cost-benefit in rulemaking authority; criminal sanctions against employers for violations that result in serious bodily injury to workers, and whistleblower provisions covering employees who refuse to work because of an "apprehension of serious injury." Provisions for the High Risk Notification legislation, such as medical monitoring costs borne by the employer are also included in the bill.

Toxic Substances Control Act—Sen. Harry Reid (D-NV), Chairman of the Senate Subcommittee on Toxic Substances, Environmental Oversight, and Research and Development, plans to hold oversight hearings on the Toxic Substances Control Act (TSCA).

Beginning on March 25, Reid will hold hearings on the effectiveness of the law. These will be the first series of hearings held on TSCA since the law was enacted in 1977. Sen. Reid has indicated he is unsatisfied with claims by the EPA and the chemical industry that the law is working. He cited the overturning of the asbestos ban and phase-out rule as evidence of his concern. Sen. Reid is also the author of comprehensive lead ban legislation, an amendment to TSCA. Reportedly, the hearings will be a pathway to full reauthorization.

States Proposed Legislation and Regulations

CALIFORNIA

Occupational Safety and Health—CA A. 2804 (Ferguson) specifies that, on and after January 1, 1993, existing law requiring every employer to establish, implement, and maintain an effective written injury prevention program including specified elements, and to provide specified training of employees in general safe and healthy work practices shall not apply to employers with less than 100 employees.

CA A. 3672 (Isenberg) relates to law which provides it is the policy of this state to vigorously enforce minimum labor standards in order to ensure that employees are not required or permitted to work under substandard conditions, and establishes procedures to protect employers who comply with the law from those who attempt to gain a competitive advantage at the expense of their workers by failing to comply with minimum labor standards.

CA A. 2968 (Horcher) eliminates provisions (for purposes of compliance with regard to hazards or other risks associated with the use of, or exposure to, a hazardous substance) stating that a Federal Material Safety Data Sheet (MSDS) or equivalent shall constitute prima facie proof of compliance.

Air Quality—CA S. 1731 (Calderon) includes in the definition of toxic air contaminants all of the hazardous air pollutants listed in certain provisions of the Federal Clean Air Act. Requires air pollution control districts and air quality management districts to submit to the U.S. EPA a program for compliance with the provisions of the Federal act applicable to hazardous air pollutants, and an operating permit program which complies with the federal act.

Containers (Labeling)—CA A. 2942 (Archie-Hudson) requires that any person who manufactures or sells five-gallon, plastic, straight-sided industrial containers or buckets

shall place warning labels on those containers; requires that those warning labels meet certain requirements; provides that the State Department of Health Services shall administer and enforce these provisions; makes violation of these provisions a misdemeanor. The bill, which is intended to prevent small children from drowning in five-gallon containers, was introduced on February 19.

Graffiti—CA A. 3457 (Elder) includes graffiti abatement as a specified purpose of a "community services district" and would enact procedures for the establishment of graffiti abatement districts with specified power for the purpose of abating graffiti. Authorizes districts to impose a special tax on real property for the purposes of abating graffiti and would authorize districts to levy a tax, pursuant to the existing authority granted to cities and counties.

Chemical Diversion—CA S. 1820 (Killea) provides that any manufacturer, wholesaler, retailer, or other person who sells, transfers, or otherwise furnishes any chemical reagent or solvent where the value exceeds \$100 or any specified chemical substance, with knowledge or reasonable cause to believe that the recipient will use the goods or chemical substance to unlawfully manufacture a controlled substance, is guilty of a misdemeanor.

Household Hazardous Waste—CA S. 1143 (Killea and Torres) relates to collection, recycling, and disposal of household products deemed hazardous; provides that a hazardous waste facilities permit is not required for collection facilities that accept latex paint for transport to recycling facilities.

Recycling (Incentive)—CA A. 2446 (Eastin) requires the Department of General Services to give a preference to the suppliers of recycled products, such as glass, oil, plastic,

solvents, and paint of up to 5% of the lowest bid or price quoted by suppliers offering no recycled products.

CONNECTICUT

Lead—CT H. 5287 (Dyson et al.) allows homeowners who have lead paint in their dwellings to receive a low interest loan for lead paint abatement.

Florida

Priority Toxics—FL S. 116 (Souto) requires the Department of Environmental Regulation to compile a list of substances that are deemed toxic or hazardous to humans. Requires persons who manufacture, import, transport, or distribute at wholesale any such substances to register with the department beginning October 1, 1993, and maintain a permanent record of sales of such substances.

Water Quality (Tax)—FL H. 1863 (Guber) re-enacts provisions relating to the use of the Water Quality Assurance Trust Fund for subsidies for water supply systems or filters for contaminated potable water wells to clarify original legislative intent. Increases from 5.9 cents to 24 cents per barrel the excise tax on solvents, pesticides, and chlorine if the balance in the Water Quality Assurance Trust Fund falls below \$3 million and provides for other tax increases on solvents depending on fund levels.

FL H. 2017 (Rush) relates to water pollution; provides a water quality excise tax on commercial fertilizer produced in or imported into the state; increases the tax on certain other pollutants; revises procedure for determination of applicable tax rates.

Georgia

Packaging—GA H. 124 (Dobbs et al.) relates to waste management so as to provide for the prohibition of toxic heavy metals in packaging waste.

Hazardous Materials—GA S. 609 (Ragan Hugh) relates to regulation of the storage, transportation, and handling of hazardous materials.

Superfund—GA H. 1394 (Porter et al.) establishes a state Superfund program; establishes strict, joint, and several liability; imposes fees on the generation, transportation, and disposal of hazardous waste, including intra-company shipments.

Idaho

Air Quality—ID H. 747 (Committee on Environmental Affairs) revises powers and duties of the director of the Department of Health and Welfare concerning air quality programs, laws, and rules and regulations; provides for consistency with Federal Law regarding clean air programs that will implement the mandates of the Clean Air Act; provides for an increase in civil penalties for air violations; provides for issuance and judicial review of emergency orders with respect to any air pollution source; provides criminal penalties for violations.

Kentucky

Hazardous Waste—KY H. 741 (Clark) requires annual payments, rather than biennial payments, on fees assessed on generators of hazardous waste; restricts exemption for secondary hazardous waste handlers to only those cases where the secondary handler presents proof the assessment was paid by the generator; deletes provision for reduced fee for

on-site disposal; deletes fee exemption for hazardous waste regulated under the Clear Water Act; sets a reduced fee of 10 cents per 100 gallons (compared to 10 cents per gallon for other hazardous wastes).

Maryland

Packaging—MD S. 554 (Boozer et al.) prohibits, on or after July 1, 1993, a manufacturer or distributor from selling or offering for sale or for promotional purposes any package or packaging component or any product in a package or packaging component to which lead, cadmium, mercury, or hexavalent chromium was intentionally added during manufacture or distribution; establishes maximum allowable concentration levels for those toxics that are incidentally presented in packaging materials.

Lead—MD H. 1408 (Hergenroeder) requires that persons who conduct specified lead paint abatement work receive accreditation; establishes the manner by which persons may receive accreditation; requires that applicable training programs be approved by the Department of the Environment (DENV); requires that the DENV must set reasonable fees to cover specified costs; requires the DENV to adopt rules and regulations; provides for injunctive relief and judicial review; sets civil and criminal penalties.

Massachusetts

Lead—MA H. 5036 (Buell) regulates the covering of lead paint or material.

Toxic Substances—MA H. 791 (Walrath) provides for the consumer right-to-know protection law.

Michigan

Occupational Safety and Health (Regulation)—Regulations have been proposed in Michigan that are aimed at preventing the release of highly hazardous chemicals, regulating spray paint booth operations, and improving employee fire emergency action plans. The regulations specify requirements for operating procedures that must be implemented by management at facilities which utilize highly hazardous chemicals; set minimum standards for fire prevention plans; and add new requirements to spray booth regulations to minimize the possibility of fire.

Minnesota

Lead—MN S. 1790 (Berglin) and H. 1934 (Clark and Ogren) imposes a 10 cents per gallon tax on paint sold by wholesaler to retailer; imposes a fee of \$10 per 1,000 gallons of petroleum products; both fees to provide revenue for a lead fund; relates to lead abatement and education programs; reduces standard for elevated blood lead levels to 10 micrograms in children up to age six and pregnant women; requires that the state provide a proactive lead education program; includes cleaning-up and swab team services; requires Board of Health to provide health education to parents of children with certain levels of blood lead.

MN H. 2501 (Bodahl et al.) relates to Housing Finance Agency programs; allows certain loans made in part with Federal funds to exceed loan maximums for lead abatement requirements; deletes limit on funding for lease-purchase housing grants and loans; extends existing housing program to new housing if accessible where the borrower or a family member is disabled.

Priority Toxics—MN H.F. 779 (Munger) requires registration of products containing "priority toxics"; imposes fees

for registration of product based on quantity of toxics contained in products sold in Minnesota.

Air Quality (Regulation)—Minnesota has announced its intention to solicit information from the public concerning regulations that it will propose restricting the use of abrasive blasting and other methods to remove lead paint from steel structures.

Mississippi

Product Liability—MS S. 2954 (Wicker et al.) codifies certain rules and establishes new rules applicable to product liability actions; provides that the manufacturer or seller of a product shall not be liable in an action for damages for personal injury or death if the claimant does not prove certain facts about the product.

Missouri

Air Quality—MO S. 544 (Goode) revises Missouri's Air Law, primarily to accommodate the new requirements of the 1990 amendments to the Federal Clean Air Act. Creates a criminal penalty for violating Missouri Air Law, rules, and standards. Expands definition of a regulated source to include sources which emit hazardous air pollutants.

New Hampshire

Recycling—NH H.C.R. 21 (Bradley) urges U.S. Congress to adopt uniform recycling product labeling standards based on standards developed by the Northeast Recycling Council.

New Jersey

Graffiti—NJ A. 803 (Catania and DeCroce) revises the law concerning graffiti.

Spray Paint—NJ S. 364 (Bennett) concerns regulation of air emissions from motor vehicle spray-paint operations.

Household Hazardous Waste—NJ A. 973 (Odgen) proposes the Household Hazardous Waste Management Act.

Hazardous Waste (Regulation)—On March 2, the New Jersey Department of Environmental Protection and Energy amended rules under the New Jersey Underground Storage of Hazardous Substances Act requiring owners and operators of underground storage tank systems to upgrade their systems. Under the new regulations, the compliance date has been extended and all owners and operators now have until December 22, 1993 to complete the upgrade (the original date was September 3, 1991). Tank owners may obtain loans from the Underground Storage Tank Improvement Fund until December 21, 1993.

Air Quality (Regulation)—The New Jersey Department of Environmental Protection has issued regulations correcting certain deficiencies in the state's clean air program that have been identified by the U.S. EPA (e.g., the state's method for averaging surface coating VOC emissions). Also under the regulations, the "bubbling" standards, affecting 94 surface coating processes in the state were made more stringent.

Packaging—NY A. 9245 (Hinchev) enacts the Environmentally Sound Packaging Act; requires packaging to be reusable or recyclable; provides exceptions and makes related provisions.

Spray Paint—NY A. 9530 (Parola et al.) prohibits the sale at retail of aerosol spray paint cans containing a fluid that is not water soluble, so that graffiti written with the paint can be easily removed.

Oklahoma

Occupational Safety and Health—OK H. 2189 (Paulk) amends sections relating to occupational health and safety to prohibit adverse personnel actions against employees for filing complaints or testifying about hazards in the workplace; requires employers to report certain accidents in writing to the Oklahoma City office of the Department of Labor; requires transmission of certain statistics of fatal occupational injuries from the Department of Health to the Department of Labor; outlines prohibited conduct by an employer and setting penalty.

Air Quality—OK H. 2251 (Rice) modifies Oklahoma Clean Air Act recreating the Air Quality Control Council and establishing membership; authorizes establishment of a Hazardous Air Pollutants Regulation Program; establishes a Small Business Stationary Assistance Program; creates a State Ombudsman Office for Small Business.

Hazardous Waste—OK S. 922 (D. Williams and Maxey) creates the crimes of unlawful waste transportation, unlawful waste management, unlawful misrepresentation of waste, unlawful disposal of hazardous waste, and unlawful concealment of hazardous waste; sets fines and sentences for persons convicted of environmental crimes and requires that fines be doubled for multiple violations.

Tennessee

Paint Tax Credit—TN S. 2543/S. 2643 (Dunavant) provides a 100% tax credit on equipment purchased by auto paint shops to comply with governmentally imposed emission control standards.

Texas

Air Quality (Regulation)—Texas has proposed revisions to its air quality regulations that carry out a number of the new requirements resulting from implementation of the Clean Air Act Amendments of 1990. Architectural and Industrial Maintenance (AIM) coatings VOC limits and associated regulations that heretofore have been confined to Dallas/Tarrant counties will now be extended to other counties. These provisions have a compliance deadline of July 31, 1993, but the regulations also include a grandfather provision for products made before July 31, 1992. The existing VOC limits for AIM coatings are not changed by the proposal. The proposal also extends to additional counties surface coating process regulations. A key feature of the surface coating process regulations is that the VOC limits are expressed in terms of "solids delivered."

Washington

Hazardous Waste (Regulation)—Washington has proposed amendments that would make its regulations relating to reporting of discharges and spills of hazardous waste less restrictive.

West Virginia

Lead—WV H. 4608 (McKinley) relates to lead-based paint hazards in residential real property; requires sellers of residential real property to disclose lead-based paint hazards to prospective buyers; provides for civil liability and a penalty for failure to make such disclosure; requires real property owners or their agents to abate lead-based paint hazards exposing pregnant women and children under age six who reside in leased premises; provides criminal penalties for failure to abate such hazards.

Toxics in Packaging

Basic Law and State Breakdown

Basic Language

(1) Shall not intentionally introduce lead, cadmium, mercury, or hexavalent chromium into any package or packaging material or components intended for use or sale in state after [] years of enactment of statute.

(2) Phase-down:

- Sum of toxics incidentally* present may not exceed
- 600 ppm two years from adoption of statute
- 250 ppm three years from adoption of statute
- 100 ppm four years from adoption of statute

*Incidental = trace quantities due to imperfect nature of refining/milling process and not knowingly introduced.

(3) Exemptions include:

- (a) Toxics added to comply with health or safety requirements of federal law or no feasible alternative. (Must petition state's Department of Environment for two years renewable exemption).
- (b) Packages containing a code indicating date of manufacture that is prior to effective date.
- (c) But for the addition of recycled materials, concentration levels not exceeded.

(4) Certificate of compliance by manufacturer of container.

Individual States

- States Following (2) & (4):

IOWA

- Phase-down begins July 1, 1992.
- Code indicating manufacture prior to July 1, 1990.

MAINE

- Phase-down begins April 1, 1992.
- Recycling exemption expires four years from effective date.

MINNESOTA

- Phase-down begins August 1, 1993.
- Recycling exemption expires August 1, 1997.
- Code or delivery indicating date of manufacture prior to August 1, 1993.

NEW JERSEY

- Phase-down begins January 1, 1993.
- Recycling exemption expires January 1, 1997.
- Code waivable by department if labeling not feasible.
- Exempts incidental presence of lead in tin cans containing food.
- Provides two two-year exemptions for lead due to incidental presence, or because added in manufacturing phase

to containers of paint, chemicals, or other non-food products. Expires January 1, 1997.

NEW YORK

- Phase-down begins January 1, 1992.
- Recycling exemption expires January 1, 1996.
- Code indicating manufacture prior to January 1, 1992.

WASHINGTON

- (2) Regulates sum of toxics intentionally introduced.
- Recycling exemption expires six years from effective date.
- 24-month window to clear inventory.

WISCONSIN

- Phase-down begins June 1, 1992.
- Recycling exemption expires June 1, 1996.
- No code or certificate of compliance provision.

VERMONT

- Phase-down begins June 6, 1992.
- Recycling exemption expires four years from effective date.

- States Following (2), (3), & (4):

CONNECTICUT

- Phase-down begins June 6, 1992.
- Recycling exemption expires in six years.

NEW HAMPSHIRE

- Phase-down begins April 27, 1992.
- Recycling exemption expires six years from effective date.

RHODE ISLAND

- Phase-down begins July 3, 1992.
- Recycling exemption expires six years from effective date.

Pending Legislation

MARYLAND

- H. 1346/S. 554
- Phase-down begins July 1, 1993.
- Recycling exemption expires July 1, 1997.

GEORGIA

- H. 124
- Phase-down begins July 1, 1994.

FLORIDA

- S. 962
- Phase-down begins January 1, 1994.

GENERAL

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

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

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

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

SUBMISSION OF MANUSCRIPTS...

...for the Journal

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

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

... by Constituent Societies For Annual Meeting Presentation

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

...for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to the Chairman of the 1992 Roon Awards Committee, Richard Himics, Daniel Products Co., 400 Claremont Ave., Jersey City, NJ 07304. (For complete details, see "Roon Awards" section of the JOURNAL in January 1992 issue.)

MANUSCRIPT PREPARATION

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

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

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

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

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

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

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

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

Title

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

Authors' Biographies and Photographs

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

Abstracts

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

Text

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

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

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

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

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

Metric System

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

Tables, Graphs, and Drawings

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

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

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

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

Photographs

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

Color prints and slides are unacceptable.

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

Nomenclature

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

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

Nomenclature of chemical compounds should conform to the style of *Chemical Abstracts*^a 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_s 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.

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Reg-Neg Meeting Held in Durham, NC, on February 4; Work Group Formed to Investigate VOC Emissions

Approximately 60 representatives from state and local regulatory agencies, environmental interest groups, industry, and the U.S. Environmental Protection Agency (EPA) met in an "exploratory" session in Durham, NC, on February 4, 1992. The meeting focused on the possible use of regulatory negotiations (reg-neg) to draft a national rule to limit volatile organic compounds (VOC) emissions from architectural and industrial maintenance (AIM) coatings.

According to a report from the National Paint and Coatings Association (NPCA), Washington, D.C., representatives agreed to form a data collection work group as the next step in the reg-neg exploration process. The work group will review the possible definitions and scope of a national AIM rule, and will consider methods for collecting necessary baseline data, including characterizations of the industry by size and market, types of products, VOC contents, etc.

Discussions at the February meeting centered on the legislative mandate for VOC reductions from consumer and commercial products, the reg-neg process itself, a listing of the issues of concern for the various affected parties, potential approaches to a national rule, and the need for more data.

Representatives from the paint industry included members of NPCA's new Reg-Neg Steering Committee, NPCA, and other allied trade association staff, as well as interested persons from contractor, manufacturer, and raw materials supplier companies.

The meeting was conducted by Keystone Center officials, who have been named "conveners" for the reg-neg effort by EPA. The first assignment of the convener is to determine the feasibility and desirability of developing a national AIM coatings rule by reg-neg or some other consensus-building process. EPA is considering development of an AIM national rule under authority of the 1990 Clean Air Act Amendments.

Use of the reg-neg process by EPA is authorized and set forth under the Federal Advisory Committee Act and the Negotiated Rulemaking Act of 1990. The reg-neg process is designed to be an open exchange of ideas and opinions involving any and all interested parties in the development of a rule. Its purpose is to develop a consensus regulation with representatives of the interested parties to minimize the controversy, litigation, and delay that is often part of traditional rulemaking. After a consensus

rule is drafted through negotiations, it then undergoes traditional regulatory public notice and comment procedures.

Authorization for NPCA to participate in reg-neg on an AIM coatings national rule was given by the association's Executive Committee in July 1991. In January 1992, the Executive Committee formed a new Reg-Neg Steering Committee to oversee NPCA's role in the process. The committee is chaired by Jerome J. Crowley, Jr., of The O'Brien Corporation.

The work group met again on March 19-20, in Washington, D.C. Discussion focused on scope and data collection issues associ-

ated with the development of a national rule to limit VOC emissions from AIM coatings through reg-neg.

Another exploratory meeting of the group is scheduled to take place on April 15-16, in Raleigh, NC. At this meeting, the findings of the scope/data work group will be presented. Other possible issues for discussion include hazardous air pollutants, state implementation plan credits, whether a consensus exists for a reg-neg effort, the schedule for a reg-neg, and the potential structures of a negotiating committee, protocols, preconditions, and possible agreements for participation.

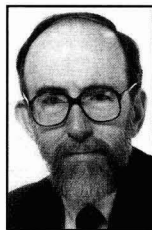
Dr. Ray A. Dickie, of Ford Motor Company To Receive 1992 Roy W. Tess Award in Coatings

The American Chemical Society's (ACS) Division of Polymeric Materials: Science and Engineering (PMSE), has announced that the 1992 Roy W. Tess Award in Coatings will be presented to Dr. Ray A. Dickie, of Ford Motor Company. The presentation will take place during the 204th Meeting of the ACS, on August 23-28, 1992, in Washington, D.C.

The Tess Award, which is given for outstanding achievement in the fields of coatings science, technology, and engineering, will be presented to Dr. Dickie in recognition of his seminal achievements in the development and evaluation of organic coatings. While polymer-metal interfaces—and related areas of surface-induced adhesion failure—have been a special interest to Dr. Dickie, he has been involved with pioneering work in the areas of coatings rheology and network modeling as well.

Among the many contributions described in over 70 publications and 36 patents, Dr. Dickie advanced the concept of cathodic delamination as the rate limiting step in corrosion control via coatings; developed a unified approach to mean-field models of blend behavior, demonstrating the applicability of these models to a wide range of polymer blends; introduced a new class of hybrid waterborne coatings for automotive application; and developed new analytical techniques and test protocols for the investigation of organic coatings. These methods have been extended recently to the evaluation of the durability of structural adhesive bonds in corrosive environments.

Dr. Dickie received the B.S. Degree in Chemistry from the University of North Dakota, and the Ph.D. Degree in Physical Chemistry from the University of Wisconsin. Also, he was involved in post-doctoral research at both the University of Glasgow (ICI Research Fellow) and at Stanford Research Institute. Dr. Dickie joined the Ford Motor Company in 1968, and is currently a Principal Research Scientist in the Polymer Science Department of the Ford Research Staff. Also, he serves on the Editorial Review and/or Editorial Advisory Boards of *JOURNAL OF COATINGS TECHNOLOGY*, *Progress in Organic Coatings*, *Journal of Adhesion Science and Technology*, and *Polymers for Advanced Technology*. Dr. Dickie has edited three books, has organized a number of international symposia, and has served as an officer of a number of scientific organizations, including General Secretary of ACS's Macromolecular Secretariat in 1990, Chairman of PMSE in 1987, and Chairman of the Great Lakes Conferences on Colloid and Polymer Science in 1982 and 1983. Among his awards are the Distinguished Alumni Lectureship in Chemistry, University of North Dakota; Outstanding Speaker Award from the Cleveland Society for Coatings Technology; and the Midgley Award of the Detroit Local Section of ACS.



Construction Contracting in January Down One Percent; Housing and Public Works Projects Continue to Surge

The total of newly started construction in January 1992 suffered a one percent setback from December 1991 as reported by the F.W. Dodge Division, of McGraw-Hill, New York, NY.

January's seasonally adjusted Dodge Index of construction contract value was 95, one point short of its best value in the past 18 months. The leading indicator of spending for ongoing construction uses 1987 as its 100 base. The Dodge report indicates

modest but steady improvement since early in 1991.

Officials at Dodge have attributed a depressed nonresidential building market to keeping the construction sector from realizing its full potential. The weakness in commercial and industrial building they claimed has offset gains in single-family housing and public works construction.

The total construction contract value for January 1992 was \$245,586 million, as

compared to \$247,891 million for December 1991.

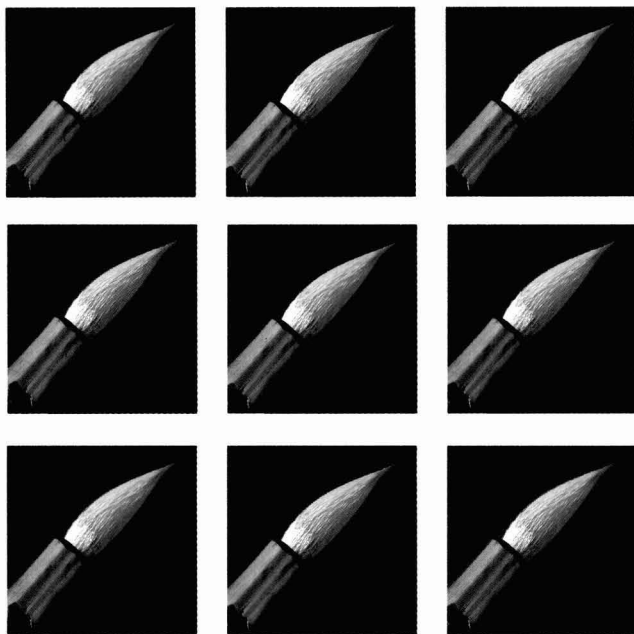
January's value of total residential building, \$115,276 million, continued its steady climb with an 11% advance over December's rate of contracting, \$103,836 million. The year-long recovery of the housing market has lifted the current rate of residential building 40% above the January 1991 low. According to officials at the F.W. Dodge Division, all of that improvement has been in single family building.

Sources at Dodge have predicted that favorable interest rates and the prospect of tax credit for first time home buyers will spur single-family housing production.

Contracting for public works construction, which surged to an all-time high in December, held within two percent of that record rate in January. Support for public works construction is developing through two sources: accelerated spending of appropriations for existing public construction programs; and the newly passed \$150-plus billion highway program.

Contracting for nonresidential buildings fell 12% in January, to \$76,165 million, following a hint of improvement in December, \$86,257 million.

On an unadjusted basis, January's contracting for new construction, at \$16.1 billion, exceeded the weak year-ago value by 14%. All regions reported double-digit gains except the West, where contracting declined two percent from the January 1991 total.



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Kentucky Forms Paint Council; Akzo's Auge Named Chairman

The National Paint and Coatings Association (NPCA), Washington, D.C., and the Louisville Paint and Coatings Association (LPCA), have combined forces to launch the Kentucky Paint Council.

The Kentucky group brings the total number to five of such paint organizations created by the NPCA in cooperation with local associations. Kentucky joins California, Illinois, Massachusetts, and New Jersey as states to have paint councils.

The reason for the paint councils is to wield a measure of clout in state capitals, where legislative and regulatory activity is continuing to pose challenges.

The Kentucky Paint Council was officially started at a meeting in Louisville, KY, on February 20, 1992. Elected to serve as Chairman of the new Council was Nelson Auge, of Akzo Coatings, Inc. Greg Brotzge, a Lobbyist with the Louisville firm of Wenz-Neely, was named the Council's Executive Director.



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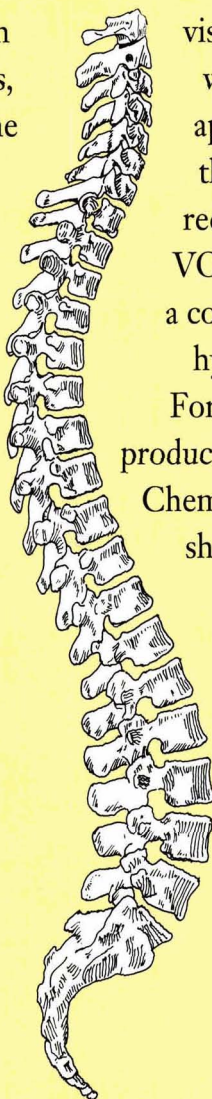
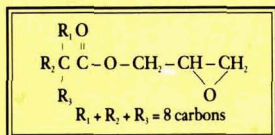
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Committee Activities

Federation Technical Advisory Committee And Society Technical Committee Chairmen Met October 3-4, 1991, in Montreal, Quebec

Sixteen Society Technical Committee representatives met with members of the Federation's Technical Advisory Committee (TAC) on October 3-4, 1991 at the Aeroport Hilton Hotel, in Montreal, Quebec, Canada.

The meeting was called to order by Technical Advisory Committee Chairman Gail Pollano with the following in attendance: Mary Somerville (Baltimore); Roland Staples (Birmingham), Darlene Brezinski (Chicago), Freidun Anwari (Cleveland), Rose Ryntz (Detroit), David Siller (Houston), Steve Bussjaeger (Kansas City), V.C. "Bud" Jenkins (Los Angeles), Daniel Letourneau (Montreal), Larry Waelde (New York), Julio Avilia (Philadelphia), Nellie Morentz (Piedmont), Michael R. Van De Mark (St. Louis), Walter Naughton (Southem), and Bob Ng (Toronto).

Technical Advisory Committee members in attendance were: Vicki Scarborough (Southern), Robert Athey (Golden Gate), John Flack (Toronto), Richard Max (Chicago), and Edward Ferlauto (Northwestern).

Meeting guests were: William F. Holmes (FSCT President-Elect), Tom Brown (Philadelphia), Horace Philipp (Montreal), and Bruce Bridges (Montreal).

Also attending were: Thomas A. Kocis, FSCT Director of Field Services, Patricia D. Viola, Editor of the *JOURNAL OF COATINGS TECHNOLOGY*, and Michael Bell, FSCT Director of Educational Services.

Joint Coatings/Forest Products Committee

Steve Bussjaeger reported on the activities of the Committee, highlighting the monograph publishing project. This project is on schedule and as a result, there will be monographs published in the spring 1992 issues of the *American Painting Contractor*. He also displayed a copy of the brochure compiled by the Committee in conjunction with the National Forest Products Association entitled "Finishing Exterior Wood Products."

Corrosion Committee

Horace Philipp reported on the activities of the Corrosion Committee and stated the Committee was meeting in Philadelphia on Tuesday, October 8, 1991. The Committee is working on the seminar for the 1992

Spring Week Program in Boston. The seminar is scheduled for May 19-20, 1992. The Committee hopes to announce the event schedule during 1991 Annual Meeting and Paint Show in Toronto in early November.

Overview of Technical Advisory Committee Activities

Chairman Pollano requested reports on the activities of the Technical Advisory Committee and the status of the Committee's projects.

COLLABORATIVE TESTING PROGRAM—Richard Max reported on the Collaborative Testing Program, conducted by Collaborative Testing Services, Inc., in Herndon, VA. He distributed a survey which sought information on the types of tests the program should be doing and also requested contributions of sample coatings for the program.

NIBS—Ed Ferlauto reported on the activities of the project, sponsored by the National Institute of Building Sciences, which is being done in conjunction with several other technical organizations. The purpose of the project is to develop national guide specifications for testing and abatement of lead-based coatings.

ADOPTIVE SOCIETY PROGRAM—Chairman Pollano explained the new Adoptive Society Program, which was designed to facilitate the flow of information from the Committee to the Constituent Societies. It is also a useful tool for Societies which need help with technical projects. These Societies can contact the designated TAC member for assistance or advice. She encouraged feedback about the program so the TAC can have an idea about its acceptance and usefulness.

BRAINSTORMING—Vickie Scarborough explained the process the meeting would follow and that the Societies would be grouped by their adoptive Societies. She explained the purpose of the brainstorming was to get each group to think through the necessary steps of a completed technical project.

Society Reports

The Constituent Society reports were given by the attendees. The following capsules the reports submitted and discussed.



Baltimore

The Society is currently involved in two projects, a survey of application properties of New York/New Jersey VOC compliant alkyd enamel vs a noncompliant alkyd enamel and the effect of proper priming and surface preparation on the performance of coatings systems. The goal of the second project is to produce a video for use in paint stores.

Birmingham

The Club reported on progress on the projects it is undertaking: publishing a Solids/Density book; working on a museum project; planning to become more involved in the educational activities of the colleges and universities; and developing a seminar scheduled for February 1992 on environmental problems. Another project of the Club is a collection of information for members on the carbon content of solvents, to assist in complying with the new VOC laws of England.

Chicago

The Society recently reformed its Technical Committee and just got the go ahead on a project to update the MSDS information. The Society envisions itself as the section to house the sheets and views this project as one to last for several years. The hope of the Committee is to eventually automate the project for future updates.

Cleveland

The Society has had a very successful year with its technical projects. It presented two papers at the 1990 Annual Meeting and provided the speaker for the October Cleveland Society meeting. The Committee also completed two studies entitled, "Changes in Hiding During Latex Film Formation, Part IV" and "Clear Liquid Separation in Cellulosic/Associative Thickeners Systems." The results of both studies will be presented as papers at the 1991 Annual Meeting. The Society is also initiating a study comparing six accelerated corrosion techniques with six interior exposure locations on eight VOC compliant coatings.

Detroit

The Society is working on a project with the University of Detroit, Polymer Technologies, Inc. The purpose of the project is to work on the development and testing of Interpenetrating Polymer Networks (IPNs) for automotive applications. The results of the work will be presented in a paper entitled, "The Effect of Siloxane Modification on the Physical Attributes of an Automotive Coating."

Golden Gate

The Society has been working on several projects during the last three years. In 1989 and 1990 the Society's project was a drying study on three different substrates (aluminum, sealed and unsealed Leneta charts) with three different coating formulations (solventborne with pigment and waterborne with and without pigment). The project was reported as part of the 1990 APJ/Voss competition and received third place. The 1991 project was an examination of dry ground recycled glass as a potential paint pigment. Students from California Polytechnic Institute—San Luis Obispo participated in the project and one of these students will make the presentation in Toronto.

Houston

The Society is presenting a paper at the 1991 Annual Meeting entitled, "Variable Characteristics of Titanium Dioxide Pigments Using SEM and Particle Size Analysis," and is involved in the preparation of the support documentations of the findings.

Kansas City

The Society is currently working on three projects: "Performance of Exterior Finishes on Medium Density Hardboard"; "Compliant Coatings: Artificial vs Natural Weathering"; and "Performance of Extender Pigments in Exterior Latex Finishes."

Los Angeles

The Society has been evaluating the projects it has been working on for the past three years. The result of this activity is an understanding of the steps the Society needs to take to complete successful projects. The goal of the Society is to develop a paper to present at the 1992 Annual Meeting. The topics under consideration include: "Color Standards: Wet, Physical, or Colorimetric"; "Color Variation from Batch to Batch"; "Color Difference Mathematics from the Paint Chemist's Eye"; and "Graffiti Abatement and Prevention Handbook."

Montreal

The Society is currently working on a study on the effects of acid rain on coatings. This is a joint project with the Northwestern

Society. The goal of this project is to present a paper at the 1992 Annual Meeting. The Society recently appointed a new Technical Chairman and hopes to begin reviewing several other topics for future project work.

New England

The Society is working to re-establish a Technical Committee, in light of several relocations and job changes outside of the coatings industry. The Society is currently involved with two projects, one dealing with the Reproducibility of Artificial Weathering and the other with an exposure test of Biocide-Containing Polymers (PRI Mildew).

New York

The Society currently has six active subcommittees, with a total of 35 members participating. Four of the subcommittees are investigating technical papers, one is working on a series of video tapes, and one is investigating the feasibility of establishing a technical symposium in the New York area. The four subjects being considered for technical papers are: "Defoamers in Waterborne Systems"; "Color Computer Usage Survey"; "Rheological Modifiers for High Solids Coatings"; and "Silicone Additives for High Solids Coatings." The Society gives special recognition to the subcommittee chairmen which successfully complete a technical project. Much of the Committee activity has come about since the Society presented a paper at the 1990 Annual Meeting, and the organization of the Committees has been streamlined. The Society's Technical Committee also recently received approval to begin working on the first video of the series entitled, "Laboratory Paint Testing Procedures." The ultimate goal of the Society is to have a series of six to eight videos containing six to nine tests per 30 minute tape.

Northwestern

The Society is presenting a paper at the 1991 Annual Meeting entitled, "Selection of Corrosion Test Methods Based on Mechanism Principles." The Society also has two other projects currently in progress, a study of the effects of acid rain (with the Montreal Society) and an evaluation of the procedure to determine the free formaldehyde contents of coatings formulated with urea formaldehyde and melamine formaldehyde crosslinkers.

Philadelphia

The Society is working on two projects, an Electronic Raw Materials Database and a VOC project to challenge the validity of ASTM D 2693-87. The Electronic Raw Materials Database is in the formative stage and the Society has requested funding from the Federation to assist in the activity. The

results of the letter project will be presented via a paper at the 1991 Annual Meeting at the session to be held on Tuesday, November 5 at 9:30 a.m. The next project of the Society will be to follow-up on ASTM Statement D 2369-87 VOC determinations which allow the prepared samples to stand at room temperature for up to 24 hours before oven insertion (current methods allow a one hour wait).

Piedmont

The Society is currently reviewing all possible options before beginning its next project, one which it hopes to produce a paper which is of a publishable quality. The three options currently being considered are: "A Study of the Effects of Nitration Level and Molecular Weight Distribution in Nitrocellulose as it Affects Lacquer Properties"; "The Effect on Veneer Faces Having Various Underlaysments by Aqueous Acrylic Coatings"; and "The Effects on System Hardness that is Comprised of a Harder Aqueous Acrylic Topcoat Applied over a Softer Aqueous Acrylic Undercoat or Sealer." The Committee will rely on a topical computer search to determine the project to proceed with.

Rocky Mountain

The Society is currently working on a study of the effects of color and insulation on the surface temperature of coatings. The Technical Committee has developed a timeline and plans to monitor the project, including the taking of photographs to track the testing results.

St. Louis

The Society will be presenting a paper at the 1991 Annual Meeting entitled, "Flash Rust Testing and Inhibitor Evaluation Through a New Spectrophotometric Integration Technique."

Southern

The Society is working on a project dealing with the yellowing of dry-wall. The current work of the project is centered on the changes in the substrate over the last few years which might contribute to the yellowing problem. This topic is becoming a very big concern in the southern United States.

Toronto

The Society recently completed a project in conjunction with the Montreal and Pacific Northwest Societies entitled, "Finishes for Automotive Plastics." The results of this project will be reported via a paper delivered at the 1991 Annual Meeting. The Society also formed a technical subcommittee to assist in the promotion of the 1991 Annual Meeting and Paint Industries' Show. This subcommittee contacted various media about

the event and discussed such topics as color computer matching, powder coatings, and trade sales coatings. In 1992 the Society plans to present a paper dealing with the study of a method for determining vehicle demand of organic pigments vs the old ASTM method D 281-84.

The Society Technical Chairs fielded questions and several parties were encouraged to join forces in order to eliminate duplication of project effort.

Motivational Speaker

FSCT President-Elect William F. Holmes, of National Pigments, Garland TX, addressed the attendees. He began by acknowledging that it was Tom Kocis' last meeting with the TAC. He gave Tom a personal thanks for a job well done.

President-Elect Holmes then explained the three things the Federation expects from the Technical Advisory Committee: Education, Manufacturing, and Technical. He cited several ways the Committee is already fulfilling its mission, via the Corrosion Committee, the Joint Coatings/Forest Products Committee, the Collaborative Testing Program, and through focus groups.

President-Elect Holmes cited several ways the Societies can become involved in new activities. He said the Society Technical Committees should stay abreast of new technical regulations and chemical industry advances, while also bringing technical expertise to bear on industry, and responding to the need for technical knowledge in the industry through such things as environmentally sound Green Seal Products.

Some of the future ideas the Committee can consider in order to meet this need is to develop a "900" number for coatings information, act on the MSDS and raw material projects, work on group dynamics to expand activities, and begin to use project champions to help move projects through the system.

President-Elect Holmes also expressed the need to get new and different people involved in the technical activities of the Federation by urging the Societies to seek speakers with vision to encourage new ideas; to serve as a traffic cop on technical paper selection; to motivate through inspiration; to recognize contributions and give them incentive to continue to contribute; to develop a history of participation; and to motivate through project selection.

He added that the participants in technical activities have to understand the technical needs of the constituency and to begin this on the local level. He challenged the attendees to look for special talents and abilities of the members and to develop projects that catch the fancy of people.

Brainstorming

The Committee broke the attendees into groups by adoptive Societies. The results of

the groups activities can be used as guidelines for the development of technical projects.

Open Forum

The Committee reviewed the comment cards and discussed the items of interest to the attendees. Items which were reviewed by the attendees included:

—How to get members interested in the projects of the Society Technical Committee.

—What is a workable meeting format?
—How to help incoming Society Technical chairs.

—The booklet prepared by the Technical Advisory Committee concerning the position of Society Technical Chairmen.

—Question on whether the exercise of brainstorming was worthwhile.

Paint Tour—Kronos TiO₂ Facility, Varennes, Quebec, Canada

The attendees were transported to the Kronos TiO₂ facility in Varennes, Quebec, Canada on Friday morning, October 4, 1991 for a tour of the plant and presentations from several of the company's personnel about the facility.

The "Windy City" will play host for the Federation's 1992 Annual Meeting and Paint Industries' Show in October at McCormick Place North.

So if you don't want to be blown away by the competition, make your plans **NOW** to attend the biggest paint industry event of the year!!!



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Prediction of Coating Failure Over Sheet Molding Compound (SMC): Solvent Permeation Studies

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The major failures attributed to coating appearance as applied over sheet molding compound (SMC) are those due to solvent popping or solvent blow-through from the substrate through the coating. Evidence has been reported by G.D. Cheever, of General Motors, which indicates solvent penetration of coating solvents into the porous substrate, which later erupts through the cured coating upon heating, thereby affording a cratered-like appearance.

Our studies relate the tendency of solvents to diffuse through a variety of coating types to the solvent blow-through resistance of the cured coating/SMC composite. Relationships are derived which correlate the ability of a coating to inhibit the solvent blow-through failure on SMC to solvent permeation resistance of a coating formulation into the SMC/coating composite. With this predictive relationship, acceptable finishes can be qualified on SMC by the coating formulation utilized.

INTRODUCTION

Consumption of automotive plastics in the United States is expected to double in this decade to a volume of 4.17 billion pounds by 1999!¹ The 10 highest growth applications alone will account for an increased 744 million pounds per year of plastics by 1999. Applications such as pick-up bodies, gas tanks, and interior trim will utilize plastics such as thermoset polyester [including sheet molding compound (SMC) and reaction injection molding (RIM)], polyphenylene sulfide (PPS), acrylonitrile-

butadiene-styrene (ABS), and polypropylene.² It is estimated that the average weight of plastic use per automobile will be 300 pounds by the end of this decade as compared to the 180 pounds used today.

The major advantages of choosing plastics as alternatives to metal substrates are numerous: (1) performance and ease of manufacturing; (2) cost effectiveness over metal alternatives as a result of: energy consumption decrease due to decrease in weight, lower cost of tooling, especially for complex shapes and styling, and faster tooling time; (3) inherent corrosion resistance properties of plastics; and (4) styling latitude.

These advantages have led to the increased use of plastics for both interior and exterior automotive parts. This increased use of plastics leads to a corresponding increase in the importance of plastic coatings. This paper will discuss the problems associated with the selection of formulated coatings for rigid exterior automotive plastics, in particular SMC. Disclosure of a predictive method for determining ultimate appearance of coating systems over the SMC/coating composite will be made based on a solvent permeation or solvent diffusion process.

SMC components are found in nearly 100 domestic automobiles in over 200 applications.³ It can match the surface finish of steel and run through E-coat dips, is lightweight, has a low coefficient of thermal expansion, and is cost effective. It has been used in the automotive industry longer than any other type of plastic composite material. With an aggregate \$150 billion in sales in 1990,³ by 1995 this number is expected to double—to more than 400 million pounds.

The reinforced plastic, i.e., SMC, is a polymeric composite consisting of reinforcing fibers embedded in a polymer matrix, and other materials such as filler and pigments may also be present.⁴ SMC is a heterogeneous substrate which is a filled, glass reinforced thermoset

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polyester sheet containing an unsaturated polyester and a low profile additive dissolved in a reactive monomer, such as styrene, with glass fibers, and a filler such as CaCO₃.⁵ In addition to these major ingredients, the basic mix contains a peroxide catalyst, thickener, and an internal lubricant or release agent (Table 1).⁶

The monomer crosslinks the polyester under heat and pressure to produce a thermoset plastic which exhibits many attributes. The advantageous properties of SMC include: intricate aerodynamic shape (which invites design freedom), reduced weight, high strength to weight ratio, good dimensional stability (including excellent overbake tolerance), excellent chemical resistance, and inherent rigidity, which enables one to use the same topcoat systems as those utilized on metal.

During the molding of SMC parts, the polyester resin solution in conjunction with the styrene monomer shrinks upon polymerization. The low profile additive, on the other hand, undergoes thermal expansion to compensate for the shrinkage.⁷ Surface defects, however, are inherent due to the composition of the substrate, stresses induced in the substrate from cutting, drilling, etc., and processing conditions (temperature/pressure relationships).

Most of the surface defects that affect painting of SMC originate at or within several hundred microns of the surface (Figure 1).⁵ Domain stratification of the low profile additive or mold release agents can cause areas of different surface free energies which affect flow, leveling, and adhesion of paints. Sanding of the substrate, to eliminate dirt problems associated with the molding process for instance, can affect mechanical and chemical adhesion as well as the appearance of porosity, voids, and fiber breakthrough which will be evidenced in a cratered or poor distinctness of image (DOI) topcoated system.

Considerable research has been conducted in an attempt to develop a coating type which would eliminate the painting problems associated with SMC. Problems associated with coating SMC include: loss of primer adhesion (chipping); solvent attack and its effect on mechanical properties; porosity of the substrate, including voids, cracks and mold lines; and general wetting of the substrate. All of these factors will affect the reproduction of gloss, DOI, and color of the topcoated substrate. Other properties affected include weatherability, chemical re-

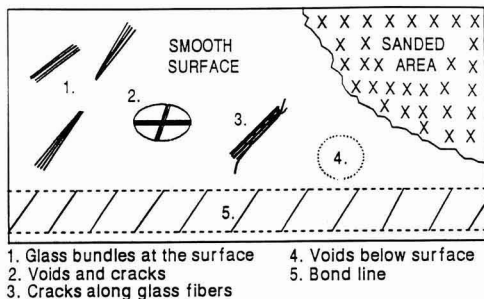


Figure 1—Representation of an SMC surface prior to painting

Composition	Wt %
Resin	
Unsaturated polyester	25-35
Styrene monomer	
Low profile additive(s)	8-14
Glass fibers	20-30
Inert filler	
Calcium carbonate	20-30
Additives	Variable
Internal lubricant or mold release agent	
Viscosity modifier	
Peroxide catalyst	

sistance, and physical and mechanical properties of the painted plastic composite.

Primers are utilized on SMC to provide several functions, some of which are: (1) adhesion to a nonuniform surface; (2) improving the surface quality by providing a uniform surface and equalizing surface tension; (3) improving surface smoothness; (4) eliminating (cover) surface defects, i.e., voids, cracks, mold lines, and glass fibers; (5) eliminating surface porosity; and (6) providing a barrier to solvent penetration.

One mode of topcoat failure on SMC is believed to result from migration of topcoat solvents through the primer into the microporous substrate.⁸ As the substrate heats, during the topcoat bake, the solvent expands and is expelled through the partially cured topcoat. The problem occurs with all types of topcoats, i.e., one-component and two-component systems and often manifests itself in the form of pits, porosities, or craters in the topcoated substrate.

A test method was developed at General Motors Research (GMR) Laboratories using fluorescent microscopy to study the effects of solvent migration on the properties of painted SMC parts.⁸ In this method, a fluorescent dye was solubilized in a model basecoat/clearcoat formulation. The model basecoat/clearcoat system was applied over a primed SMC substrate and cured. The amount of dye which penetrated through the coating system was then calculated by polishing the painted/SMC composite and exposing it to fluorescence microscopy. In this manner, depth of dye penetration could be correlated to solvent penetration through various primer systems.

In this paper, we propose the use of a simplified solvent permeability test to qualitatively correlate the ranking achieved in the "Cheever" test to ultimate appearance of topcoated SMC parts. It was determined previously⁸ that primers which exhibited low solvent penetration allowed for topcoating without ultimate solvent blow-through and thus produced good appearance in the topcoated substrate.

EXPERIMENTAL METHOD

Solvent Permeability Test

Each primer formulation (see Table 2) to be tested was spray applied over a Whatman #40 and #42 ashless filter

paper (pore sizes of filter paper are 8 μm and 2.5 μm , respectively) attached by means of tape to a 4 \times 12 in. cold rolled steel (CRS) panel. The panel and filter paper were baked horizontally in a gas fired oven for a specified bake schedule (Table 3). The thickness of the coating on the filter paper was calculated by measuring the thickness of the coating on the steel panel on which it was supported. (In cases where more than one layer of primer was applied, the first primer layer was baked, cooled, and the second primer layer was applied and then baked). The filter paper was then reduced in size by laying the paper flat on a horizontal surface, placing the flat ring of the Fisher/Payne permeability cup (Figure 2) over the paper, and cutting, by means of an Exacto-knife, around the periphery of the flat ring.

The sized coated filter paper was then placed coated side down on top of the Fisher/Payne cup filled with 5 mL of solvent-blend mixture (Table 4). The cup gasket was placed on top of the sized, coated filter paper, followed by the flat ring, and the ring was secured by means of the knurled head screws (placed equidistant around the circumference of the permeability cup) to the cup.

The entire permeability cup/coated filter paper/solvent-blend mixture was weighed on an analytical balance to the nearest 0.01 g. The cup was inverted at room temperature for 3 min (to mimic the flash time in topcoating processes), then placed right-side up in a 250°F electric oven for 30 min (to mimic topcoat bake). The permeability cup was removed from the oven, allowed to cool to room temperature, and reweighed to the nearest 0.01 g. By subtracting the weight of the permeability cup before and after the baking procedure, the total amount of solvent permeated through the film could be determined.

In order to determine the amount of solvent loss due to possible leaks in the permeability cup, the previously mentioned procedure was followed with one exception: a piece of steel shimstock, 1 mil in thickness, replaced the coated filter paper. The steel shimstock, being impermeable to solvents, allows one to account for solvent evaporation through the gasket/film/permeability cup interface.

GMR Fluorescent Microscopy Test

SMC plaques were cut from production material obtained from Buick-Oldsmobile-Cadillac (BOC) and primed with the selected primer. Each primer coat was baked at the specified bake schedule (Table 5). The primer was not sanded between coats.

The topcoat was applied at GMR. A white basecoat was doped (0.5 wt% [based on total solids]) with 7-diethylamino-4-methyl coumarin. The clearcoat was applied wet-on-wet, flashed 20 min, and baked 30 min at 250°F.

A 1 \times 1 in. (25mm \times 25mm) section was cut from each panel using a diamond saw and then polished. All cutting and polishing procedures were done so that the polished surface was perpendicular to the supported sides. The actual film build was determined optically. Each sample was examined using fluorescent microscopy. The intensity of the fluorescence (a measure of the amount of dye present) was determined using a photomultiplier tube mounted in the camera part of the microscope.

Measurements were taken through a 5 \times 100 μm slit and were repeated in five intervals until the detected fluorescence was negligible.

Voltage was plotted against depth of penetration and the area under the curve [volt \times cm] was determined. Correlation of laboratory data to production results indicates that values less than 3 \times 10⁻³ Vcm are considered to be effective barriers to solvent penetration.

Results of the solvent permeation tests previously described were then related to results obtained for the same primer formulations in the GMR fluorescent microscopy test and the SMC cratering (described in the following).

Primed SMC Cratering Potential

SMC plaques from a Navistar hood headlight opening cutout were subjected to a bending stress to expose porosity and glass fibers. The stress was applied by holding both ends of the headlight opening cutout (size of cutout was 2 in. wide by 8 in. long) and pushing down simultaneously on the ends so that the middle of the plaque buckled. The stress was continually applied and relieved so that a cracking noise could be heard but so that the panel did not show any visible cracks. In this manner, porosity and glass fibers were exposed.

The stressed plaques were then wiped with isopropanol. The primer system to be studied was spray applied and baked at the designated bake schedule (Table 6) in a gas fired oven. In cases where the total dry film thickness exceeds 1.0 mil, the primer coat was applied by a two stage process where the first primer layer was applied, baked, and cooled followed by the second primer layer which was applied and then baked.

Table 2—Primer Formulations

Designation	Chemistry	P/B	Solids	VOC
A	Polyurethane dispersion/Acrylic latex	0.12	37.2	2.50
B	Alkyd/Epoxy-ester/Imino melamine	1.0	51.0	3.44
C	Polyurethane polyol/Melamine	1.0	50.0	3.55
D	Alkyd-epoxy-ester/Melamine	1.0	57.7	3.10
E	Alkyd-epoxy-ester/Melamine	1.0	56.4	3.20
F	Polyurethane dispersion/Acrylic latex/Imino melamine	0.12	38.8	2.2
G	Alkyd/Epoxy-ester/Imino melamine	1.13	52.0	3.3
H	Alkyd/Epoxy-ester/Imino melamine	1.0	50.7	3.5
I	Alkyd/Epoxy-ester/Blocked isocyanate	1.13	52.0	3.5
J	Polyester/Epoxy-ester melamine	1.01	55.2	3.3

Table 3—Results of Solvent Permeability Tests

Primer designation	Total DFT* (Mils)	Filter paper no.	Bake (min @ °F)	Δ Wavg ^b	Δ Wavg ^c corrected	Δ Wavg corrected ^c × DFT total	Ranking (1 = Best)
A	2.1	40	30 @ 300	1.86	1.41	2.96	14
	2.0	42	30 @ 300	1.38	0.92	1.84	13
F	2.1	40	30 @ 300	1.05	0.60	1.26	3
	2.0	42	30 @ 300	0.68	0.22	0.44	1
F	1.8	40	30 @ 250	1.13	0.68	1.22	2
	2.0	42	30 @ 250	0.84	0.38	0.76	3
F	1.1	40	30 @ 300	1.30	0.85	0.94	1
	1.1	42	30 @ 300	0.97	0.51	0.56	2
B/J	2.0	40	30 @ 300	1.27	0.82	1.64	7
	1.8	42	30 @ 300	1.11	0.65	1.17	8
G	1.7	40	30 @ 300	2.06	1.61	2.74	13
	1.7	42	30 @ 300	1.22	0.76	1.29	12
J	1.8	40	30 @ 300	1.37	0.92	1.66	8
	1.8	42	30 @ 300	1.16	0.70	1.26	11
C	1.8	40	30 @ 300	1.58	1.13	2.03	11
	1.8	42	30 @ 300	1.08	0.62	1.12	6
C	0.8	40	30 @ 300	2.42	1.97	1.58	6
	0.8	42	30 @ 300	1.68	1.22	0.98	4
C	0.8	40	30 @ 300 ^d	3.01	2.56	2.05	12
	0.8	42	30 @ 300 ^d	1.87	1.41	1.13	7
I	1.0	40	30 @ 300	2.00	1.55	1.55	5
	1.0	42	30 @ 300	1.65	1.19	1.19	9
D	1.8	40	30 @ 300	1.25	0.80	1.44	4
	1.8	42	30 @ 300	1.09	0.63	1.13	7
E	1.8	40	30 @ 300	1.53	1.08	1.94	9
	1.8	42	30 @ 300	1.13	0.67	1.21	10
B/H	1.8	40	30 @ 300	1.57	1.12	2.02	10
	1.8	42	30 @ 300	1.04	0.58	1.04	5

(a) DFT = Dry film thickness.
 (b) Δ Wavg = Average value of Wi-Wf (initial-final weights) results.
 (c) Δ Wavg corrected = Δ Wavg corrected for weight loss constant of cup.
 (d) 30 min @ 400°F overbake after 30 min @ 300°F bake.

Appearance rankings were made based on the amount of craters evidenced in the cured painted substrate (examples of good and poor SMC cratering potential are shown in Figure 3).

DISCUSSION OF RESULTS

Tables 3, 5, and 6 list the primer formulations tested by the solvent permeability test (Fisher/Payne cup method),

GMR solvent penetration test (Dale Cheever’s fluorescent microscopy test), and SMC cratering potential test, respectively. It should be noted, particularly for the GMR solvent penetration test, and the solvent permeability test, that total dry film thicknesses of the primers can vary significantly from values typically seen in the field (1.0-2.0 mils).

In an attempt to quantify the relative resistance of a coating to permeation, the penetration (as determined by solvent loss or dye absorbed in the solvent permeation or GMR fluorescent microscopy test, respectively) is multiplied by the total primer thickness. This allows for the normalization of the results based on the concentration (dc/dx). According to Fick’s first law of diffusion, the

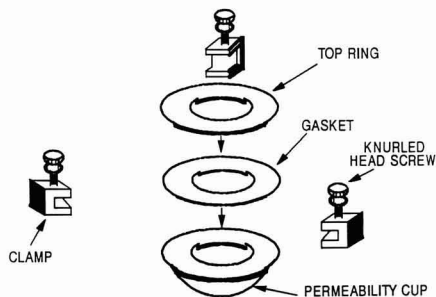


Figure 2—Fisher/Payne permeability cup

Table 4—Solvent-Blend Mixture Composition*

Component	Parts by Weight
Toluene	3
Butyl acetate	58
Methyl amyl ketone (MAK)	6
Xylene	11
Mineral spirits	7
Butanol	2
Ektapro EEP	13

(a) Representative of the solvent blend utilized in Navistar White Basecoat.

Table 5—Results of GMR Solvent Penetration Tests

Primer designation	Total DFT (Mils)	Bake (min @ °F)	Solvent penetration (Dye absorption × 10 ⁻² V.cm)	Total DFT ^a × solvent penetration (10 ⁻² V.cm mil)	Ranking (1 = Best)
A.....	3.50	30 @ 300	1.0	3.5	9
F.....	2.80	30 @ 300	0.07	0.2	5
F.....	2.50	30 @ 250	0.10	0.25	6
F.....	1.40	30 @ 300	0.12	0.17	3
B/J.....	2.20	30 @ 300	1.0	2.2	8
G.....	2.70	30 @ 300	0.39	1.05	7
I.....	2.80	30 @ 300	0	0	1
C.....	2.0	30 @ 300	0.09	0.18	4
C.....	1.0	30 @ 300	0.06	0.06	2
C.....	0.8	30 @ 300 ^b	0	0	1
I.....	4.7	30 @ 300	0	0	1
D.....	—	—	—	—	—
E.....	—	—	—	—	—
B/H.....	2.5	30 @ 300	1.2	3.0	10

(a) DFT = Dry film thickness.
 (b) 30 min @ 400°F overbake after 30 min @ 300°F bake.

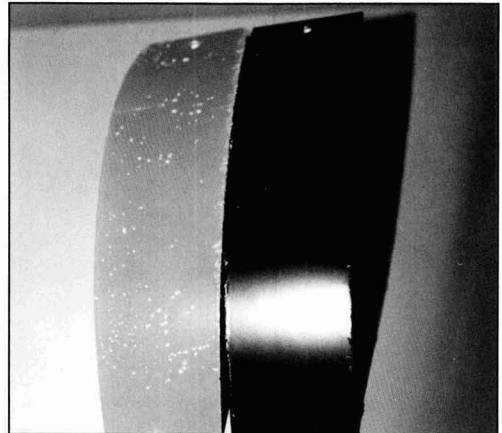


Figure 3—Solvent/porosity problem in SMC as evidenced by craters

flux J of a substance through a plane perpendicular to the direction of diffusion is directly proportional to the concentration gradient dc/dx,

$$J = D (dc/dx)$$

where D is the diffusion coefficient. The flux J is the quantity of substance diffusing per unit time through a unit area. It is therefore appropriate to assume that the amount of dye (in the GMR test) or solvent (in the permeability cup test) diffused through the primer film per unit time (3 min flash and 30 min bake) is equal to a constant (the diffusion coefficient) multiplied by the change in concentration per mil of film.

Since the diffusion coefficient is a constant related to the coating being tested, we can rewrite Fick's law to correlate more directly the results of the permeability tests as:

$$-dc = J dx$$

where the change in concentration (noted here by -dc to denote solvent loss or dye absorbed) is equivalent to the flux J multiplied by the film thickness dx. Here, J represents the amount of solvent or dye permeated or absorbed respectively through the film per unit time.

Table 3 depicts the results obtained in the solvent permeability test utilizing two different filter paper "carriers" for each primer. Different pore sizes of filter paper were chosen in attempts to correlate "voids" in the filter paper to possible "voids" created upon molding of SMC parts.

As exhibited in Table 7, four varying SMC substrates molded at different SMC molding operations were tested according to Dale Cheever's solvent penetration test. It can be seen that each substrate does yield a different degree of dye absorption, through solvent penetration, with substrate 1 affording approximately twice the penetration resistance of substrates 2 and 3. This also translates through to the same substrates primed with a poly-

ester/melamine system, where substrate 1 is approximately two times as resistant to solvent penetration as substrate 3. Substrate 4, which was in mold coated, shows no sensitivity to solvent penetration, as determined by no dye absorption.

The differences in the previously mentioned solvent penetration results of the varying SMC substrates is believed to be due to the different molding operations of each substrate. It is possible that some operations induce more porosity or surface imperfections in the molding operation that in turn lead to greater solvent penetration. For this reason, we chose to look at filter paper of varying pore size in the solvent permeation (Fisher/Payne cup) test in efforts to predict a primer's sensitivity to solvent penetration over a variety of substrates of differing porosities.

In an effort to correlate the results of the different test methods utilized to solvent penetration results, a ranking

Table 6—Primed SMC Cratering Potential

Designation	Total DFT (mils)	Bake (min @ °F)	Ranking (1 = Best)
F.....	2.0	30 @ 300	1
F.....	1.1	30 @ 300	2
F.....	1.8	30 @ 250	3
C.....	0.8	30 @ 300	4
C.....	1.8	30 @ 300	5
C.....	0.8	30 @ 300 ^b	6
B/H.....	1.8	30 @ 300	7
B/J.....	1.8	30 @ 300	8
G.....	1.7	30 @ 300	9
I.....	1.8	30 @ 300	10
A.....	2.0	30 @ 300	11

(a) DFT = Dry film thickness.
 (b) 30 min @ 400°F overbake after 30 min @ 300°F.

Table 7—Effect of Substrate on Solvent Penetration

Substrate	Primer	Film thickness (mil)	Dye absorption (x10 ⁻² Vcm)
1.....	None	0	2.0
2.....	None	0	3.9
3.....	None	0	3.2
4.....	Inmold coated	3.2	0.0
1.....	Polyester/Melamine	2.2	0.6
3.....	Polyester/Melamine	2.2	1.0

method was used. The Spearman rank correlation,⁹ R, is defined as:

$$R = \frac{1 - 6 \sum d^2}{n^3 - n}$$

where R is a correlation coefficient (a rating of 1 is indicative of exact correlation whereas 0 is no correlation), d is the difference in relative rank of one test result to another (a ranking of 3 in one test vs a ranking of 1 in the comparative test would yield a d value of 2), and n is the number of samples tested (in our testing, 11 samples were included).

The Spearman rank correlations of the solvent permeation (Fisher/Payne cup) test utilizing #40 and #42 filter paper, and the cratering potential test as compared to the GMR fluorescent microscopy test, are shown in Table 8. From the results, there appears to be little correlation of the solvent permeation test and the cratering potential test to the GMR fluorescent microscopy test.

However, when one compares the solvent permeation tests and the GMR fluorescent microscopy tests to the cratering potential test, as shown in Table 9, a very good correlation exists. The #42 filter paper in the solvent permeation test has a 96% correlation to results obtained in the cratering potential test, as opposed to a 77% correlation with the #40 filter paper. This indicates that the #42 filter paper (2.5 μm pore size) closely simulates the porosity of the SMC substrate utilized in the cratering potential test.

Table 8—Spearman's Rank Correlation of Penetration Tests by GMR Fluorescent Microscopy Test

GMR Ranking ^a	#40 Ranking ^a	#42 Ranking ^a	Cratering potential ranking ^a
C (overbake)	9	7	6
I	6	9	10
C (low film)	4	3	4
F	3	1	1
C	8	6	5
F (low bake)	2	3	3
F (low film)	1	2	2
G	10	10	9
B/J	5	9	8
A	11	11	11
B/H	7	5	7
Σd ²	180	170	152
R	0.18	0.23	0.31

(a) Rating (1 = best, 11 = worst).

A possible reason for the differences observed in the GMR fluorescent microscopy test versus the other solvent penetration tests performed could be based on the types of solvent penetration measured. The GMR test measures solvent penetration of a basecoat/clearcoat through a previously primed and baked SMC substrate. The solvent permeation and cratering potential tests, on the other hand, measure the solvent penetration of the primer into the substrate. It therefore makes sense that there is a closer correlation between the solvent permeation tests and the cratering potential tests.

If one addresses the overall results of the solvent penetration either into (solvent permeation and cratering potential) or through the primer (GMR test), several trends on primer type versus solvent porosity can be drawn (see Tables 8 and 9).

1) Crosslinked waterborne primers (i.e., F) exhibit the optimum solvent penetration resistance not only due to the coalesced film surface (which acts as a barrier to topcoat solvent penetration) but also because of lower solvent content (lower VOC, see Table 2) versus solvent-borne counterparts. The lower solvent content in the primer retards wicking (penetration) due to solvent penetration into the substrate during the primer coating process relative to the higher solvent content in the solvent-borne coating.

2) Primers that have a higher degree of crystallinity (i.e., C) exhibit less solvent penetration. This may be due to the inability of solvents to diffuse through the coating at a rate comparable to those less crystalline (i.e., G) primers.

3) In general, higher film builds, regardless of coating type, limit solvent diffusion and thus yield lower solvent penetration. This could be the reason that higher primer film builds, once topcoated, exhibit less solvent "blow-through" as demonstrated in the cratering potential tests versus lower film thicknesses of the same primer.

4) Uncrosslinked films (i.e., A) exhibit the worst solvent penetration resistance because they form no barrier

Table 9—Spearman's Rank Correlation of Penetration Tests by Cratering Potential Tests

Cratering potential ranking ^a	#40 Ranking ^a	#42 Ranking ^a	GMR Ranking ^a
F	3	1	4
F (low film)	1	2	7
F (low bake)	2	3	6
C (low film)	4	4	3
C	8	6	5
C (overbake)	9	7	1
B/H	7	5	11
B/J	5	8	9
G	10	10	8
I	6	9	2
A	11	11	10
Σd ²	50	8	152
R	0.77	0.96	0.31

(a) Rating (1 = best, 11 = worst).

to topcoat solvent migration through the primer and into the substrate.

5) Overbaking primers tends to yield poorer solvent penetration resistance (Table 9, C). This could be due to enhanced stress formation (i.e., self-condensation of melamine) and hence microcracks that would allow for solvent migration into the substrate.

6) Primers crosslinked with blocked isocyanates exhibit worse solvent penetration resistance than those crosslinked with melamines (Table 9, I vs G, respectively). This may be due to changes in crosslink density because of differences in the relative rates of curing (the deblocking of the isocyanate versus condensation with the melamine).

The effect of P/B on relative penetration rates was not examined in this study so that the lower P/B in the waterborne systems should not be compared to the higher P/B in the solventborne system. The P/B was chosen in all cases to obtain similar dry film conductivities (165 on a Ransburg meter) and gloss ranges (30 on a 60° gloss meter).

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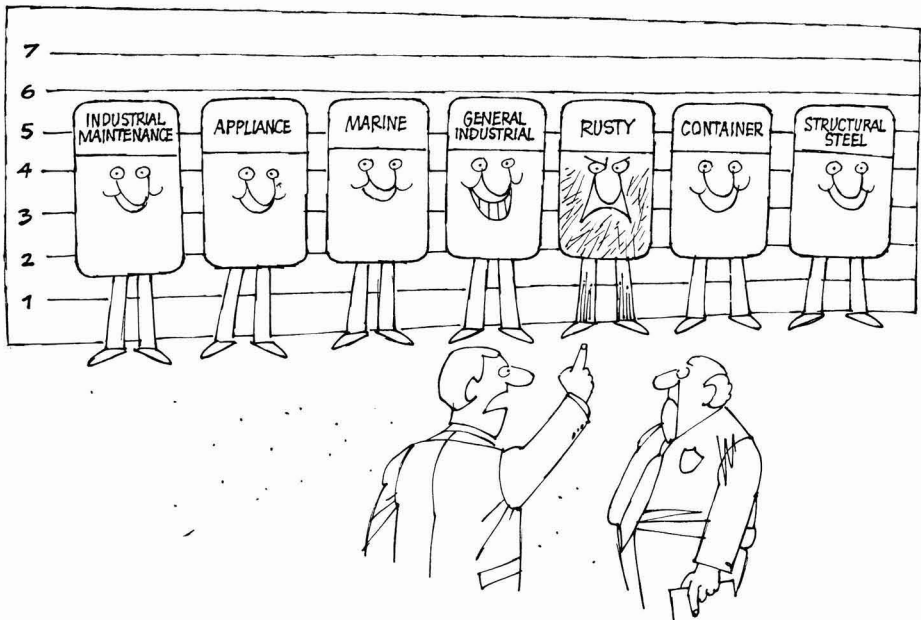
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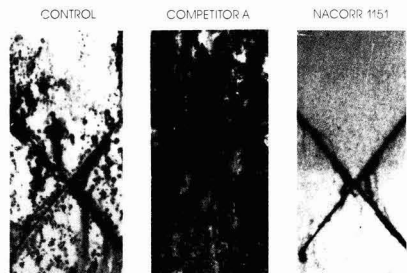
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T_g -Temperature Property (T_g TP) Diagram For Thermosetting Systems: Anomalous Behavior of Physical Properties vs Extent of Cure

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Princeton University*

The relationships between the isothermal physical properties in the glassy state of amorphous thermosetting crosslinked polymers and chemical conversion are anomalous and complex. In this manuscript, a generalized framework for correlating the basic physical properties of a high-glass transition temperature (T_g) thermosetting amine/epoxy system vs extent of cure at isothermal temperatures from above T_g to deep in the glassy state is reported in terms of the T_g -Temperature Property (T_g TP) Diagram which is introduced with this report. The framework arises from consideration of the isothermal shear modulus and the isothermal physical aging rate vs extent of cure, both of which display maxima and minima

throughout a wide range of temperatures below T_g . Use of T_g as a direct measure of conversion results in linearization of the anomalous maxima and minima of the physical properties vs extent of cure in the T_g TP Diagram. The anomalous behavior is related to specific phenomena such as the glass transition (vitrification) and the glassy-state β -transition (T_β) which change with conversion, and also gelation. The different behavior of the material vs extent of cure corresponds to different regions. Such simple diagrams are intellectually useful for understanding the properties of materials for both undercured materials (with change of conversion) and fully cured materials (with change of stoichiometric ratio).

INTRODUCTION

An understanding of the relationships between bulk properties and conversion is important for the ongoing development of thermosetting polymeric systems. The sensitivity and the one-to-one relationship between the conversion and glass transition temperature (T_g) for thermosetting systems implies that T_g is an appropriate parameter for measuring the conversion during cure regardless of the cure path.¹⁻⁴ Theoretical analyses of this relationship have been reported.^{1,5}

The basic physical properties of epoxy glasses, such as the density, modulus, water absorption, and creep,

change with increase of the extent of cure (as measured by time of cure, conversion, crosslinking density, or T_g).⁶⁻¹⁹ Many experimental reports indicate^{6,8-11} that the greater the extent of cure, the lower the density, the lower the modulus, and the more water absorbed for different epoxy systems at 25°C. However, the opposite has also been reported for the density which was found to increase with increase of T_g .¹² Other reports show that the relationship between density or modulus and conversion displays a maximum at room temperature for epoxy systems^{13,19} as well as for cyanate ester/polycyanurate systems.^{17,18} The location of the maximum was suggested to be related to gelation and to be independent of the cure temperature.^{18,19} The manner in which the physical properties in the glassy state of thermosetting resins change with extent of cure is therefore controversial.

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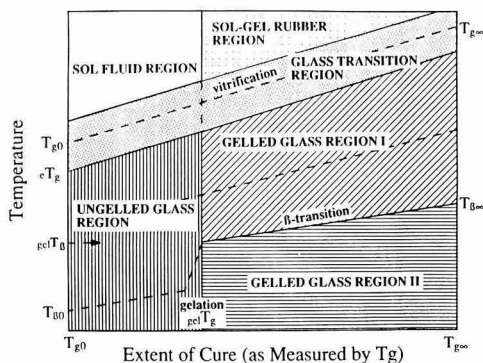


Figure 1—Schematic T_g -Temperature Property Diagram for thermosetting systems. The physical properties of the curing system are determined by the different regions which are separated by gelation ($_{gel}T_g$), and the transition contours for the glass transition (T_g), the end of the glass transition ($_{\infty}T_g$) and the β -transition (T_{β}) vs extent of cure (see also Figure 20). Anomalies occur isothermally when increasing conversion causes the material to pass from one region of the diagram to another

The basic physical properties of a material are interrelated.^{13,17-22} The anomalous changes in the density of a material vs extent of cure implies that the modulus, water absorption, creep, etc., will also change anomalously with increasing extent of cure. In practice, measurements of the density and water absorption for uncured systems are difficult to obtain throughout a wide temperature range because of the extreme rheological changes that occur during transformation of liquid monomer to solid crosslinked polymer. In contrast, relative modulus, obtained using the torsional braid analysis (TBA) technique,^{6,23} is an appropriate parameter for measuring changes in the physical properties of thermosetting systems vs extent of cure throughout a wide range of temperature (300°C in this work) and rheological behavior (liquid to glass in this work). In principle, a single TBA specimen can be used to obtain all of the thermomechanical data (relative modulus and mechanical loss), transition temperatures (T_g and T_{β}), and extents of cure (as measured by T_g), which thereby facilitates comparison of data.

In this paper, the study of a tetrafunctional aromatic diamine-cured difunctional aromatic epoxy shows that the relationships of two basic physical properties vs extent of cure at isothermal temperatures deep in the glassy state are complex functions with maxima and minima. Modulus and the rate of physical aging were the selected properties. Data were obtained using the TBA technique. A general framework for understanding and summarizing the relationships between properties and extent of cure at various temperatures from the liquid state to the glassy state is the T_g -Temperature Property (T_g TP) diagram which is introduced with this manuscript (Figure 1; see also the discussion associated with Figure 20). The X-axis of the diagram is labeled "extent of cure (as measured by T_g)" of the system. The Y-axis is labeled "tem-

perature" of the system. The properties of the curing system may be separated into different regions (see Figure 1) by the glass transition (T_g), the end of the glass transition ($_{\infty}T_g$) and the β -transition (T_{β}) vs extent of cure and also by gelation ($_{gel}T_g$). The behavior of the physical properties of a material with respect to increasing cure is determined by its temperature and its T_g . The diagram is developed herein using a high- T_g epoxy system which has been previously investigated in this laboratory.^{1,2} It is considered that the form of the diagram applies to all thermosetting systems.

MATERIALS AND EXPERIMENTAL

Chemicals

The chemical system used was a liquid difunctional epoxy (diglycidyl ether of bisphenol A, DER 332, DGEBA, Dow Chemical Corp.) with a tetrafunctional aromatic diamine (trimethylene glycol di-*p*-aminobenzoate, TMAB, Polaroid Corp.) (Figure 2). The epoxy monomer is a viscous liquid at 25°C with an epoxide equivalent weight (EEW) of 174 g/eq. The amine curing agent is a highly crystalline solid (melting point = 125°C) with an amine hydrogen equivalent weight of 78.5 g/eq. The chemicals were stoichiometrically mixed at 100°C with vigorous stirring for 15 min in order to dissolve the amine in the epoxy resin. Immediately after mixing, the warm liquid was degassed for 10 min in a vacuum oven held at room temperature. The resulting clear viscous liquid mixture was stored at -15°C. The glass transition temperature of the initial mixture, $T_{g0} = 0^\circ\text{C}$; the glass transition temperature of the fully cured material, $T_{g\infty} = 180^\circ\text{C}$; the β -transition temperature of the initial mixture, $T_{\beta0} \approx -160^\circ\text{C}$; the β -transition temperature of the fully cured material, $T_{\beta\infty} = -35^\circ\text{C}$; the glass transition temperature of the material at its gelation point,^{1,2} $_{gel}T_g \approx 50^\circ\text{C}$; the β -transition temperature of the material at its gelation point, $_{gel}T_{\beta} \approx -75^\circ\text{C}$ (see later).

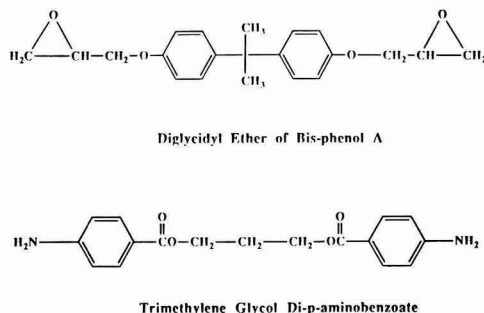


Figure 2—Chemical structures of DGEBA and TMAB

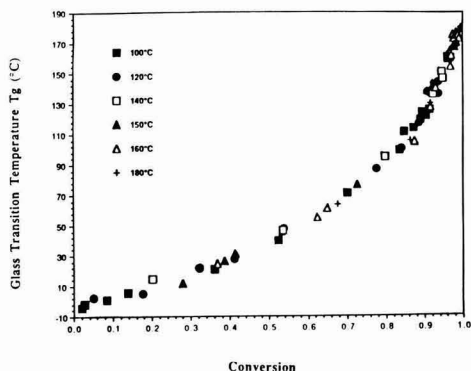


Figure 3—Glass transition temperature vs fractional chemical conversion for a stoichiometrically equivalent DGEBA/TMAB system^{1,2}

Specimen Preparation

A heat-cleaned glass braid was dipped in the viscous reactive liquid mixture at room temperature for 30 min; the impregnated glass braid was squeezed between aluminum foil to remove excess material and to insure good wetting of the glass filaments. The final amount of material on the braid was approximately 15 mg. The specimen was mounted to form the TBA inner pendulum, which was inserted into the preheated chamber of the TBA instrument (40°C). All subsequent experiments were performed in an atmosphere of flowing helium. Reviews of the TBA technique have been published.²³ The automated TBA torsion pendulum system is manufactured by Plastics Analysis Instruments, Inc., Princeton, NJ. The frequency of the freely damped oscillations is from 3 to 0.2 Hz. The sensitivity of the technique ($T < T_g$) is 0.01% of the property being measured (i.e., modulus and mechanical damping).

Modulus vs Extent of Cure

An uncured specimen was initially heated to 140°C at 5°C/min and was then cooled at 1.5°C/min through the glass transition to -180°C. Dynamic mechanical measurements were obtained during the cooling (designated as the *preaged process* in which physical aging effects are minimized; the T_g obtained during cooling is designated as the *preaged T_g*), which provided the modulus and mechanical damping vs temperature and assignments for T_g and T_g . The specimen was then heated to above its T_g to permit further cure. One specimen was used for obtaining all of the relative modulus vs extent of cure (i.e., T_g) data at different temperatures by repeating the procedure many times. The relative modulus = G'_c/G'_u , where G'_u = modulus of the uncured specimen, and G'_c = modulus of the partially cured specimen.

Physical Aging vs Extent of Cure

A specimen was initially heated to a temperature about 100°C above the initial T_g , and was then quenched, at 5°C/min, through the glass transition to the isothermal

aging temperature ($T < T_g$, such as $T = T_g - 30$, $T_g - 50$, $T_g - 70^\circ\text{C} \dots$). Data were obtained during the cooling to provide T_g values. The specimen was then held at the aging temperature for more than 1000 min during which the physical aging was monitored by measuring the increasing relative modulus [data were collected after 40 min when isothermal conditions (i.e., $T = T \pm 0.1^\circ\text{C}$) had been established]. After aging, the specimen was heated at 1°C/min through the glass transition to about 50°C above T_g to eliminate the effects of physical aging and also to permit further cure. The specimen was then quenched again at 5°C/min through the glass transition to the same isothermal aging temperature to monitor the physical aging process for the increased conversion. The procedure was repeated 8 to 10 times for each aging temperature until the specimen was fully cured. A new specimen was used for each isothermal aging temperature vs extent of cure experiment.

It is noted that the preaged T_g assignments at 5°C/min cooling rate were systematically different ($\sim 2^\circ\text{C}$) from those obtained at 1.5°C/min.

RESULTS AND DISCUSSION

T_g vs Conversion

The preaged glass transition temperature, T_g , has been found to be a good index for monitoring chemical conversion,^{1,2} since there is a one-to-one relationship between T_g and conversion (Figure 3). The reported data of Figure 3 were obtained using the DSC technique.^{1,2} The fact that T_g increases nonlinearly with conversion in crosslinking systems is considered to arise from the dependence of T_g on the crosslinking density (which is considered to be made up of trifunctional crosslinking units) and on the number average molecular weight.^{1,2,5} Both experimental and theoretical analysis of the thermosetting system used in this work imply that the T_g vs conversion relationship is unique regardless of the chemical kinetics or the time-temperature cure path.^{5,24} This is important since T_g is easily measured, sensitive to conversion with sensitivity increasing with increasing conversion, and di-

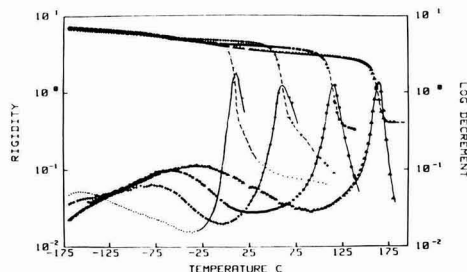


Figure 4—Dynamic thermomechanical results for the curing system throughout cure. Data were obtained on cooling after heating the specimen to successively higher temperatures (i.e., $T > T_g + 30^\circ\text{C}$). T_g and T_g of the curing system are determined from the maxima in the logarithmic decrement

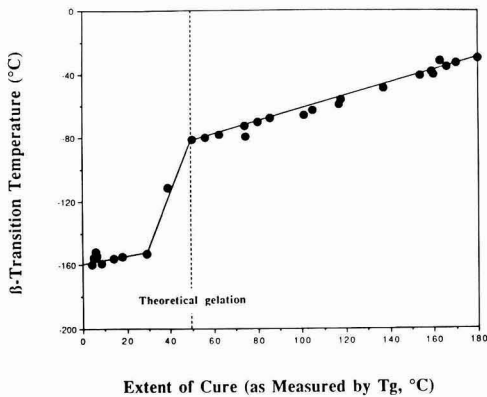


Figure 5— T_{β} vs extent of cure (as measured by T_g)

rectly relevant to the thermomechanical behavior of the material. Consequently, in the experiments reported here, the preaged T_g was used to monitor chemical conversion (hereafter designated T_g rather than preaged T_g).

T_g and T_{β}

A temperature scan of the material from the liquid or rubbery state into the glassy state yields the glass transition (T_g) and secondary transition (T_{β}) values as deter-

mined from the maxima in the logarithmic decrement. T_g and T_{β} of the curing system increase with extent of cure throughout cure (Figure 4). In the gelation region, T_{β} vs T_g displays a jump. This may be the consequence of the micromechanism of the β -transition before gelation being different from that after gelation. T_{β} increases linearly with T_g after the gelation point (Figure 5). It appears that the changes of T_{β} and T_g are affected by similar structural factors, that is, the crosslinking sites, after gelation.⁶ The β -transition temperature of the curing system at its gelation point, defined here as $_{gel}T_{\beta}$, is -75°C . Like the corresponding glass transition temperature of the curing system at its gelation point, $_{gel}T_g(50^{\circ}\text{C})$,²⁵ $_{gel}T_{\beta}$ is a material parameter of the curing system, which for the case of gelation occurring at a definite conversion (Flory's theory), is independent of the cure temperature.^{26,27} The increase of T_{β} after the gel point with increased extent of cure significantly affects the glassy state physical properties of the curing system, as will be discussed.

Isothermal Modulus, Density, and Water Absorption

The moisture absorption behavior vs extent of cure depends on the presence of appropriately sized holes, which are related to the free volume (or specific volume, or density) of the material.²⁰ Figure 6 shows that the density at 25°C decreases, and the water absorption at 25°C increases as the extent of cure increases (after gelation). The density is inversely related to water absorp-

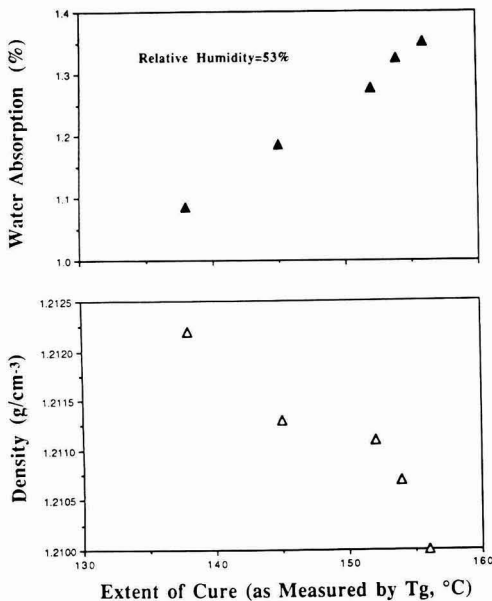


Figure 6—Water absorption and density vs extent of cure (25°C).^a The density is inversely related to water absorption

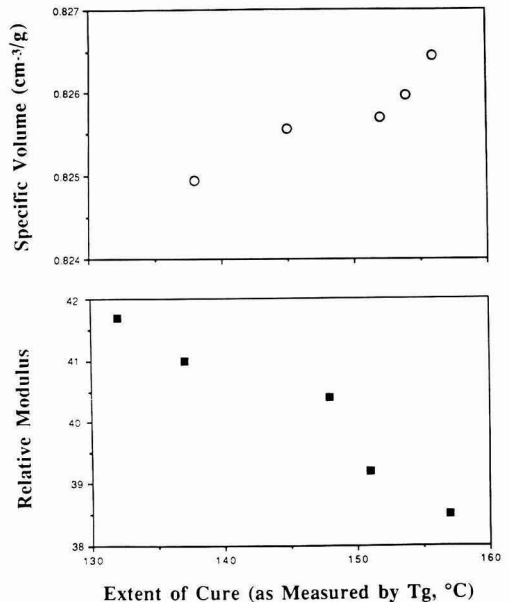


Figure 7—Specific volume and modulus vs extent of cure (25°C).^b The modulus is inversely related to specific volume (i.e., the modulus is proportional to density)

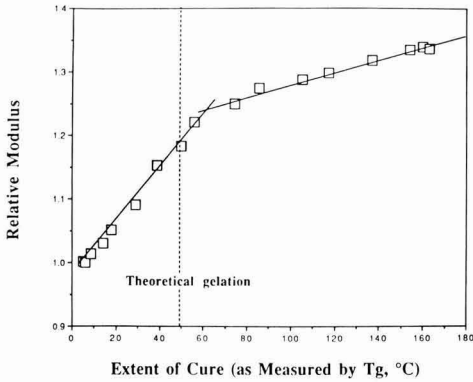


Figure 8—Isothermal modulus (–110°C) vs extent of cure. The theoretical gelation value for T_g is evaluated from Flory's theory^{26,27} and the T_g/conversion^{1,2} experimental relationship

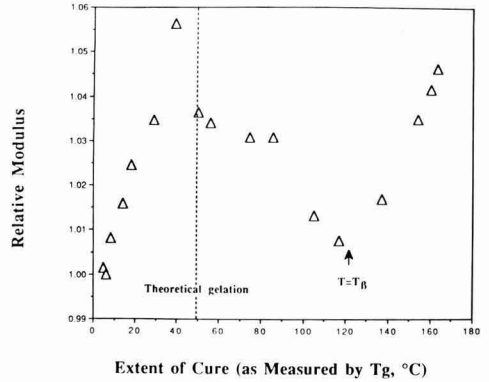


Figure 10—Isothermal modulus (–50°C) vs extent of cure. The theoretical gelation value for T_g is evaluated from Flory's theory^{26,27} and the T_g/conversion^{1,2} experimental relationship^{1,2}

tion.^{7,10,20,22} It is observed that post-curing an epoxy resin yields another interesting result: the T_g increases, whereas the modulus at 25°C decreases.^{6,20} The inverse relationship between the modulus and specific volume at 25°C is presented in Figure 7. These results show that the basic physical properties of the glassy state are related to

one another and all change anomalously with increase of the extent of cure. Therefore, investigation of changes of the modulus vs extent of cure can be used to predict corresponding changes in other properties.

Isothermal Modulus vs Extent of Cure for T < gelT_β (–75°C)

The modulus of the curing system at temperatures below gelT_β (≈ –75°C) increases linearly and sharply with increase of the extent of cure (as measured by T_g) until the vicinity of gelation (Figure 8). The relationship remains linear thereafter but with a decreased slope. The results for different temperatures below gelT_β show (Figure 9) that the critical point at which the modulus changes slope, which is designated macroscopic gelation on account of the macroscopic modulus changing slope in the proximity of the theoretical gelation point, is not very sensitive to temperature over a wide temperature range below temperature gelT_β.

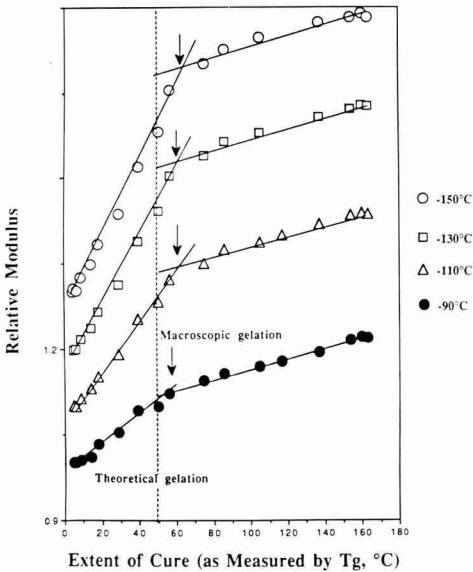


Figure 9—Isothermal modulus vs extent of cure for T < gelT_β (–75°C). gelT_β is the β-transition temperature of the curing system at its theoretical gelation point. The theoretical gelation value for both T_g and T_β are evaluated from Flory's theory^{26,27} and the T_g/conversion^{1,2} relationship

Isothermal Modulus vs Extent of Cure for gelT_β (–75°C) < T < T_{g0} (0°C)

The modulus vs extent of cure (as measured by T_g) for temperatures between gelT_β and T_{g0} (–75 to 0°C) is a source of surprise; for example, at the temperature T = –50°C (Figure 10) which is always deep in the glassy state, the modulus increases rapidly reaching a maximum when the T_g of the material ≈ 40°C, then decreases until the modulus reaches a minimum when the T_g of the material ≈ 120°C, after which the modulus increases again with increase of the extent of cure. There is no significant influence of temperature on the extent of cure at the maximum (Figure 11), which is designated macroscopic gelation on account of its proximity to the theoretical gelation point.^{1,2,26,27} The modulus of the curing system before and after gelation behaves inversely. After gelation the modulus decreases with increasing cure until

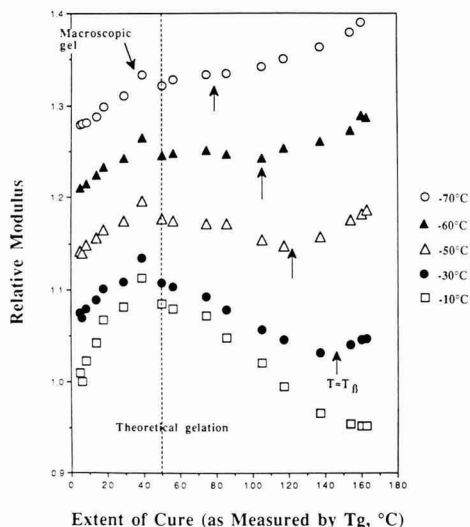


Figure 11—Isothermal modulus vs extent of cure for $T_g(-75^\circ\text{C}) < T < T_g(0^\circ\text{C})$. The theoretical gelation value for both T_g and T_g are evaluated from Flory's theory^{26,27} and the T_g /conversion^{1,2} and the T_g/T_g experimental relationships

reaching a minimum. The extent of cure at the minimum increases with temperature. Correlation with experimental data shows that the minimum occurs when T_g rises through the material temperature (Figure 11). It is noteworthy that the modulus again behaves inversely before and after this minimum with respect to increasing cure.

Isothermal Modulus vs Extent of Cure for $T > T_g(0^\circ\text{C})$

The material is initially in the liquid state when temperature $T > T_g(0)$. Figure 12 shows that the modulus of the material at $T = 30^\circ\text{C}$ rises through vitrification ($T_g = T$), reaches a maximum beyond vitrification, and then decreases with increasing extent of cure.

However, the maximum is not related to the gelation point, which is in contradiction to previous reports.^{18,19} Experimental results show that the extent of cure at the maximum increases with increase of temperature (Figure 13). On using $T_g - T$ as the X-axis to replot the experimental data of Figure 13, the modulus vs extent of cure at different temperatures shows the same shape with the same maximum at $T_g - T = 35^\circ\text{C}$ (Figure 14). The maximum in the isothermal modulus vs extent of cure is related to the end of the glass transition region, which therefore is defined as the end of glass transition of the curing system, eT_g , ($eT_g \approx T_g - 35^\circ\text{C}$).

Isothermal Physical Aging Rate vs Extent of Cure for $T_\beta < T < T_g$

The modulus of the partially cured material, after cooling from above T_g at $5^\circ\text{C}/\text{min}$ to a specific tempera-

ture (T) below T_g , increases with aging time (t_a), for example, as presented in Figure 15 for different extents of cure for $T = 14^\circ\text{C}$. The increase of modulus is related to the spontaneous reduction in the excess volume, which is trapped in the glassy state during cooling. Many studies, including small strain creep, stress relaxation, modulus, enthalpy relaxation, volume relaxation, and dielectric relaxation²⁸⁻³³ experiments, have shown that physical aging at long times is linear with respect to logarithmic aging time. Figure 16 shows that the increase of the modulus of the uncured material deep in the glassy state is linear with the logarithm of t_a at long times.

The aging rate is defined as

$$R_a(T) = [d(G'/G'_0)/d(\log t_a)]$$

where, G'_0 is the initial modulus of the material at the beginning (after 40 min when isothermal conditions had been established) of isothermal aging. Aging rate vs extent of cure results for different temperatures are presented in Figure 17. The physical aging rate, $R_a(T)$, of this material at given aging temperatures (i.e., $T = -35.5, -15, 14, 45^\circ\text{C}$) decreases with increase of extent of cure until reaching a minimum, after which $R_a(T)$ increases again with further increase of extent of cure. This anomaly is the consequence of the dynamic thermomechanical $\tan\delta$ spectrum which shows a minimum between T_g and T_g .³³ The extent of cure at the minimum increases with aging temperature. However, on using $T_g - T$ as the X-axis to replot the experimental data of Figure 17, the aging rates at different temperatures vs extent of cure show the same shape with the same minimum at $T_g - T \approx 100^\circ\text{C}$ (Figure 18). As the distance from the equilibrium state increases, as measured by $T_g - T$, the physical aging rate initially decreases, but then increases for $T_g - T > 100^\circ\text{C}$ until $T_g - T \approx T_g - T_g$. Interestingly, all curves may be simply vertically shifted together, as shown in Figure 19, which shows that the physical

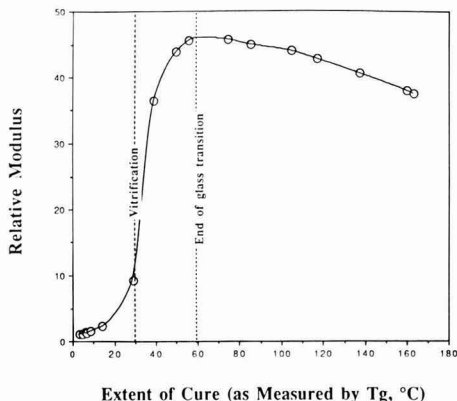


Figure 12—Isothermal modulus (30°C) vs extent of cure. The vitrification value is defined as $T_g = T$. The value of the end of glass transition is evaluated from the maximum of the isothermal modulus vs extent of cure

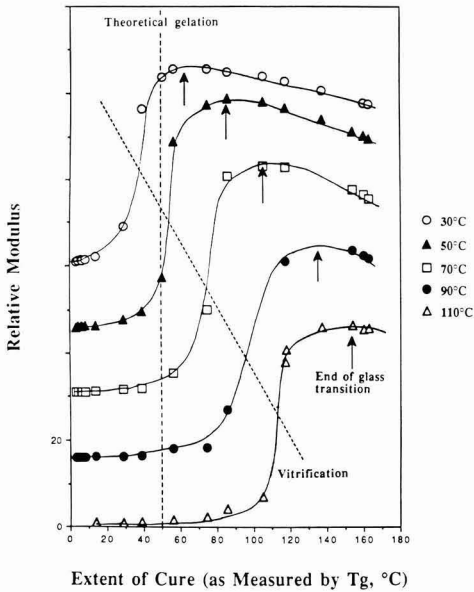


Figure 13—Isothermal modulus vs extent of cure for $T > T_g(0^\circ\text{C})$. The arrows mark the vicinity of the end of glass transition

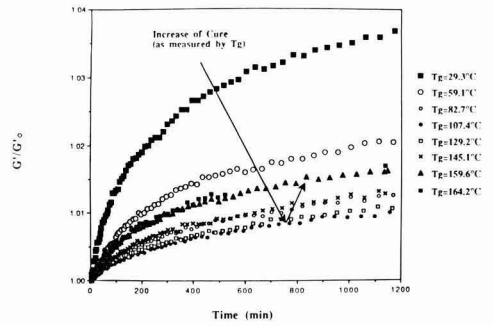


Figure 15—Isothermal modulus at 14°C vs aging time for different extents of cure, after cooling from above T_g at 5°C/min to 14°C. The rate of aging decreases and then increases with increasing of extent of cure (see arrows)

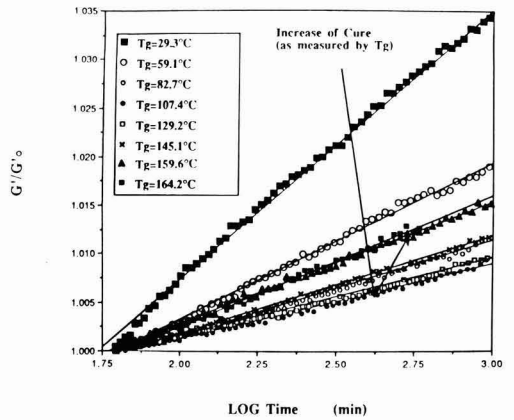


Figure 16—Physical aging rate at 14°C vs logarithm time for different extents of cure. Physical aging at long times is linear with respect to logarithmic aging time

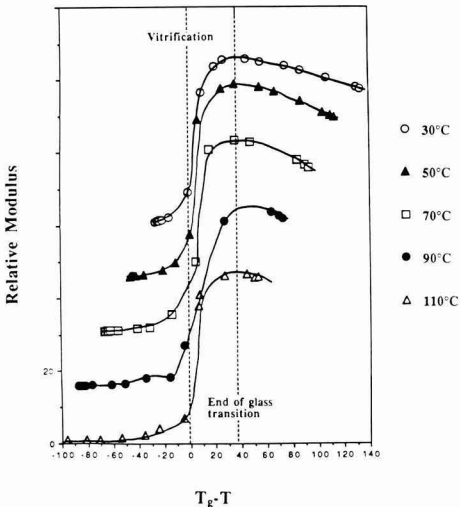


Figure 14—Relative modulus vs $T_g - T$. Experimental data of Figure 13 replotted using $T_g - T$ as the X-axis

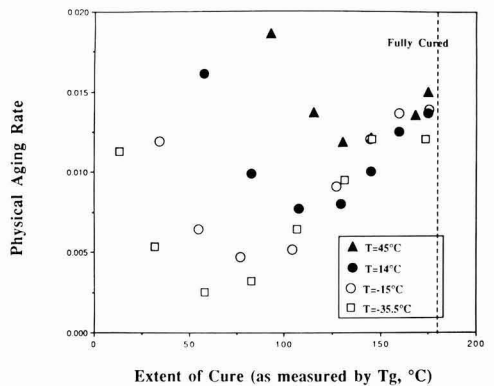


Figure 17—Physical aging rate vs extent of cure for different isothermal temperatures

aging process of this material at a given temperature, T , is mainly governed by the departure of the material from its equilibrium state (as measured by $T_g - T$) regardless of chemical structure.³³ The vertical shift factor is a function of aging temperature which follows a restricted form of the Arrhenius equation with an "activation energy" = 3 kcal/mol.³³

T_g -Temperature Property (T_g TP) Diagram

The results can be summarized in the form of the T_g -Temperature Property (T_g TP) Diagram (Figure 20), which shows that the basic properties of the curing system may be separated into different regions by the different transition lines, that is, gelation ($_{gel}T_g$), and the glass transition (T_g), the end of the glass transition (${}_eT_g \approx T_g - 35^\circ\text{C}$), and the β -transition (T_β) vs extent of cure.

(1) Ungelled glass region, $T < {}_eT_g$ and $T_{g0} < T_g < {}_{gel}T_g$; the modulus of the material increases linearly and sharply with increase of extent of cure.

(2) Gelled glass region I, $T_\beta < T < {}_eT_g$ and ${}_{gel}T_g < T_g < T_{g\infty}$; the modulus of the material decreases with increase of extent of cure. The physical aging rate passes through a minimum with increase of extent of cure; the minimum is related to the T_g and T_β transitions.³³

(3) Gelled glass region II, $T < T_\beta$ and ${}_{gel}T_g < T_g < T_{g\infty}$; the modulus of the material increases at a low rate with increase of extent of cure.

(4) Glass transition region, ${}_eT_g < T < T_g + 20^\circ\text{C}$ and $T_{g0} < T_g < T_{g\infty}$; the modulus of the material shows a large jump with increase of extent of cure because of vitrification, attaining a maximum at ${}_eT_g$ beyond vitrification. The glass transition region includes three lines in the T_g TP Diagram; that is, onset of glass transition ($\approx T_g + 20^\circ\text{C}$), vitrification (T_g), and end of glass transition (${}_eT_g \approx T_g - 35^\circ\text{C}$).

(5) Sol fluid region, $T > T_g + 20^\circ\text{C}$ and $T_{g0} < T_g < {}_{gel}T_g$; the material is a viscous fluid with low modulus. The modulus shows a small jump near the gel point with increase of extent of cure.⁶

(6) Sol-gel rubber region, $T > T_g + 20^\circ\text{C}$ and ${}_{gel}T_g < T_g < T_{g\infty}$; the modulus increases with increase of extent of cure.

The anomalous behavior of isothermal modulus and isothermal physical aging rate of the system vs extent of cure implies that all basic physical properties display anomalous isothermal changes with increase of extent of cure. The anomalous behavior at different temperatures depends on gelation and on the conversions at which T_g and T_β of the material meet the temperature of the material. The changes of properties at different temperatures vs extent of cure are summarized in the form of the T_g TP Diagram.

The significance of the T_g TP Diagram is that the critical points (such as the maximum and minimum of modulus, and the minimum of the physical aging rate vs extent of cure) are linear or parallel to the vitrification (T_g) line. In other words, the properties of thermosetting materials in the glassy state are mostly determined by the interval $T_g - T$ of the material from the glass transition temperature. For example, it appears that there is a superposition principle for normalizing the physical aging behavior of thermosetting glasses which involves a shift of $T_g - T$ (i.e., a measure of departure from the equilibrium state) and a shift of $f(T)$ (i.e., a function of measurement temperature). Use of T_g as a measure of extent of cure (rather than conversion) results in linearization of relationships between the critical points and temperature in the T_g TP Diagram. This facilitates construction of T_g TP Diagrams for different systems. These simple diagrams are intellectually useful for understanding the changes of properties of materials vs extent of cure of both undercured material (with change of conversion) and fully cured materials (with change of stoichiometric ratio).

The data in this paper could have been presented as specific three-dimensional T_g -Temperature-Property Diagrams, that is, the T_g -Temperature-Modulus Diagram and the T_g -Temperature-Physical Aging Rate Diagram. All other low-deformation properties can be similarly summarized. The T_g -Temperature Property Diagram is

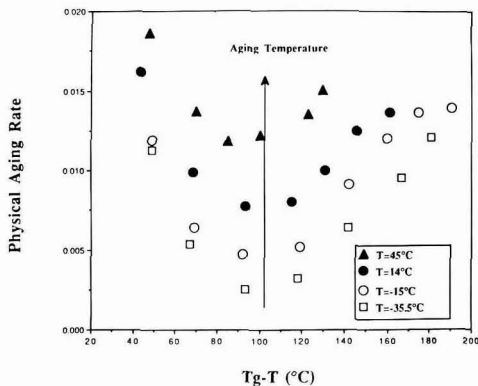


Figure 18—Physical aging rate vs $T_g - T$. Experimental data of Figure 17 replotted using $T_g - T$ as the X-axis

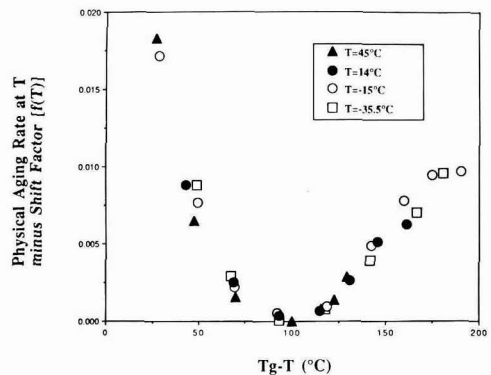


Figure 19—Unique physical aging rate vs $T_g - T$. Superimposed data of Figure 17 obtained using a double shift [horizontal = $T_g - T$, vertical = $f(T)$]

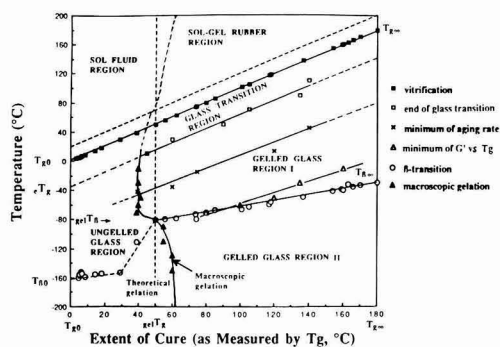


Figure 20—T_g-Temperature Property Diagram. The theoretical gelation values for T_g and T_β are evaluated from Flory's theory^{26,27} and the T_g/conversion^{1,2} and the T_β/T_g experimental relationships. The marked macroscopic gelation point values are assigned from the changes of the relative modulus (in the glassy state) vs extent of cure which occur near the theoretical gelation point (see also Figures 9 and 11)

the basis for all three-dimensional specific property diagrams.

The anomalous behavior in the glassy state is not widely appreciated. Earlier work in this laboratory had correlated various physical phenomena vs extent of cure to the anomalous behavior in density. The present work shows that the anomalous behavior in the modulus and physical aging vs extent of cure is related to gelation and to the various transition events which occur when T_g and T_β of the material meet the temperature of the material. Future research will seek to provide an explanation in structural and kinetic terms. A preliminary explanation of these anomalies in the behavior of properties vs extent of cure considers: (1) crosslinking sites occupy more volume than would be expected; this produces an influence in the vicinity of gelation; and (2) increase of crosslinking density and average molecular weight lead to a decrease of segmental mobility (i.e., an increase of relaxation time) which depends on T_g-T.

The T_gTP Diagram is related to other cure/transformation diagrams, that is, the Time-Temperature-Transformation Cure Diagram and the Conversion-Temperature-Transformation Diagram.³⁴

CONCLUSION

The isothermal physical properties in the glassy state of thermosetting crosslinked polymers vs conversion are anomalous and complex. The anomalous behavior at different isothermal temperatures vs extent of cure depends on gelation and when T_g and T_β of the material meet the temperature of the material. The changes of properties at different temperatures vs extent of cure are summarized in the form of a T_g-Temperature Property (T_gTP) Diagram. An explanation is being sought on the basis of kinetic and structural contributions.

ACKNOWLEDGMENT

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Utilization of Hydroxyl Terminated Polybutadiene in Air Dry Rust Inhibitive Primers

James J. Salitros
Elf Atochem North America, Inc.*

Hydroxyl terminated polybutadiene (HTPB) has been utilized for its reactivity with isocyanate resins to produce sealants and waterproofing membranes with excellent hydrophobic properties. Resistance to chemical solutions in water is excellent and surpasses most other resins. Resistance of the HTPB modified polyurethanes to most solvents is not good, as evidenced by swelling of the films.

Unsaturation in the HTPB backbone is responsive to oxidative crosslinking with the use of driers routinely used for promoting the drying of thin film alkyd resin coatings. Air-dry primers were formulated using pigments designed for rust inhibition. These primers containing HTPB and rust inhibitive pigments were applied to different metal substrates and subjected to salt fog testing. Thin films of HTPB based primers have excellent resistance to aqueous chemical solutions and organic solvents.

HTPB based primers were used under various topcoats to determine primer recoatability and intercoat adhesion. HTPB based primers are suitable for use under alkyds, chlorinated rubber enamels, and high gloss two-component urethane topcoats.

INTRODUCTION

Hydroxyl terminated polybutadiene (HTPB) resin was originally conceived as a synthetic drying oil in the late 1950s by Dr. O.W. Burke, of Burke Research Company,¹ while working for Texas Butadiene and Chemical Company. The product was intended for the rubber products industry for use as a "liquid rubber" that would

eventually replace conventional solid rubber. Commercialization of HTPB actually began around 1966-68, when a "semi-works" production facility was built with an annual capacity in excess of 500,000 pounds.²

HTPB resins are liquid, low molecular weight polymers of 1,3-butadiene (*Figure 1*). Olefinic and hydroxyl functionality are distinguishing characteristics of the HTPB resins. The HTPB resins can undergo addition or chain-reaction polymerizations at the carbon centers. They can also participate in condensation or step-reaction polymerization at the oxygen centers. A generalized structure for HTPB resins is given in *Figure 1*.

HTPB resins are used in various industries where the terminal hydroxyl group has been the reaction site of interest, primarily the reaction with isocyanate materials to produce polyurethanes. These specific applications utilize some of the special properties of the HTPB, such as their good chemical resistance, low temperature stability, and end group reactivity.³⁻⁷

Because HTPB resins are responsive to autooxidative crosslinking with the use of driers commonly used in alkyd resins, single package air-dry coatings can be produced. Coatings that have excellent adhesion to steel, excellent resistance to aqueous solutions of chemicals, and solvent resistance can be formulated. HTPB has low volatile content and significant viscosity reduction with most solvents currently used in coatings. Viscosity reduction with several coating solvents is shown in *Figure 2*.

EXPERIMENTAL

HTPB, as is, will air dry at room temperature in about 30 days in thin films, at <1 mil dry film thickness (dft). An initial drier study was undertaken to determine which driers could be used to make an HTPB resin-based coat-

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RAW MATERIALS

HTPB	Elf Atochem, N.A., Inc.
Barytes	Pfizer Inc.
Talc	Cyprus Industrial Minerals Company
Mica	U.S. Mica Company, Inc.
Barium metaborate	Buckman Laboratories
Calcium borosilicate	HALOX Pigments
Zinc phosphate	HALOX Pigments
Red iron oxide	Pfizer Inc.
Thixotrope	Rheox, Inc.
Anti-settling agent	Rheox, Inc.
Xylene	Exxon Chemical Company
High flash naphtha	Exxon Chemical Company
Ester solvent	Exxon Chemical Company
MIBK	Eastman Chemical Products, Inc.
Butyl acetate	Eastman Chemical Products, Inc.
Driers	Hüls America, Inc. Akzo, Chemical Division Mooney Chemicals, Inc.
Chelating agents	Mooney Chemicals, Inc. R.T. Vanderbilt Company, Inc.
Aluminum organic complex	Manchem
Anti-skinning agent	Akzo, Chemical Division

ing dry overnight. A combination of cobalt, zirconium, and calcium driers produced a dry time of 18-24 hr at 1 mil dft. The drier metal content was 0.10 cobalt, 0.19 zirconium, and 0.17 calcium wt% on resin solids. The results of the test show that HTPB is responsive to the use of paint driers to shorten the dry time of an HTPB coating to a practical and reasonable interval.

Two primers were formulated utilizing the previously stated drier combination, and each primer was applied to 10 phosphate treated steel panels. After seven days at ambient temperature, nine panels were tested to determine adhesion to phosphate-treated steel, impact resistance, chemical resistance, and rust inhibition (salt fog testing ASTM B-117) (see Tables 1-2).

DRIER STUDY

Additional tests were designed to develop primers with dry times of less than 18 hr for a 2 mil dft. A screening experiment following the guidelines of Box and Hunter⁸ was run to determine whether different driers could be

used with HTPB to obtain shorter dry time intervals (see Table 3). An 80% solids by weight of HTPB in high flash naphtha was used to evaluate the effect of the driers. Single drier containing films, with the exception of cobalt and manganese, did not surface-dry within 15 days. The cobalt and manganese containing films dried within 24 hr. A dry time interval of 12 hr was obtained by lowering the level of active drier cobalt to 0.05 wt%. Zinc was used to replace calcium drier. The level of zinc was 0.38 wt%. Zirconium was increased to 0.75 wt%.

PIGMENT EVALUATION

To determine whether different rust inhibitive pigments would be effective in HTPB primers, four primers were made using the drier combination selected. Each primer differed only in the choice of rust inhibitive pigment. The pigments used were zinc phosphate, a calcium borosilicate, and a modified barium metaborate. Mica was used as a control pigment in this test. Volume substitution of the pigments was used to maintain consistent PVC (see Table 4).

SALT FOG TESTING

Primers were prepared using the revised drier combination. Primers were applied by a wire-wound rod to phosphate treated panels and dried at ambient temperature for seven days. The panels were scribed with an "x" at one end of the test panels. Six replicate panels of each primer were exposed to continuous salt fog. Panels were examined at 500 hr intervals for blistering and creep from the scribe marks (see Table 5).

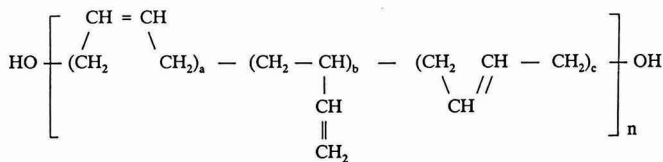
RECOAT TEST

To check topcoat compatibility, panels coated with primer B-4 were exposed to salt fog. The adhesion, impact resistance, and flexibility of these panels were determined before and after 1500 hr of salt fog testing. The following topcoats were used: polyester polyurethane, high solids medium oil alkyd enamel, and chlorinated rubber. The results are shown in Table 6.

DISCUSSION

HTPB resins react with diisocyanate materials to form water resistant hydrolytically stable polyurethanes.⁹ These properties would find useful applications in coatings for steel, since water is known to be required for the

Figure 1—HTPB resins—microstructure. a=0.2, b=0.2, and c=0.6



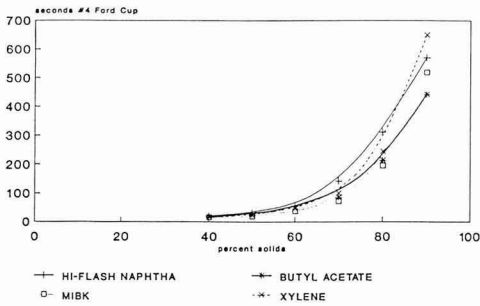


Figure 2—HTPB resins—solids/viscosity

corrosion of steel. A resin that could prevent the passage of water would improve the durability of coatings on steel, especially in environments where water is a problem for coatings on steel.

Preliminary studies were begun to see whether the water resistant properties of the HTPB resin would be maintained when formulated into a typical coating for steel.

HTPB resin does not dry like an alkyd or a drying oil. Linseed oil, without driers, becomes sticky (tacky) and remains in that drying stage for a long time. Because the oils dry from the surface down, the linseed oil films have a tendency to wrinkle.

Alkyds were developed to have better properties than drying oils, especially with respect to film forming and dry properties.

HTPB resin, without driers, remains wet for a long time and sticky for a short time before surface drying. It takes about 30 days for a drierless HTPB film to surface dry, whereas linseed oil may take only five to six days. Since the resin dries from the surface down, like drying oils and alkyd resins, through drying takes a very long time.

The initial drier combination of cobalt, zirconium, and calcium produced a dry time of 18-24 hr, which seemed to be adequate for initial testing. Primers were made as indicated in Table 1. At this point, VOC level was not a concern. The primers were reduced 15% with xylene and spray applied to six 4" x 6" treated panels taped to a board. A seventh panel was used to obtain wet film thickness. After drying, film thickness was measured by using an Elcometer dft gauge. The backs and edges were coated with an epoxy polyamide primer to prevent rusting.

Salt fog testing was run only on Primer A-1. A panel was removed from testing at 250-hr intervals to measure undercutting at the scribe. Only rust from the scribe came off when the tape was pulled.

At 750 hr, a panel was pulled out of the test and checked for undercutting. This panel was immersed in xylene up past the scribe to remove the coating to determine underfilm corrosion. Immersion for seven days did not soften the coating. The panel was immersed in methyl ethyl ketone for 30 days with no loosening or softening of the film. A thick application of a heavy-bodied methylene chloride containing paint stripper was put on the panel.

Table 1—Formulations: Primer—Set A

Raw Material	HTPB Based Primers	
	A-1	A-2
HTPB	150.0	150.0
Xylene	145.0	145.0
Thixotrope (modified clay)	5.0	5.0
Pre-mix		
Red iron oxide	75.0	150.0
Barytes	150.0	150.0
Talc	150.0	150.0
Barium metaborate	100.0	—
Mica	—	25.0
Disperse to 4 Hegman		
HTPB	75.0	75.0
Xylene	230.8	233.3
Cobalt drier (12% metal)	1.9	1.9
Zirconium drier (18% metal)	2.4	2.4
Calcium drier (5% metal)	7.5	7.5
Methyl ethyl ketoxime	3.8	3.8
	1096.4	1098.9
Properties		
lb/gal	10.96	10.98
VOC (g/L)	463.0	466.0
VOC (lb/gal)	3.8	3.9
Weight, % solids	64.8	64.7
Volume, % solids	46.2	45.8
PVC	35.0	34.5

Table 2—Results: Primer Cured Properties—Set A

	Control (alkyd)	A-1	A-2
Dry film thickness, mils	2.0	2.0	2.1
Mechanical Properties			
Pencil hardness (ASTM D 3363-74)	2B	2B	2B
Adhesion (ASTM D 3359-87)	5B	5B	5B
Impact resistance, in.-lbs (ASTM D 2794-84)	160/160	160/160	160/160
1/8" Mandrel bend (ASTM D 522-88)	Pass	Pass	Pass
MEK double rubs (ASTM D 4752-87)	80	100	100
Corrosion Resistance			
(ASTM B-117)			
1,000 hr:			
Blisters	N/A	none	N/A
Creep, in.	N/A	1/32	N/A
Chemical Resistance			
(7 days immersion)			
Reagents			
Sulfuric acid, 10%	blistered	N/A	— ^a
Sodium hydroxide 10%	N/A	— ^b	— ^b
Acetic acid, 5% (vinegar)	blistered	— ^a	— ^a
Isopropanol, 50%	blistered	— ^a	— ^a
Water, tap	blistered	— ^a	— ^a

(a) Not affected.
 (b) Slight color change.
 Note: Substrate—cold-rolled steel, phosphate treated; cure—7 days at 20°C.

Table 3—Drier Screening

Active Driers	Auxiliary Driers	Others
Cobalt	Zirconium	Aluminum-organic complex
Manganese	Calcium	Organic chelating agents
	Zinc	Iron

The panel was covered with aluminum foil to minimize solvent loss. Overnight the film was softened enough to be removed with a cotton cloth. There was neither under-film corrosion nor undercutting from the scribe.

The resistance to aqueous chemicals after seven days immersion was very good for Primer A-1 and Primer A-2. There was some discoloration in the sodium hydroxide solution. Primer A-1 was not tested in sulfuric acid, since the inhibitive pigment is reactive to acids. The tap water immersion continued for 30 days with Primer A-2 and had no surface defects. Adhesion was excellent.

A shorter dry time interval for HTPB resin-based coatings would enable a more direct comparison with high solids alkyd systems currently used to coat steel. It became necessary to examine the driers used with HTPB more carefully. A screening test was devised and run to determine which paint driers were useful with the HTPB resin. The driers used in these tests are listed in Table 3.

An 80% solids by weight of HTPB in high flash naphtha was used in the testing. To examine the properties of single drier systems, dry times at different film thicknesses were determined for each drier.

Table 4—Formulations: Primer—Set B

Raw Material	HTPB Based Primers			
	B-1	B-2	B-3	B-4
HTPB	200.0	200.0	200.0	200.0
High flash naphtha	127.4	127.4	127.4	127.4
Thixotrope (modified clay)	3.0	3.0	3.0	3.0
Anti-settling agent	7.3	7.3	7.3	7.3
Pre-mix				
Red iron oxide	100.0	100.0	100.0	100.0
Barytes	200.0	200.0	200.0	200.0
Talc	200.0	200.0	200.0	200.0
Barium metaborate	133.3	—	—	—
Calcium borosilicate	—	93.7	—	—
Zinc phosphate	—	—	114.9	—
Mica, 325	—	—	—	101.5
Disperse to 4-5 Hegman				
HTPB	82.5	82.5	82.5	82.5
High flash naphtha	20.6	20.6	20.6	20.6
Ester solvent	128.9	128.9	128.9	128.9
Cobalt drier (12% metal)	1.2	1.2	1.2	1.2
Zirconium drier (18% metal)	11.8	11.8	11.8	11.8
Zinc drier (16% metal)	6.8	6.8	6.8	6.8
Methyl ethyl ketoxime	.5	.5	.5	.5
	1223.3	1183.7	1204.9	1191.5
Properties				
lb/gal	12.23	11.84	12.05	11.91
VOC (g/L)	347.0	347.0	347.0	347.0
VOC (lb/gal)	2.9	2.9	2.9	2.9
Weight, % solids	76.4	75.6	76.0	75.8
Volume, % solids	61.3	61.3	61.3	61.3
PVC	34.8	34.8	34.8	34.8

In single drier systems, cobalt, manganese, and the aluminum organo complex were the only driers that showed indications of curing the film. The other driers produced films which remained wet for over two weeks, with no indication of drying.

Cobalt and manganese driers performed as expected. They improved the surface dry of the HTPB resin but the film surface wrinkled when the dry film was thicker than 1.5 mils. At a dft of 1.5 mils the films began to wrinkle after two days. This is an example of the surface dry of the coating which prevents oxygen from entering the film and essentially slows the through-drying process to an unacceptable level.

Various levels and combinations of zirconium drier, calcium drier, and zinc drier were added to the cobalt and/or manganese system and evaluated for their effect on dry time and film thickness before wrinkling of the surface occurred. Several combinations resulted in films up to 6 mils dft that did not wrinkle. The films were observed for 30 days and showed no signs of wrinkling even though through-dry was very poor in some of the drier combinations used.

The aluminum organic complex, in combination with cobalt drier, improved the through-dry of the films the greatest amount, but could not be used because of gelation of the coating in the can within five days. An attempt was made to improve in-can stability of the aluminum containing system by using different solvent combinations. All gelled within two weeks.

Even though occasionally used in bake coatings, iron drier was tested because a prior HTPB resin formulation had gelled. Iron contamination was considered to be a

Table 5—Results: Primer—Set B

	B-1	B-2	B-3	B-4
Dry film thickness, mils	3.0	2.9	3.1	3.2
Mechanical Properties				
Pencil hardness	2B	2B	2B	2B
Adhesion (cross-hatch % retained)	100	100	100	100
Impact resistance, in.-lb (reverse)	160	160	160	160
1/4" Mandrel bend	Pass	Pass	Pass	Pass
MEK double rubs	100	100	100	100
Corrosion Resistance				
(ASTM B-117)				
500 hours:				
Blisters	8F	2D	6F	4D
Creep, in.	1/64	1/32	1/64	1/32
1,000 hours:				
Blisters	8MD		2D	2D
Creep, in.	1/32		1/32	1/32
1,500 hours:				
Blisters	6MD			
Creep, in.	3/8			
2,000 hours:				
Blisters	4MD			
Creep, in.	1/2			

Note: Substrate—cold-rolled steel, phosphate treated; cure—7 days at 20°C.
Rating: Blistering—panels are rated according to ASTM D-714 and recorded as to size and frequency. 8 = small; 6 = medium small; 4 = medium large; 2 = large; and F = few; M = medium; MD = medium dense; D = dense.

possible cause. However, iron drier did not affect the dry time of the HTPB resin.

The biggest surprise came when organic chelating agents were tested. Dry time of the HTPB resin was retarded. The material seems to function as an "anti-dry" agent. Drawdowns of this varnish were still wet after four weeks.

Because higher solids, low VOC formulations were being examined, a drier system of cobalt/zirconium/zinc (.05/.75/.38) was used in test Set B. Three rust inhibitive pigments were chosen for use in this preliminary study. These materials are currently being used in the coatings industry.

These materials were used only to see what effect they would have on a coating based on HTPB resin, not to determine which rust inhibitive pigment is the best with HTPB resin. Formulation optimization is beyond the scope of this preliminary study and would require more detailed experimentation. The results of continuous salt fog testing are shown in Table 5.

Of the 24 phosphate treated panels coated with the HTPB based primer, 75% had blistered over most of the panel surface at 1000 hr. The panels that blistered first in the test had little creep undercutting from the scribe.

Inspection of the topcoated panels from Test C, Table 6, furnished an explanation for the extreme blistering seen in Table 5. The impact test and mandrel bend test showed an extreme loss of flexibility. Examination of the film showed the primer firmly attached to the topcoat. A close look at the panels shows a thin layer of primer at the metal surface. There was a slight odor of uncured HTPB resin at the metal surface. This is a definite indication that the primer was not completely cured at 3.0 dry mils in the drying interval before testing.

Because of the difficulty in stripping the primers (Set B), an attempt was made to duplicate the solvent resistance of the salt fog exposed panels. Primer B-2 was applied to cold-rolled steel panels and phosphate-treated steel panels. Eight panels of each type were prepared with 2.0 dry mils of primer and cured at room temperature. Weekly, a panel of primed cold-rolled steel and treated steel was put into four jars containing a different solvent in each jar. Solvents employed were xylene, methyl ethyl ketone, butyl acetate, and isopropyl alcohol. Even with 28 days cure time, Primer B-4 did not develop the solvent resistance to equal the solvent resistance of the coated panels exposed to continuous salt fog for 12 days. The reason for this discrepancy has not been determined.

SUMMARY

HTPB resin-based coatings, in thin films, have excellent resistance to aqueous solutions of inorganic chemicals. Resistance to mineral acids and bases is much greater than the resistance of alkyd binders to such chemicals. Thorough curing of the HTPB-based system results in

Table 6—Results: Topcoats Over HTPB Primer

	C-1 ^a	C-2 ^b	C-3 ^c
Dry film thickness, mils	5.6	5.9	4.4
Mechanical Properties			
Pencil hardness	HB	2B	B
Adhesion (cross-hatch % retained)	100	100	100
Impact resistance, in.-lbs (reverse)	160	160	60
1/4" Mandrel bend	Pass	Pass	Pass
Salt Fog Exposure—1,500 hours			
Adhesion (cross-hatch % retained)	100	100	100
Impact resistance, in.-lbs (reverse)	10	5	5
1/4" Mandrel bend	Delaminate	Delaminate	Delaminate

(a) C-1—Polyester polyurethane.
 (b) C-2—Alkyd.
 (c) C-3—Chlorinated rubber.
 Note: Substrate—cold-rolled steel, phosphate treated; topcoating of Primer B-4—24 hr; and cure—7 days at 20°C.

films which are solvent resistant, as indicated by immersion testing. Adhesion to steel and aluminum is excellent.

In air-dry coatings, these properties can be attributed to the unique dual functionality of HTPB. The number of primary hydroxyl end groups contribute to substrate adhesion without adversely affecting water resistance. The crosslinking produced through the unsaturation across the polymer backbone contributes to the resistance properties of the coatings.

Curing in films of HTPB-based coatings greater than 2 mils dft is, at this time, somewhat slower than the alkyds they were compared with. However, optimization of the curing of HTPB-based coatings, through drier modification, should be attainable.

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Pigment Stabilization Through Mixed Associative Thickener Interactions

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North Dakota State University*

The role of associative thickeners in the development of latex coating film gloss is examined. The classical explanation relating film gloss to flow and leveling through low viscosities at low shear rates is found invalid in associative thickener formulations. Increases in gloss arise from improved stabilization of titanium dioxide (TiO₂) particles. This requires two separate interactions: (1) the efficient adsorption of hydrophobe-modified maleic acid alternating copolymer on the surface of TiO₂, through hydrogen bonding or an acid-base interaction, and (2) interactions of the hydrophobes of this copolymer with the hydrophobes of ethoxylated urethane (HEUR) thickeners. This interaction provides greater electrosteric stabilization to the pigment, improved thickening efficiency of the pigment paste and coating formulation, and higher film gloss.

INTRODUCTION

In general, the molecular weights of hydrophobically-modified, ethoxylated urethanes (HEURs) are too low to promote thickening of aqueous solutions by hydrodynamic or entanglement considerations.¹ The thickening viscosity of both commercial^{2,3} and model⁴ HEURs and hydrophobically-modified, hydroxyethyl cellulose⁵ is increased by anionic and the former by nonionic surfactants. Both conventional surfactants are present in waterborne latex coatings. Depending upon the surface stabilizers on the latex and the hydrophobicity of both the terminal and internal hydrophobes of HEUR thickeners, these water-soluble polymers have been shown to desorb⁶ and adsorb⁷⁻⁹ on latex surfaces which can also influence

the viscosity of the formulation. Factors such as latex median size,¹⁰⁻¹² surface stabilizers, architecture of the associative thickener¹ and the type and amount of conventional surfactant⁴ present also are key to defining both the low and high shear rate viscosity of coating formulations. The hydrophobicity of the coalescing aid also plays an important part in defining viscosity at low shear rates.¹³ This manuscript describes one of the more significant contributions of associative thickeners that has not been previously reported, the stabilization of titanium dioxide (TiO₂) dispersions, and thereby, improved film gloss and formulation cost efficiency.

EXPERIMENTAL

Materials

Model and commercial oligomeric acids and associative thickeners are employed in this investigation. The commercial dispersant, Tamol 731 (Rohm and Haas), is composed of alternating diisobutylene and maleic acid repeating units¹⁴ (DIBMA) while Tamol 850 and 963 are methacrylic (PMAA) and acrylic acid (PAA) oligomers, respectively. Model dispersants, to parallel Tamol 850 (PMAA) and Tamol 731 (alpha-olefin/maleic acid) also were studied. The alpha olefin/maleic acid (AO/MA) copolymers contain different α -olefins (1-decene, 1-tetradecene, 1-octadecene). The three commercial HEUR thickeners examined in this study were supplied with cosolvent, which was removed by precipitation, resolution, and precipitation sequences.¹⁵ Model thickeners were synthesized and are described elsewhere.¹⁶ The model HEURs used in this study are illustrated in *Figure 1*. Components and their levels in the formulations used are listed in the *Appendix*. The nonionic surfactant used in these studies has an average degree of ethoxylation of 9 and an average branched hydrocarbon structure of 13 (Tergitol 15-S-9, Union Carbide).

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Table 1—21% Pigment Volume Concentration; 32% Nonvolatile Volume Pigment Stabilizer; Tamol 850 (Commercial PMAA). Other Components Listed in the Appendix

Latex Size	Thickener	KU ^a	KU ^b	Wt%	LSV (Pa s)	Leneta Sag	Gloss		
							60°	20°	
560 nm	HEC	90	90	0.62	5.80	16	9	0	
		105	110	0.80	13.3	21	15	0	
		120	132	1.01	25.7	32	16	0	
	708	90	89	0.43	1.18	8	37	3	
		105	110	0.56	1.67	10	40	4	
		120	121	0.67	3.24	12	45	6	
	200	90	80	1.48	0.69	9	35	4	
		105	102	1.87	1.87	12	32	4	
		120	116	2.11	2.65	13	36	6	
	117 nm	HEC	90	86	0.36	3.63	13	30	3
			105	105	0.52	9.83	25	31	3
			120	121	0.73	23.4	45	32	3
708		90	90	0.24	0.69	7	37	3	
		105	108	0.39	2.06	8	39	3	
		120	118	0.48	2.36	11	40	4	
200		90	90	1.00	6.49	39	58	14	
		105	109	1.29	9.63	>60	49	14	
		120	122	1.50	15.2	>60	51	11	
390 nm		HEC	90	90	0.51	3.54	13	56	16
			105	102	0.66	7.27	18	52	9
			120	116	0.82	10.1	21	52	9
	708	90	93	0.36	1.38	8	33	2	
		105	102	0.53	1.67	10	34	4	
		120	115	0.65	1.77	14	32	3	
	200	90	110	0.83	2.36	10	44	7	
		105	136	1.02	4.92	13	50	8	
		120	>140	1.30	9.93	14	48	9	

(a) Attempted to formulate coating to approximately this KU.
 (b) Actual KU of coating.

thickened with cellulose ethers. In the experiments described in the following, the latex, thickener, pigment dispersant, and TiO₂ with different inorganic surface treatments (3% Al₂O₃) are examined in a matrix study to determine the components and parameters important in attainment of higher film gloss. Formulations using oligomeric acrylic acid as dispersant gave gloss values similar to those employing oligomeric methacrylic acid. For brevity, the data from the PAA dispersant studies are omitted from the following discussion.

COATINGS WITH PMAA DISPERSANT STABILIZED TiO₂—Coatings utilizing PMAA as the TiO₂ dispersant and HEC as the thickener were prepared with three different median size acrylic copolymer latices (listed in the Appendix). The largest median size latex, 560 nm, is the most susceptible to depletion flocculation in the presence of polymer due to the greater attractive potential between larger particles.²¹ A relatively high viscosity at low shear rates and low film gloss are observed. (Table 1.) Higher film

gloss has been related to better flow and leveling through lower viscosities at low shear rates.¹⁹ The smallest latex, 117 nm, with lower attractive forces, also provides formulations with equally high viscosities at low shear rates. The higher viscosities are related to hydration and the greater surface area of the smaller latex, resulting in a greater effective volume fraction (0.42 for a 5 nm hydration layer^{9,10}) of the formulation with the small latex. Although the low shear rate viscosities are equivalent in the hydroxyethyl cellulose (HEC) thickened coatings, the gloss of the small latex formulation is higher than that of the coatings containing the largest binder. In a prior study²² with similar latices and thickened with HEC, more rigid flocculate structure with larger particle size latices are observed, possibly explaining the lower gloss. Such a mechanism for gloss differences is questionable in view of the following observations noted in coatings formulated with HEURs.

The HEUR-200 dispersions containing the 117 nm latex have greater viscosities at low shear rates than the HEUR-708 formulations, but the gloss values of the HEUR-200 coating formulations are higher than the HEUR-708 formulations. Furthermore, when these studies are extended to an intermediate size latex, 390 nm, coatings thickened with HEC have higher low shear rate viscosities than the HEUR-708 thickened coatings, but film gloss of the HEC coatings are much higher. Film gloss from the HEUR-708 median size latex combination is unexplainably low. All of the previously mentioned observations cannot be explained by the general rheological approach relating film gloss to low shear rate viscosity and flow and leveling behavior.

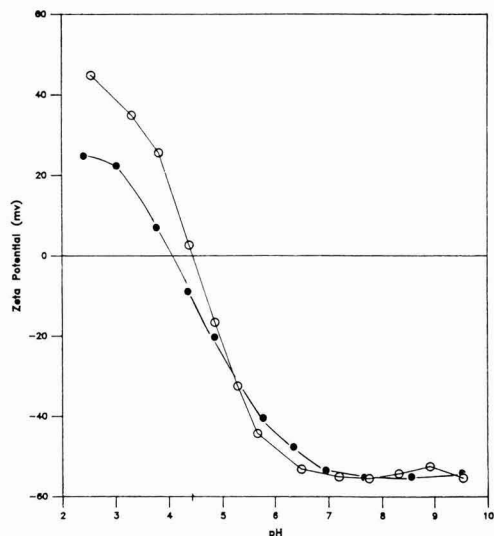


Figure 2—Zeta potential dependence on pH of 1 wt% aqueous R900 TiO₂ dispersion stabilized with oligomeric polyacids (0.75g oligomer/100g pigment). Key: O—methacrylic acid oligomer; ●—1-decene maleic acid oligomer (AO(C₁₀)/MA)

Table 2—21% Pigment Volume Concentration; 32% NVV Pigment Stabilizer; Tamol 731 (DIBMA). Other Components Listed in the Appendix

Latex Size	Thickener	KU ^a		Wt%	LSV (Pa s)	Leneta Sag	Gloss		
		KU ^a	KU ^b				60°	20°	
560 nm	HEC	90	95	0.62	6.09	17	5	0	
		105	116	0.83	13.8	19	9	0	
		120	124	0.92	18.6	28	11	0	
	708	90	84	0.35	0.69	6	52	8	
		105	102	0.46	1.67	8	57	11	
		120	116	0.57	2.36	9	63	16	
	200	90	83	1.33	1.18	6	48	6	
		105	98	1.56	2.06	12	52	7	
		120	106	1.69	2.36	14	56	9	
	117 nm	HEC	90	88	0.39	5.41	14	33	1
			105	103	0.52	11.3	17	28	0
			120	118	0.76	20.2	24	32	0
708		90 ^c	93	0.26	0.79	6	53	11	
		105 ^c	104	0.34	1.38	6	58	14	
		120 ^c	114	0.45	2.26	8	60	17	
200		90	90	0.98	6.09	14	62	16	
		105	104	1.18	7.27	30	66	21	
		120	112	1.36	9.93	32	68	21	
390 nm		HEC	90	96	0.52	6.19	20	48	6
			105	107	0.65	10.0	23	50	6
			120	120	0.80	14.4	29	45	4
	708	90 ^c	96	0.25	4.62	8	69	22	
		105 ^c	103	0.34	5.11	9	69	22	
		120 ^c	116	0.48	5.5	10	68	20	
	200	90	86	0.42	4.22	8	73	24	
		105	107	0.63	4.72	13	73	25	
		120	132	0.88	8.16	14	72	25	

(a) Attempted to formulate coating to approximately this KU.

(b) Actual KU of coating.

(c) Phase separation occurred in these coatings.

Table 3—Model Dispersant Adsorption on TiO₂ in 32% NVV TiO₂ Dispersions

Dispersant	pH	Thickener or Surfactant Added To Dispersion		Adsorption on Titanium Dioxide ^a
		g's/100g	uequiv/m ²	
Ethoxylated Surfactant ^b	1.3	1.3		0
HEUR Thickener ^c	0.42	0.42		0
		Adsorption on TiO ₂ ^d		Surfactant Adsorption on Pretreated TiO ₂ ^d
		g's/100g	uequiv/m ²	
PMMA	9.6	0.086	0.60	0.10
AO(C ₁₀)/MA	10.1	0.293	1.60	0.71
AO(C ₁₄)/MA	10.2	0.309	1.40	1.01
AO(C ₁₈)/MA	10.2	0.314	1.22	1.12

(a) Thickener level; g/100g pigment, experimental uncertainty ± 15%.

(b) b-C₁₃H₂₇(EtO)₉OH surfactant.

(c) HEUR-708 thickener separated from cosolvent by precipitation of the thickener into a nonsolvent.

(d) 0.75g dispersant/100g pigment; isoelectric point 8.7.

A possible explanation of these observations was sought by analyzing the surface of the three films obtained with the intermediate size, bimodal latex. In some waterborne coating systems containing HEUR thickeners, a thin hazy film has been observed to reduce gloss at the film surface.²³ The haze could be due to crystalline poly(oxyethylene) [POE] blocks from such segments of the HEUR thickener. Photoacoustic (PA)-FTIR was used to obtain information on a molecular level at various depths.²⁴ In this particular study, of surfaces with equivalent roughnesses, the surface region spectra were identical to methyl methacrylate copolymers²⁵ and did not indicate the presence of crystalline poly(oxyethylene) at the surface of the lower gloss film. A POE control was used in these experiments.

COATINGS WITH DIISOBUTYLENE/MALEIC ACID (DIBMA) DISPERSANT STABILIZED TiO₂—With the DIBMA dispersant, a difference in low shear rate viscosities or film gloss (*Table 2*) of HEC thickened coatings was not observed relative to the PMAA dispersions. The DIBMA dispersant is structurally different from the PMAA dispersant; the diisobutylene monomer, that alternates with the maleic acid, is hydrophobic. The acid monomer contains contiguous acid functionalities, in contrast to the 1,3 alternating acid functions that exist in PMAA. The coatings containing DIBMA stabilized pigment with HEUR thickeners were, however, higher in gloss than the PMAA stabilized pigment formulations with all three latices.

As an independent entity, the AO/MA copolymers are an interesting family. For example, such copolymers with covalently bound anthryl groups²⁶ have been shown to exhibit strong domain associations with sodium dodecyl sulfate. In other fluorescence studies²⁷ a PMAA (MW = 11,000) was not able to solubilize hydrophobic pyrene at a pH greater than 4; a 1-octadecene/maleic acid copolymer (MW = 10,000) in this latter study solubilized hydrophobic pyrene molecules across a pH range up to 10.

HEUR thickeners contain hydrophobes, and, although small, hydrophobes exist on the DIBMA backbone. An interaction between the hydrophobic segments of the thickener and the dispersant could provide steric stabilization to complement the electrostatic forces and provide a greater barrier to flocculation of the pigment and thereby improvement in film gloss. The experiments that follow support the presence of such an interaction.

Nonadsorption of Nonionic Components on TiO₂

The surface of TiO₂ is positively charged in low pH solutions, neutral at the isoelectric point (IEP), and negatively charged in high pH solutions. Based on prior art,^{28,29} the adsorption of nonionic components with minimal proton donating functions would not be expected on TiO₂ in an alkaline media. This is observed; neither the nonionic (ethoxylated) surfactant, added to the formulation with TiO₂, or a commercial associative thickener (HEUR-708) adsorb on the surface of TiO₂ (*Table 3*) under alkaline conditions, pH = 9-9.5.

Adsorption of Model Dispersants on TiO₂

Adsorption of anionic polyelectrolytes on a negatively charged pigment surface also would seem to be severely restricted due to charge-charge repulsions. This has been observed; the amount of a simple acid (i.e., glycolic acid, with one acid and one alcohol group) adsorbed from acidic or neutral media is significantly greater than observed in alkaline media.^{28,29} No adsorption was noted at the higher pH with a comparable compound containing two contiguous carboxyl groups but without a hydroxyl unit (succinic acid). At the higher pH, adsorption is observed with citric acid, containing three carboxylate groups and one hydroxyl unit. The amount adsorbed approaches that of glycolic acid at a pH of 4. These differences were attributed to the ability of the acids with alcohol groups to hydrogen bond to the substrate, and therefore to their pK_a. Adsorption of compounds containing only acid functionalities on Geothite (α-FeO.OH) and Gibbsite (γ-Al₂O₃·3H₂O) surfaces from alkaline media has been observed, and the importance of the "conjugate acid of the anion" was proposed for adsorption above the point of zero charge of the clay.^{30,31}

Two factors favor the adsorption of high molecular weight polyacids. The first is the close proximity of pendant acid functions which inhibits ionization of all of the carboxylate groups due to electrostatic repulsions. With repeating acid units, unionized carboxylated groups would be present to facilitate hydrogen bond or acid-base interactions with the pigment surface. The second factor favoring adsorption is that, even with low enthalpic interaction, the detachment of all interacting acid segments from the TiO₂ surface will not occur simultaneously for statistical reasons.

Oligomeric acrylic acid (PAA), a negatively charged polyelectrolyte at high pH, has been observed to adsorb³²⁻³⁴ on TiO₂, above the pigment's isoelectric point. The adsorption of our model methacrylic acid oligomer (PMAA, Table 3) on TiO₂ is similar to that reported for PAA.

The notable observation in this study is the high adsorption from alkaline media of the AO/MA co-oligomer [AO(C_x)/MA] dispersants (Table 3). This is due in part to the difference in pK_a of 1,2 contiguous carboxyl units, relative to 1,3 alternating acid groups. In part, it also is related to the presence of the repeating hydrophobe unit. Interactions have been observed between neighboring hydrophobe and carboxyl groups that lower the dielectric constant in the area around the carboxyls contiguous to the hydrophobic groups.³⁵ The pK_a of the first acid was 3.1; the pK_a of the second acid group was 10.8. Similar results were observed in smaller alpha-olefin maleic copolymers.³⁶ At a pH of 9.3, approximately 50% of the carboxyl groups from either set of AO/MA oligomers are un-ionized.

Adsorption of Nonionics on Model Dispersant Pretreated TiO₂

When the pigment is pretreated with model dispersants, the nonionic surfactant is observed to "adsorb" in proportion to the amount of dispersant adsorbed on the

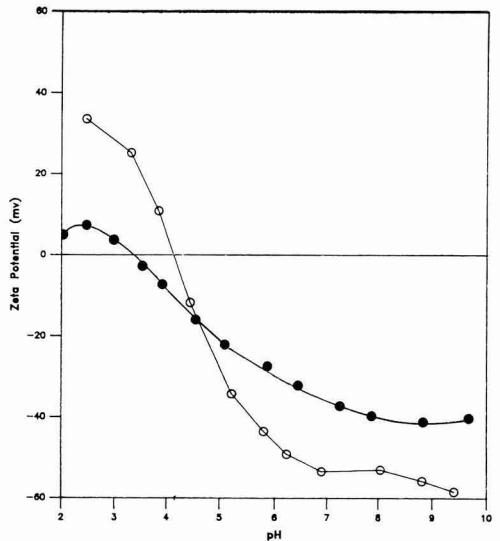


Figure 3—Zeta potential dependence on pH of 1 wt% aqueous R900 TiO₂ dispersion stabilized with oligomeric acid (0.75g oligomer/100g pigment), thickener—(NP(EtO)₁₀₀C₆)₃N. Key: same as in Figure 2

pigment surface (PMAA vs AO/MA), and with the AO(C_x)/MA dispersants, in proportion to the alpha olefin size (Table 3). The "association-adsorption" behavior of model and commercial HEUR thickeners on model PMAA and AO/MA dispersant stabilized TiO₂ in the absence of the formulation surfactant is given in Table 4.

The model C₈H₁₇IP(EtO)₅₉₅IPC₈H₁₇ thickener (Figure 1) does not adsorb on the weakly hydrophobic PMAA dispersant, stabilized pigment, and the [NP(EtO)₁₀₀]₂TMXDI model exhibits greater adsorption than

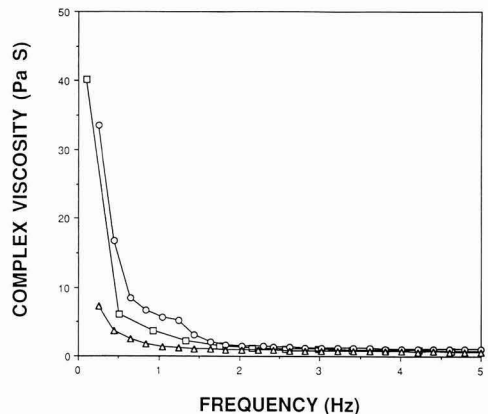


Figure 4—Complex viscosity (n') dependence on frequency of 32% NVV R900 pigment dispersion. Commercial dispersant—PMAA; Key: O—thickener, HEUR-708; Δ—HEUR-200; □—HEC

Table 4—Model HEUR-Thickener Distribution 32% NVV TiO₂ R900 9.3 PH Dispersions

Oligomeric Acid used in Pretreatment ^a	HEUR Model	HEUR Added ^b	HEUR Conc. ^b
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	C ₈ IP(EtO) ₅₉₅ IPC ₈	0.90	0.00 0.42 0.61
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	(NP ₁₀₀) ₂ TMXDI	0.90	0.00 0.71 0.78
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	(NP(EtO) ₅₀ C ₆) ₃ N	0.64	0.09 0.41 0.59
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	(NP(EtO) ₁₀₀ C ₆) ₃ N	0.64	0.29 0.55 0.62
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	Control	0.0	0.06 0.10 0.05
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	Commercial HEUR HEUR-270	0.42	0.00 0.40 0.39
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	HEUR-200	0.90	0.00 0.56 0.54
PMAA AO(C ₁₀)/MA AO(C ₁₄)/MA	HEUR-708	0.43	0.00 0.39 0.41

(a) 0.75g dispersant/100g pigment. Uncertainty ± 20%.
(b) g/100g pigment.

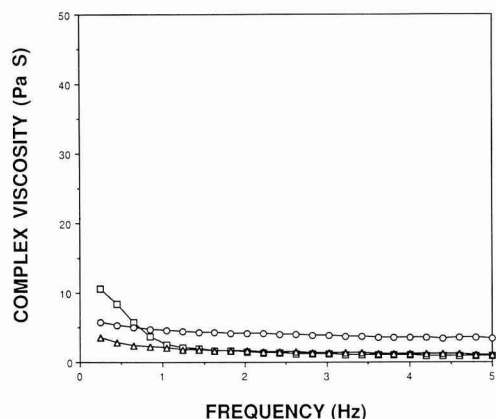


Figure 5—Complex viscosity (η') dependence on frequency of 32% NVV R900 pigment dispersion. Commercial dispersant—DIBMA. Key: same as in Figure 4

C₈H₁₇IP (EtO)₅₉₅IPC₈H₁₇ on the AO(C₁₀)/MA treated TiO₂. The C₈H₁₇IP-hydrophobe is comparable in size to the nonylphenol units on the other model HEURs (Figure 1), but the concentration of the C₈H₁₇IP-group is low due to the considerably higher POE molecular weight in this model. The trimer thickeners appear to adsorb on the hydrophilic PMAA treated TiO₂ because the hydrophobes in the (NP(EtO)₁₀₀C₆)₃N and (NP(EtO)₅₀C₆)₃N models are separated by an average of only 100 and 50 oxyethylene units but the internal hydrophobe has a considerable mass. These model HEURs exhibit a strong tendency to phase separate from soluble solutions due to significant intramolecular hydrophobic associations.

No significant adsorption of commercial HEUR thickeners on PMAA stabilized pigment is observed, but in parallel with the previously mentioned studies, adsorption of the commercial HEURs is significant on the AO(C_x)/MA stabilized TiO₂ (Table 4). HEUR-200 exhibits the highest adsorption on the model AO/MA treated TiO₂ which is reflected in several exceptionally high gloss formulations. The two most currently competitive thickeners, HEUR-708 and 270, exhibit similar adsorption behavior. The relative adsorption of the three commercial HEUR thickeners on the AO(C₁₀)/MA treated TiO₂ is very similar to their nonionic surfactant sensitivity previously reported.³

Adsorption on Commercial Dispersant Pretreated TiO₂

Equating Tamol 731 with the AO(C_x)/MA models and Tamol 850 with the PMAA model dispersant, identical trends in comparative adsorption studies of commercial HEUR thickeners on commercial dispersant treated TiO₂ are observed. In these studies, a poly(oxyethylene) precursor of many of our model HEURs was investigated. This unmodified polymer, (HO(EtO)₅₉₅H), did not adsorb on any of the pigment-dispersant interfaces.

Electrosteric Stabilization of the Pigment

The primary mechanism for stabilization of disperse phases in a medium of low dielectric constant is steric or entropic; electrostatic repulsive forces are generally responsible for particle stabilization in aqueous media.³⁷⁻³⁹ "Those skilled in the art" synthesize latex particles under conditions that produced nonsurfactant surface moieties that will stabilize latices by electrosteric mechanisms in aqueous media. This minimizes flocculation due to variations in salinity of local water supplies, and through the use of less ionic surfactants, less water sensitive coating films are produced. In large particle vinyl acetate latices, the complementary stabilizers are hydroxyethyl cellulose grafts⁴⁰; in small acrylic latices the surface moieties are generally oligomeric methacrylic acid segments.^{13,41,42} The latter expand the electrical double layer and complement this mode of stabilization with steric stabilization. The surface of TiO₂, with or without its inorganic surface treatment (alumina), is higher in interfacial energy than any of the compositionally different latices (i.e., vinyl acetates, acrylics, or styrene) used in

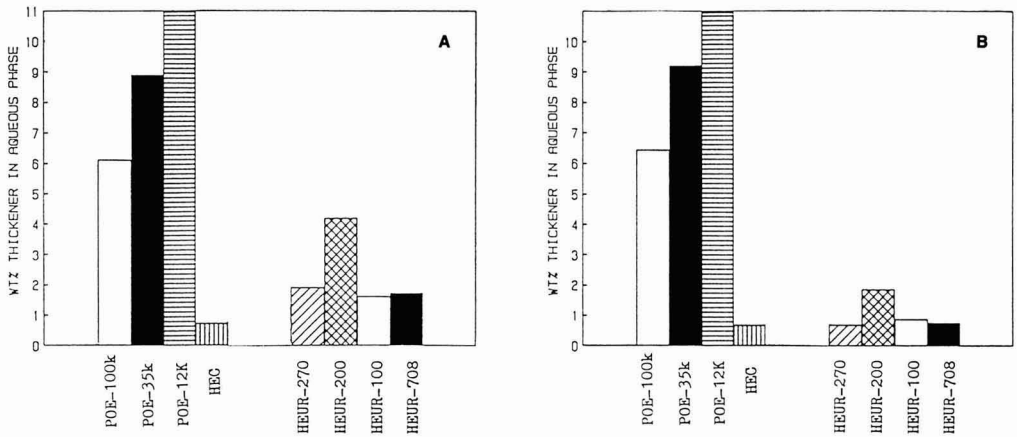


Figure 6—Thickener necessary to obtain a given KU in a 32% NVV R900 pigment dispersion, 1.33g b-C₁₃H₂₇(EtO)₉OH surfactant/100g pigment, 0.75g dispersant/100g pigment. A—dispersions stabilized with PMAA dispersant (dispersions 90 KU ± 3 KU); B—dispersions stabilized with DIBMA dispersant (HEUR thickened dispersions 101 KU ± 2 KU, HEC 91 KU, POE-12k 72 KU, POE-35k 72 KU; POE-100k 86 KU)

waterborne coatings, yet this high energy inorganic surface is the poorest stabilized in the crowded environment of a waterborne coating formulation. It would follow that if any disperse phase was prone to flocculate by a depletion layer or by a suppression of the electrical double layer mechanism, it would be the high energy pigment.

SURFACE CHARGE MEASUREMENT—Zeta potential measurements were made to assess the electrostatic contribution to the stability of TiO₂ dispersions, and thereby, to the gloss differences observed. Adsorption data presented in Table 3 indicate approximately twice the level of AO(C₁₀)/MA, relative to PMAA, will be present on the TiO₂ surface. Prior literature indicates that only half the acid functions will be ionized at high solution pH; therefore it is not surprising that above a pH of five, the zeta potentials of the pigments stabilized with the two different model dispersants are equivalent (Figure 2). Despite the greater adsorption of the model HEUR, (NP(EtO)₁₀₀)₂TMXDI, on the AO(C₁₀)/MA stabilized TiO₂ the charge density of the two dispersants are similar. The greater adsorption of (NP(EtO)₁₀₀C₆)₃N does effect a lower particle charge density, at a pH of 9, of the AO(C₁₀)/MA stabilized pigment pair relative to this HEUR/PMAA stabilized pigment (Figure 3). Another method of assessing the pigment's stability is by low stress rheology measurements.

LOW STRESS RHEOLOGY—Complex viscosities from oscillatory measurements are summarized for the hydrophilic PMAA dispersant in Figure 4. The complex viscosity response of the dispersions increases abruptly at low oscillation frequencies, indicative of structure in these dispersions. High viscosity at low shear rates in colloidal systems may be attributed to flocculation of the

particles.⁴³ Clusters of particles arising from weak attractive forces (van der Waals) trap some of the continuous phase and increase the effective volume fraction of the dispersion.⁴⁴ As energy is imparted to the system through shearing, these clusters break down and the viscosity decreases.

Dispersions stabilized by the hydrophobic DIBMA dispersant do not exhibit the high complex viscosity at low oscillation frequencies indicative of flocculated pigment with the HEUR thickeners. An increasing complex viscosity is observed with the nonhydrophobe HEC thickened dispersions (Figure 5). This suggests a hydrophobic association between the DIBMA dispersant on the pigment and the HEUR thickener in solution that may reduce flocculation, via increased electrosteric stabilization.

Table 5—Influence of Dispersant on 20° Gloss of 32 NVV Dispersions (0.79 v/v Fraction 117nm Acrylic Latex/0.21 v/v Fraction R900) (1.33g 15S9 Surfactant/100g Pigment; 0.75g Dispersant/100g Pigment)

Thickener	WT%	Commercial Associative Thickeners			
		PMAA	AO(C ₁₀)/MA	AO(C ₁₄)/MA	AO(C ₁₈)/MA
HEUR-270	0.5	27	37	39	36
	0.8	30	40	41	41
HEUR-200	1.0	14	28	34	33
	1.7	25	32	34	36
HEUR-708	0.5	23	47	42	43
	0.8	28	41	43	42
Model Associate Thickener					
(NP(EtO) ₁₀₀ C ₆) ₃ N	0.8	27	47	48	48
	1.2	18	41	45	46
(NP(EtO) ₁₀₀) ₂ TMXDI	1.0	20	44	43	43
	1.7	22	39	38	43

Gloss Studies Revisited

Many of the components added to a full coatings formulation (i.e., the coalescing aid, freeze thaw stabilizer, and antifoaming agent) were omitted to simplify the coatings formulation. With all three commercial HEUR thickeners studied, 60 and 20° film gloss values were higher in model (AO/MA) stabilized pigment formulations than coatings containing model PMAA stabilized pigments. The same trend is noted with model HEUR thickener/model dispersant stabilized TiO₂ dispersions. Selected values are listed in *Table 5*.

The results, in total, indicate that the charge per se is not the primary factor affecting greater pigment stability. A similar conclusion has been observed with alkyd/melamine waterborne systems. No correlation was evident between the amount of surface charge on the particle and its stabilization. The important factor was the adsorption of the alkyd at the TiO₂ interface.⁴⁵

Thickening Efficiency

Pigment dispersions were formulated to a 90 KU viscosity with a variety of different thickeners. In this part of our study, four nonhydrophobe modified thickeners, HEC, and three poly(oxyethylene) polymers of molecular weights (100,000-POE-100K), (35,000-POE-35K), and (12,000-POE-12K) were used. The amount of nonhydrophobe modified thickener necessary to attain an approximate 90 KU pigment dispersion remains constant between the PMAA (*Figure 6A*) and the DIBMA TiO₂ dispersions (*Figure 6B*), but only half the level of HEUR thickener is necessary to attain 100 KU dispersions with the hydrophobic DIBMA stabilized pigment. When this approach is utilized in preparing a coating formulation, the low shear rate viscosities and thickening efficiency differences are present, but they are not as great as noted in *Figures 4-6*. The pigment concentration is of course reduced in the total formulation.

CONCLUSIONS

It has been demonstrated that two types of interactions are necessary to effect optimum utilization of TiO₂ in waterborne coatings. The first is the presence of dispersant with a proton donating component to achieve adsorption on the pigment's surface. The dispersant should contain hydrophobic groups to facilitate interaction with the hydrophobes of the HEUR thickener and thereby "adsorption" on the surface of TiO₂. The HEUR-dispersant association contributes steric stabilization to the electrostatic forces provided by the dispersant's adsorption. Several interactions need more quantitative definition to realize optimum performance. For example, the structural properties of the formulation surfactant and of the HEUR thickener that define their competition for the hydrophobic domains of the attached dispersant are needed. This is not an easy area of quantification, for commercial HEURs and the model thickeners of similar molecular design synthesized in our laboratories are complex mixtures⁴⁶ of compounds to be expected from a step growth polymerization. We are making significant progress in

this area and these data will be reported in a future manuscript.

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APPENDIX

Abbreviations

NP	Nonyl phenol
NP ₅₀	Nonyl phenol—reacted with ethylene oxide to 50 units
NP ₁₀₀	.....	Nonyl phenol—reacted with ethylene oxide to 100 units
C ₆	.....	Hexamethylene
C ₈	.....	Octyl
N	.....	Nitrogen
TMXDI	..	M—Tetramethylxylene diisocyanate
EtO	.....	Ethylene oxide
IP	.....	Isophorone diisocyanate
HEUR	.....	Hydrophobe-modified ethoxylated urethane
LSV	.....	Low shear viscosity
HSV	.....	High shear viscosity
KU	.....	Kreb unit

Latex Characteristics*

Latices ^a	AC-234	AC-64	AC-490
Composition ^b	MMA/EA	MMA/BA	MMA/BA
Latex MPS ^c (nm)	117	560 (5% 700)	390 (5% 290)

(a) Rohm and Haas was the supplier for all three latices.
 (b) MMA—Methyl methacrylate; EA—Ethyl acrylate; BA—Butyl acrylate.
 (c) MPS—Median particle size.

*We also have done extensive studies with small particle model latices (100-200nm). Our results with these latices are similar to those found with latex AC-234.^{1,13,42}

Model Dispersants

Dispersant	Mw	Mn
1-decene/maleic acid	2600	1520
1-tetradecene/maleic acid	3270	1910
1-octadecene/maleic acid	3100	1250
poly(methacrylic acid)	Mv = 5,500	

Thickener Characteristics

Thickener	Composition	Source	MW(w) ^c	MW(n) ^d
HEUR-200	(HM ^a ethoxylate	Union Carbide	71,400	44,600
HEUR-270	-urethane	Union Carbide	74,800	49,000
HEUR-708	copolymers)	Rohm and Haas	37,000	23,200
(NP(EtO) ₁₀₀) ₂ TMXDI	Nonyl phenol hydrophobe	NDSU	—	10,100
C ₈ IP(EtO) ₅₉₅ IPC ₈	Octyl hydrophobe	NDSU	—	21,000
(NP(EtO) ₁₀₀ C ₆) ₃ N	Nonyl phenol hydrophobe	NDSU	—	—

(a) Hydrophobe modified.
 (b) Model thickener.
 (c) Determined by size exclusion chromatography.
 (d) Molecular weight reported by source.

Formulation Components for Tables 1 and 2

Material	Mass (g)
TiO ₂	(R900/R902) 42.73
Dispersant	(mass listed based on 100% active) 1.06
Tergitol 15-S-9	(formulation surfactant) 0.57
Ethylene glycol	(freeze-thaw stabilizer) 3.04
Texanol	(coalescing aid) 3.04
Colloid 581B	(antifoaming agent) 0.73
PhHgAc	(antifungus agent) 0.09
Latex	(based on 46% solids latex) 92.35
Water and Thickener	56.39
	200g

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Society Meetings

CDIC FEB.

"Biocides"

The meeting's first technical speaker was Angela Downey, of Rohm and Haas Company. Her presentation focused on "BIOCIDES IN PAINTS AND COATINGS."

The speaker defined a biocide as any substance that is toxic to microorganisms. She explained that the purpose of a biocide is to stop the growth of microorganisms.

According to Dr. Downey, a biocide is needed in a coating formulation to provide in-container and drier film protection. Many of the common ingredients in coatings can serve as a nutrient source for microorganisms. Some of the more common microorganisms found in coating formulations include: bacteria, fungi, yeast, and algae. The speaker said that bacteria, yeast, and fungi are all implicated in in-can spoilage. Fungi and algae are responsible for dried film spoilage.

The speaker stated that omitting a preservative in a water-based coating can result in microbial growth. As a result of this microbial growth in the coating, viscosity loss, discoloration, phase separation, foul odor, and gassing are possible consequences.

Dr. Downey reported that the use of an in-can preservative ensures coatings do not sustain microbial spoilage during manufacture, packing, transportation, or storage.

The speaker said there are approximately 100 different preservatives on the market today. Dr. Downey described in detail the screening procedures used to test a preservative's effectiveness.

She stated that the growth of microorganisms in wet paint leads to the growth of microorganisms on dried coatings, resulting in discoloration and disfigurement. Mildew growth increases dirt pickup and water ingress, which ultimately leads to cracking and flaking. The speaker reported that incorporating a film preservative into a coating ensures it will remain free of mildew growth for a number of years.

The various routes that bacteria take to enter a product during manufacture were explained. Dr. Downey said the routes can be through ingredients such as water, or they can come via the environment, such as the air.

Q. You mentioned that you don't need a preservative if there are solvents present. Would a water-reducible alkyd need a preservative?

A. I cannot give you an answer without knowing the specific formulation. Probably you will need to check it out on a case by

case basis. As a general rule, solvent-based coatings don't support microorganisms. However, there are exceptions and that may well be one.

Q. In the "cocktail," do you have a set number of microorganisms you use in a test?

A. Yes. We actually quantify it and standardize it so it is the same volume of cells we add each time. We standardize it to 10^8 bacteria and 10^6 fungi and yeast per gram.

The second speaker was Richard Bennett, of Yasui Seiki Company (USA). Mr. Bennett discussed "HIGH TECHNOLOGY LABORATORY AND PILOT COATING MACHINES."

The speaker briefly reported on the history surrounding his company's machine design. He said that coated product development over the past 10-15 years has been to turn toward thinner and thinner coatings. Conventional coating machines presented unwanted obstacles to researchers.

Mr. Bennett showed the components of a number of designs and how they have solved technical production problems for systems with film thicknesses as low as 0.02 microns (200 angstroms).

PAUL R. GUEVIN, JR., Secretary

CHICAGO FEB.

"Polyurethanes"

Werner J. Blank, of King Industries, Inc., spoke about "POLYURETHANES AS REACTIVE COSOLVENTS IN WATERBORNE COATINGS."

The speaker talked about a low molecular weight aliphatic urethane diol that was used as a reactive cosolvent and as a replacement for glycol ether in waterborne industrial finishes. He stated that the urethane diol was found to be compatible with water-soluble, dispersed, and emulsion polymers, to raise the application solids of the formulation and lower the VOC.

Also, Mr. Blank said the urethane increased film hardness, improved response and gloss, and in some formulations, raised the water and corrosion resistance of the coating system.

CLIFFORD O. SCHWAHN,

CLEVELAND JAN.

"R&D Dollar"

"IMPROVING THE RETURN OF YOUR R&D DOLLAR" was presented by H. David Warren, of Tremco, Inc.

The speaker explained the two basic principles applied to research and development: do the right research and development by developing products based on customer interest, and do the research and development right.

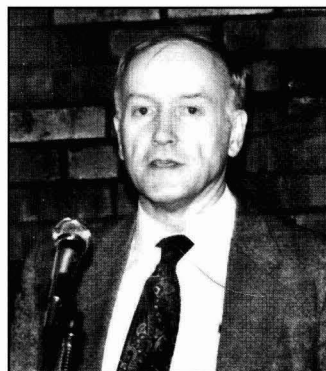
Among topics discussed were maintaining a pool of ideas from which the best can be developed with the limited resources available, and having plenty of ideas that compete for the research and development dollar.

According to Mr. Warren, the ideas should be sorted and a mechanism developed to categorize the ideas. Generally, ideas fall into two categories, commercial value and potential success. The speaker went on to say that projects, generally, fall into four categories:

- (1) small commercial value projects with high risk of failure, which should usually be rejected;
- (2) small value projects with low risk, which should be pursued but not over emphasized;
- (3) high value projects with low risk, which should be pursued; and
- (4) high value projects with high risk, which should make up the bulk of potential projects. They should not be rejected because they often tend to give the biggest "payoff."

The speaker stated that for an effective research and development program, a balance of projects in all categories is required.

After the projects have been categorized, Mr. Warren said feasibility should be de-



CHICAGO TECHNICAL SPEAKER—Werner J. Blank discusses polyurethanes with Chicago Society members at the February meeting

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Willow Grove Restaurant, Linthicum, MD). JOHN KURNAS, Mineral Pigments Corp., 12116 Conway Rd., Beltsville, MD 20705.

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

CDIC (Second Monday—Location alternates between Columbus, Cincinnati, Dayton, and Indianapolis). PAUL R. GUEVIN, JR., P.R. Guevin Associates, P.O. Box 811, Westerville, OH 43081-0811.

CHICAGO (First Monday—Sharko's Restaurant, Villa Park, IL). GREGORY E. MCWRIGHT, ANGUS Chemical Co., 2911 Sanders, Northbrook, IL 60062.

CLEVELAND (Third Tuesday—Brown Derby, Independence, OH in Sept., Oct., Nov., Dec., Feb., March; Jan. and Apr. meetings, Landerhaven, Mayfield Heights, OH). FREIDUN ANWARI, Coatings Research Group, Inc., 2340 Hamilton Ave., Cleveland, OH 44114.

DALLAS (Thursday following second Wednesday—The Harvey Hotel, Dallas, TX). ROBERT GIBNEY, Kerr-McGee Chemical Corp., P.O. Box 565026, Dallas, TX 75212.

DETROIT (Second Tuesday—meeting sites vary). RON ANDRUS, BASF Corp., 5935 Milford Ave., Detroit, MI 48210.

GOLDEN GATE (Monday before third Wednesday—alternates between Francisco's in Oakland, CA, and Holiday Inn in S. San Francisco). DONALD NOLTE, John K. Bice Co., 280 Missouri St., San Francisco, CA 94107.

HOUSTON (Second Wednesday—Hobby Airport Hilton, Houston, TX). RICHARD W. RYAN, Exxon Chemical Co., P.O. Box 5200, Baytown, TX 77520.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). YVONNE D'ARCY, Cook Paint & Varnish Co., P.O. Box 419389, Kansas City, MO 64141.

LOS ANGELES (Second Wednesday—Steven's Steakhouse, Commerce, CA). PHILIP C. BREMENSTUHL, Ashland Chemical, Inc., 999 Town & Country Rd., Orange, CA 92668.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). MIKE R. MOILANEN, United Catalysts, Inc., P.O. Box 32370, Louisville, KY 40232.

MEXICO (Every fifteen days—Gabriel Mancera, Mexico City, Mexico). SERGIO ROJAS, Pinturas International, S.A. De C.V., Ganaderos 234, Col. Granjas Esmeralda, 09810 Mexico, D.F., Mexico.

MONTREAL (First Wednesday—Le Biftheque, Ville St. Laurent, Quebec). JACQUES BROUILLETTE, BAPCO, 1470 Nobel St., Boucherville, Que., J4B 5H3, Canada.

NEW ENGLAND (Third Thursday—Sheraton Lexington Hotel, Lexington, MA, alternate meetings twice a year in Sturbridge, MA and Providence, RI). JOANNE E. MONIQUE, Ashland Chemical Inc., 400 Main St., Tewksbury, MA 01876.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). ARMAND J. STOLTE, RHEOX Inc., P.O. Box 70, Hightstown, NJ 08520.

NORTHWESTERN (First Tuesday after first Monday—Jax Cafe, Minneapolis, MN). SARAH OEBBER, H.B. Fuller Co., 3530 Lexington Ave., N., St. Paul, MN 55126.

PACIFIC NORTHWEST (PORTLAND SECTION—Third Tuesday; PUGET SOUND SECTION—Third Wednesday; VANCOUVER SECTION—Third Thursday). FLORA WONG, Saguaro Ltd., 106-150 E. Fifth St., N. Vancouver, B.C., V7N 1L5, Canada.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, GSB Bldg., Bala Cynwyd, PA). BRIAN O'CONNOR, McWhorter Resins, Inc., 7600 State Rd., Philadelphia, PA 19136.

PIEDMONT (Third Wednesday—Ramada Inn Airport, Greensboro, NC). DENNIS GILLESPIE, Lomas Minerals and Chemicals, P.O. Box 605, Indian Trails, NC 28079.

PITTSBURGH (Second Monday—Montemurro's Restaurant, Sharpsburg, PA). TIMOTHY ZEFFIRO, J.M. Gillen Co., P.O. Box 588, Bridgeville, PA 15017.

ROCKY MOUNTAIN (Monday following first Wednesday—Zangs Brewery, Denver, CO). LOUIS HARTNELL, Mountain-West Resources, Inc., P.O. Box 16784, Denver, CO 80216.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant, St. Louis, MO). MICHAEL SCHNURMAN, Kop-Coat, Inc., 328 Henley Ind. Ct., St. Louis, MO 63144-1599.

SOUTHERN (GULF COAST SECTION—third Thursday; CENTRAL FLORIDA SECTION—third Thursday after first Monday; ATLANTA SECTION—third Thursday; MEMPHIS SECTION—bi-monthly on second Tuesday; and MIAMI SECTION—Tuesday prior to Central Florida Section). MARY G. FINNIGAN, McCullough & Benton, Inc., 2900 G Carolina Center, Charlotte, NC 28208.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). DAVID JACK, Technical Coatings Co Ltd., 1164 Walkers Ln., Burlington, Ont., L7M 1V2, Canada.

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

terminated. The feasibility can be determined by multiplying the probability of success by the estimated commercial value of the project divided by the estimated capital investment. According to Mr. Warren, if the number is greater than one, the project is feasible, with higher numbers showing greater future potential.

The next step in the process is to select a portfolio of research and development projects from the pool of feasible projects.

The speaker said the progress of the project portfolio must be continually monitored and adjustments made when required. Also, when a project gets older, it is important to determine when to terminate it by considering only future capital requirements rather than expenditures already incurred.

According to Mr. Warren, several factors must be considered in doing the actual research and development, including: the cycle time, prioritization of the research goals; productivity design of the project; and development of a monitoring process.

The speaker stated that the initial stages of a project should be completed rigorously and thoroughly. During the preliminary investigation, detailed investigation, development, trial/validation, and commercialization, the project should be reevaluated for feasibility, commercial potential, and chance of success.

In conclusion, Mr. Warren focused on three points to get the most out of the research and development dollar. First, the proper choice of projects must be made from a large pool of ideas. Second, projects must be developed by a team consisting of all company departments and the customer. Third, this approach to research and development will be required to remain competitive in the 1990s so that new technologies can be developed on a regular, predictable basis.

Q. How do you determine the amount of money to be spent on research and development?

A. This question should really be answered in two parts: what you can afford, and what you can afford in the long-term. Recently, more and more emphasis has been placed on long-term goals. In the long-term, funding is generally not a problem, more money will become available as nonfruitful projects are killed and funding often takes care of itself.

Q. What are the most effective ways to develop new research and development ideas and who decides which ideas should be worked on?

A. Time should be intentionally devoted to the development of new ideas by teams of people with different skills. Customers should be included in this process. The viability of the new ideas can then be decided by a team of senior marketing, manufacturing, research and development, etc., people.

FREIDUN ANWARI, Secretary

KANSAS CITYJAN.

"Driers"

Retired Society member Warren O. Manley, formerly of Cook Paint and Varnish Company, was nominated and elected to Society Honorary Membership.

"NEW GENERATION DRIERS FOR THE COATINGS AND INK INDUSTRIES" was the subject of a technical presentation given by Cleveland Society member Robert G. Middlemiss, of Mooney Chemicals, Inc.

YVONNE D'ARCY, *Secretary*

NEW ENGLANDJAN.

"Economy Outlook"

A moment of silence was observed in memory of Luke M. Diliello, formerly of Cabot Stains, who passed away recently.

The meeting's speaker was Arthur Werts, of Eastman Chemical Products. Mr. Werts talked about the "ECONOMY OUTLOOK FOR 1992."

The speaker discussed the Real Gross National Product and the Real Gross Domestic Product. It was pointed out that the Gross National Product growth for 1992 is expected to be 2.5%. The average growth for the last 10 years has been 2.7%.

Mr. Werts said that consumer attitudes have to change, confidence has to be reinstated.

The speaker discussed retail sales growth, housing starts, auto sales, industrial production, inflation, prime interest rates, crude oil prices, unemployment, and problems.

In conclusion, Mr. Werts' forecast for 1992 was to expect reasonable economic growth and for inflation to remain moderate.

Q. How does President Bush plan to jump start the economy?

A. The Feds and Mr. Bush will work together to lower interest rates. Consumer refinancing will help the economy, and they will have more money to spend and reduce debt.

Q. How much does the Federal Budget affect the economy?

A. The Federal Budget has a small impact on the economy—it can be a mute point.

JOANNE MONIQUE, *Secretary*

NORTHWESTERNJAN.

Manufacturing Meeting

The meeting's first speaker was Pius Eigenmann, of Buhler, Inc. His topic was "QUALITY CONSCIOUS MANUFACTURING."

Total quality management was discussed. Dr. W. Edwards Deming's 14 points

which management must recognize to develop a quality-oriented, customer-driven business culture were briefly explained.

One of Dr. Deming's 14 points, cease depending on mass inspection to achieve quality, was the focus of the presentation.

Mr. Eigenmann stated that research has shown that more time is spent testing and adjusting a typical production batch than in manufacturing the batch. He said this has a great impact on delivery, cost, and productivity. Also, each adjustment leads to inefficiencies because it can throw off production schedules. Variations in manufacturing times makes it more difficult to provide short delivery times and forces manipulators to maintain more inventory of finished goods.

The speaker spoke about consistency and productivity, stating the manufacturers must gain control over product formulation, raw materials, and the manufacturing process itself. In order to accomplish this, he said producers need to focus on cleanliness in the plant, ensuring raw materials are weighed correctly and in the proper sequence, using consistent operating parameters, and implementing an effective system for controlling operating parameters.

According to Mr. Eigenmann, both formulation and production parameters are essential to produce a consistent product. Also, proper selection and operation of the most efficient type of equipment is important. He stated that in recent years, coating and ink manufacturers have increased their productivity by developing automated production lines.

In conclusion, Mr. Eigenmann said to manufacture quality products consistently and stay competitive in changing market conditions, innovative and efficient manufacturing technology becomes essential. Also, accurate weighing and controlled production will improve quality, delivery, and efficiency by increasing output, reducing waste, and saving energy.

Q. Where is most of your business currently?

A. Unfortunately, it is harder to sell automation in the U.S. In contrast, Europe and Japan seem to adopt high technology more readily.

Q. Can automation work in small plants as well as large plants?

A. Absolutely. The goal is to have the ability to control the machine, and not let the machine control the product.

The second speaker was Drew A. Willoughby, of Cuno, Inc. His presentation focused on "SELECTING THE PROPER FILTER CARTRIDGE FOR A PIGMENTED PAINT PROCESS."

Discussed were the many process variables that must be taken into consideration in the selection of proper filter, including: flow, differential pressure, temperature, viscosity, solids, pigment and containment size, carrier fluid, and batch size.

According to the speaker, the types of particles to be removed determine filter selection. Also, it is necessary to understand the ways to rate filters, and to be able to compare information from different suppliers.

Clarification, structural design, rigidity, and filter density of filters were described. Mr. Willoughby said clarification refers to removal of all particles that create cloudiness or turbidity, which is caused by small particles. He stated that the structural design, rigidity, and filter density affect the type and efficiency of filtration.

Q. How many problems are caused by filter replacement practices?

A. Filter manufacturers feel the problems in the production of coatings were created upstream. It is the filter's job to correct those problems.

SARAH E. OEBSER, *Secretary*

PIEDMONTJAN.

"Waste Reduction"

Thomas W. Mitchell, of Hüls America, Inc., presented the Hüls Gavel to President Ruby Johannesen, of Southchem, Inc.

Ms. Johannesen explained that the vote held during the December meeting to add a new type of Society membership has been declared invalid. The Federation's Affiliated Membership is available to anyone who is eligible for Active, Associate, Educator and Student, or Retired Membership in a Constituent Society, but whose employment or residence is not within the boundaries of any Constituent Society.

Sara Robinson, of HeucoTech Ltd., reported on the possibility of a "Mini Trade Show" to be sponsored by the Society. The event is scheduled tentatively for March 1993 (during the week of St. Patrick's Day) at a site yet to be determined.

Ms. Robinson said that an exhibitor's conference and technical seminar are being pursued as part of the two-day event. The number of suppliers in the "Show" will be limited due to space limitations at the sites under consideration.

The theme of the conference is "Compliance." Any topic that has to do with compliant coatings or compliance in general, from raw materials to finished products, would be welcome for presentation at the technical seminar.

The meeting's technical presentation was given by David Williams, of the North Carolina Department of Environment, Health, and Natural Resources. His topic was "WASTE REDUCTION."

DENNIS C. GILLESPIE, *Secretary*

Future Society Meetings

Birmingham

(May 7)—63rd Annual General Meeting.

CDIC

(May 11)—“DEFOAMERS—THEORY & PRACTICE”—Kenneth Briendel, Henkel Corporation.

Cleveland

(Apr. 21)—“THE ADVENTURES OF A CHEMIST-COLLECTOR”—Dr. Alfred Bader, Aldrich Chemical Co.

(May 19)—“ADVANCES IN RESIN TECHNOLOGY FOR WATERBORNE STAINS”—Al Heitkamp, Cargill Inc.

Detroit

(May 12)—“COLOR THEORY”—Speaker from Byk-Gardner, Inc.

Golden Gate

(May 18)—“STATISTICAL PROCESS CONTROL”—Dan Baker, McWhorter, Inc.

(June 15)—Manufacturing Committee Seminar.

Louisville

(Apr. 15)—“WATER BASE COATINGS” Symposium. LSCT/LPCA Joint Meeting. Speaker to be announced.

(May)—Ladies’ Night. Joint LSCT/LPCA Meeting.

(June 1)—Annual LSCT/LPCA Golf Outing.

New York

(May 12)—Past-President’s Night—PaVaC Awards Night—“WATERBORNE COATINGS: RETROSPECT AND PROSPECT”—Robert M. Fitch, Fitch & Associates.

Philadelphia

(Apr. 24)—Awards Night.

(May 14)—“THE MALCOLM BALDRIGE PROCESS—A FRAMEWORK FOR IMPROVEMENT”—Ross C. Loeser, E.I. du Pont de Nemours & Co., Inc.

Piedmont

(Apr. 15)—“THE INFLUENCE OF EQUILIBRIUM AND DYNAMIC SURFACE TENSION ON WOOD COATINGS SURFACE DEFECTS”—David Warnke, Air Products & Chemicals, Inc.

(June 17)—Past-Presidents’ Night. PSCT Technical Committee, Sara Robinson.

Pittsburgh

(May 11)—Tour of the Miles Inc. Paint Laboratories.

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Elections

CDIC

Active

Schinner, Joseph R.—Akzo Coatings Inc., Columbus, OH.

Associate

Marzano, Brian P.—Sun Chemical, Fairfield, OH.
Rall, Eric L.—W.R. Grace & Co., Baltimore, MD.

CHICAGO

Associate

Jaegersberg, Rolf K.—PPG Industries, Inc., Oak Creek, WI.

CLEVELAND

Active

Anderson, Bruce J.—Jamestown Paint & Varnish Co., Jamestown, PA.

Erwin, Emmett M.—The Lubrizol Corp., Euclid, OH.

Fensel, Fred A.—Gibson-Homans, Shaker Heights, OH.

Kelley, Mary M.—Sherwin-Williams Co., Cleveland, OH.

Mandat, Michael J.—Barnet Aluminum, Cleveland.

Mendat, Ryne P.—Degussa Corp., Akron, OH.
Nargiello, Maria R.—Degussa Corp., Akron.

Patel, Sohini Y.—Sherwin-Williams Co., Cleveland.

Pizem, Catherine A.—Sherwin-Williams Co., Cleveland.

Thompson, Wendy A.—Sherwin-Williams Co., Cleveland.

Yap, Michael L.—Koch Materials Co., Heath, OH.

Associate

Denison, Don C.—Schabel Products Corp., Cleveland, OH.

Murray, Christopher—North Pak, Macedonia, OH.

Sirocky, Mike P.—Schabel Products Corp., Cleveland.

Wylie, Geoff B.—Sandoz Chemical Corp., Vermilion, OH.

Retired

Dreka, George B.—Cleveland Heights, OH.

KANSAS CITY

Active

Braun, Kevin G.—Technical Coatings, N. Kansas City, MO.

Fitzpatrick, William J.—Technical Coatings, N. Kansas City.

Heinrich, David S.—Pratt & Lambert, Wichita, KS.

Hendrick, Bill L.—Sherwin-Williams Co., Cook Paint Div., Gladstone, MO.

Hon, Norman A.—Sherwin-Williams Co., Cook Paint Div., N. Kansas City.

Johnson, Steven D.—Technical Coatings, N. Kansas City.

Truesdale, James H.—Sherwin-Williams Co., Cook Paint Div., N. Kansas City.

PHILADELPHIA

Active

Arora, Kartar S.—Henkel Corp., Ambler, PA.
Bassner, Sherri L.—Air Products, Allentown, PA.

Bryant, David A.—RHEOX Inc., Hightstown, NJ.
Folkman, David W.—Pennsbury Coatings, New Britain, PA.

Guzman, Albert S.—United Gilsonite Lab., Scranton, PA.

Ingram, John R.—M.A. Bruder & Sons, Inc., Philadelphia, PA.

Lamb, Douglas M.—Du Pont Co., Philadelphia.

Marshall, John F.—S.G. Pinney & Associates, Drexel Hill, PA.

McNair, J. Craig—Pflaumer Bros., Inc., Norristown, PA.

Mills, Wyatt J.—Du Pont Co., Philadelphia.

Podolsky, George—Harcros Pigments Inc., Easton, PA.

Ross, Christopher A.—M.A. Bruder & Sons, Inc., Philadelphia.

Valmores, Pons—Finnaren & Haley Inc., Conshohocken, PA.

Walker, Frederick H.—Henkel Corp., Ambler.

Yeh, A.G.—Du Pont Co., Philadelphia.

Associate

Pfister, Gregory, J.—PFI-Chem Sales Co., Newark, DE.

Yosh, James P.—Henkel Corp., Ambler, PA.

PIEDMONT

Active

Bray, James H. III—Akzo Coatings Inc., High Point, NC.

Engle, C.R.—Hilton Davis Co., Atlanta, GA.

Fanslau, Robert D.—Valspar Corp., High Point.

Howard, Charles T.—Blue Ridge Talc Co., Henry, VA.

Associate

Brannon, James B.—Rieke Corp., Woodstock, GA.

Kaye, Ken—Southern Micro Instruments, Raleigh, NC.

Reynolds, David L.—Eastman Chemical Products, Inc., Greensboro, NC.

Tarbell, Scott C.—Cargill, Inc., Forest Park, GA.

Worsley, David F.—Southchem, Greensboro.

TORONTO

Active

Flynn, Michael F.—Madison Chemical, Milton, Ont.

Hansen, Steve P.—Interprovincial Inks, Maple, Ont.

Jeu, Eileen V.—K-G Packaging, Concord, Ont.

McCleery, William T.—Valspar Inc., West Hill, Ont.

Ramaswamy, Tarakad L.—Bapco Inc., Concord.

Associate

Biduk, Stephen—Geneq Inc., Toronto, Ont.

Foxwell, Michael S.—L.V. Lomas Ltd., Brampton, Ont.

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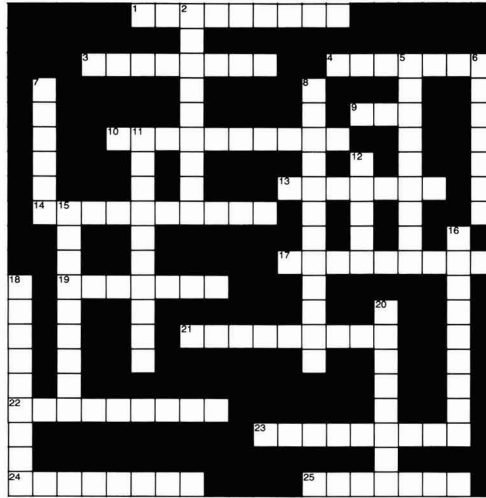
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For more information, contact your local Society, or write to Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422

CrossLinks

by Earl Hill



Solution
to be
Published in
May Issue

No. 47

ACROSS

1. Kind of bacteria
3. Balance used for Sp. Gr.
4. Opposite of inorganic
9. Type of board (Abr.)
10. Class of organic acids (Chem.)
13. Natural calcium carbonate
14. What are compounds that can behave as acids or bases
17. Mica like
19. Orange or red pigment found in plants; from the Latin for carrot
21. Drier metal, M_____
22. The acid of shellac
23. To scale from a surface
24. Common ingredient of car polish
25. Companion of Munk

DOWN

2. Group of asbestos minerals; used to make 9 Across
5. Non fibrous, magnesium silicate extender pigment
6. Brilliantly clear
7. Uncommon semidrying vegetable oil
8. A family of pigments, Q_____
11. Varying forms or modifications exhibited by elements or compounds
12. Natural Copal resin from Africa
15. Common mineral form which is a Synonym for 17 Across
16. A closed reaction vessel, usually operates under pressure
18. Opposite of aromatic (Chem.)
20. Mineral form of mica

Datacolor International, Lawrenceville, NJ, has announced the restructuring of its sales operations in the Americas. The following personnel appointments have been made: **Don Walker**—Eastern Division Sales Manager/Southeast, Mid-Atlantic, New England, and Canada; **Ron Baker**—Western Division Sales Manager/Ohio, Midwest, Southwest, West Coast, and Central and South America; **Phil Jannetto**—Area Sales Manager/Chicago and Midwest; and **Dan Hendrickson**—Area Sales Manager/Mid-Atlantic.

Robert J. Silinski has accepted the promotion to Northeast Regional Manager for the Wheelabrator Corporation, La Grange, GA. In this capacity, Mr. Silinski will be responsible for both the company's direct sales force and a network of distributors in the Northeast. Prior to this position, he was Regional Manager/Equipment Sales.

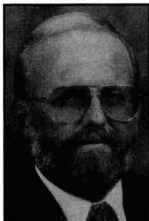
Michael N. Wise, Sr. has been appointed Regional Manager. Mr. Wise will undertake the responsibility for a network of distributors selling aftermarket products, equipment modernization programs, and other services in Texas, New Mexico, Louisiana, and Mexico. He has been with the firm for more than eight years.

Ray Nowland has accepted the position of Regional Manager for Wheelabrator. In this capacity, Mr. Nowland will be responsible for managing a distributor network that sells aftermarket products and services for nine western states.

Also, **Michael L. Selz** has been named Regional Manager for the seven-state region in the Southeast. Mr. Selz joined Wheelabrator in 1987.

Troy Corporation, East Hanover, NJ, has given the title of Southern Regional Sales Manager to **Frederick A. Casper**. Based in Tampa, FL, Mr. Casper will handle sales of Troy's biocides and performance additives for customers in North Carolina, South

Carolina, Georgia, Florida, eastern Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas, excluding El Paso. Prior to this appointment, he was Vice President/Technical Director at Sun Coatings.



The Society of Manufacturing Engineers (SME), Dearborn, MI, has selected six leaders in manufacturing engineering, management, education, and research to receive its 1992 International Honor Awards. They include: Gold Medal—**Nathan A. Chiantella**, of CMfgE, Consultant; Joseph A. Siegel Service Award—**Robert A. Dougherty**, of Dougherty & Associates; Frederick W. Taylor Research Medal—**Wilfried Konig**, of Technical University of Aachen, Germany; Education Award—**Raffaello Levi**, of Politecnico di Torino, Italy; Donald C. Burnham Manufacturing Management Award—**William C. Hanson**, of Digital Equipment Corporation; and Albert M. Sargent Progress Award—**William A. Kerr**, of Pratt & Whitney/United Technologies Corporation.

In addition, **Daniel Tellup**, of Lockheed Corporation, was elected SME's 1992 Honorary Member.

The Specialty Products Division of Pratt & Lambert, Inc., Buffalo, NY, has named **Walter Greizerstein** Technical Director. Dr. Greizerstein is a member of the Western New York Society, American Chemical Society, and the Adhesives & Sealant Council.

Whittaker, Clark & Daniels, S. Plainfield, NJ, has named **Kenneth J. DePaul** Senior Accounts Manager. His responsibilities will include field sales in central New Jersey, and Long Island City and Brooklyn, NY. Mr. DePaul joined the firm in 1974 as a sales trainee following his graduation from college. He is a Past-President of the New York Society.

John C.D. Woodruff has been promoted to Senior Accounts Manager/North Carolina and South Carolina for Whittaker, Clark & Daniels. Mr. Woodruff, who previously served as Account Manager, joined the company in 1974 as a Sales Representative.

In addition, Mr. Woodruff and **Donald J. Kelley** are the 1991 recipients of the firm's President's Award for their outstanding sales efforts. Mr. Kelley currently serves as Account Manager in West Virginia, western Virginia, and western New York. He has been with the company since 1984.

John Yurchisin, Senior Technical Sales Representative for CIBA-GEIGY Corp., Hawthorne, NY, has been named 1991 Salesman of the Year for the company's Resins business. Mr. Yurchisin joined CIBA-GEIGY in 1989. Prior to that, he was employed for a number of years in chemical sales and marketing at General Mills Chemical/Henkel.

R. Michael Hendricks and **Robert E. Davis**, both of Axess Corporation, have been elected to serve on the Board of Directors of Rheometrics, Inc., Piscataway, NJ. Mr. Hendricks, currently President of Axess, has nearly 30 years of experience in polymer related industries, including planning, marketing, development, and negotiations. Mr. Davis, who serves as Managing Director at Axess, has more than 30 years' experience in the fields of specialty chemicals and aerospace.

Deeks and Company has announced the addition of **Phillip Scott Reese** to their technical sales staff. Mr. Reese will be working out of the company's Cincinnati, OH sales office where he will be responsible for accounts in northern Kentucky, western Ohio, and southern Michigan. Mr. Reese replaces **Tony Espelage** who retired in January following 42 years in the industry.



Norman R. Oost has been appointed Rocky Mountain Area Manager for Van Water & Rogers Inc., a subsidiary of Univar Corporation, Kirkland, WA. In this position, he will oversee the operations of the company's branch offices in Colorado, Idaho, Nevada, Utah, and Wyoming. A 33-year veteran of Van Waters, Mr. Oost most recently served as Manager of Field Sales Training and Interim Director of National Accounts.

High Solids Polyester Resin

A data sheet featuring a new high solids polyester resin, which is designed to allow some chemically induced sheen control for high solids coatings, has been printed. The resin is a low viscosity, 100% nonvolatile polyester that was developed for low VOC, hard, and solvent resistant coatings for metal office furniture and other general industrial applications. Further details on Cargill 133-1916 resin are obtainable by writing Richard Johnson, Cargill, Inc., P.O. Box 5630, Minneapolis, MN 55440.

Accelerated Weathering

The introduction of an accelerated weathering instrument, that is designed to perform faster tests without sacrificing simulation of a product or material's end use conditions, has been made through a data sheet. The instrument features a high irradiance xenon arc system, automatic irradiance control, a high uniformity three-tier sample rack, and a patented airflow system. For more details on the 3SUN High Irradiance Xenon Weather-Ometer®, contact Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613.

Temperature Bath/Circulators

The introduction of a series of constant temperature bath/circulators and coolers has been made through a product release. The baths feature: stable electronic control of temperature to 0.1°C, digital display of set point and control temperature, coarse and fine set point adjustment, and adjustable high temperature/low liquid level safety cutout. For further technical details on the TC-Series baths, contact Brookfield Engineering Labs., Inc., Dept. NR-87, 240 Cushing St., Stoughton, MA 02072.

Spectrophotometer

A four-color, four-page brochure featuring a hand-held spectrophotometer designed to permit quick pass/fail color measurement decisions in-the-field or on the plant floor has been printed. The unit features a pistol-grip handle and trigger for one-hand operation. Contact Macbeth, P.O. Box 230, Newburgh, NY 12551-0230 for more details on the ColorChecker™ 545 spectrophotometer.

Curing Agent

The product release introducing a new curing agent has been issued. The agent is a modified polyamide designed for use with epoxy resins to formulate high solids, two component, ambient cure coatings. For more information on CMD 894, contact George Roy, Rhône-Poulenc Inc., Specialty Resins Group, 9808 Bluegrass Pkwy., Louisville, KY 40299.

Software

A software system, designed to increase productivity by improving inventory, product costing, MSDS generation (including SARA reporting), formulation, and more, has been introduced through a product flyer. The system is fully integrated with IBM Platinum Series Accounting Software. For a free demo disk on BatchMaster Version 3, contact Pacific Micro, 1500 Pacific Coast Hwy., Ste. E, Seal Beach, CA 90740.

Auxiliary Filtration

An 18-page, full-color industrial brochure featuring auxiliary filtration for critical component protection has been released. The bulletin provides a detailed description of the filters and their methods of construction. To receive a copy of the brochure on Last Chance Filters and strainers, write Pall Corp., 2200 Northern Blvd., East Hills, NY 11548.

Thermoplastic

Properties of a high-temperature polybenzimidazole polymer are described in a new brochure. The literature succinctly summarizes, in tabular format, the key electrical, thermal, physical, and chemical properties of this product. Write Hoechst Celanese Corp., PBI Performance Parts, 18207 Chisholm Trail, Ste. 216, Houston, TX 77060 for technical information on Celazole®.

Fumed Silica

The use of a fumed silica in liquid and powder coating applications is the topic of a new 24-page publication. The fully illustrated brochure provides information on the properties that the fumed silicas impart in coatings systems. Contact Cabot Corp., P.O. Box 188, Tuscola, IL 61953-0188 for a copy of the publication, "CAB-O-SIL® Fumed Silica in Coatings."

Market Study Report

The industry report, "Non-Residential Anti-Corrosion Markets & Materials in the U.S. (1992)," is now available. Topics covered in the report include: coatings used in both industrial new construction and maintenance applications, and markets for abrasives, other materials, equipment, and contractor services. Attention is also paid to market shares between high solids and waterborne coatings, between new construction and maintenance, and among various contractors. For more information, contact WEH Corp., P.O. Box 470038, San Francisco, CA 94147.

Gas Cylinder Management System

A new gas cylinder management system is the focus of a recently published brochure. The system features computerized bar coding which reportedly provides complete cylinder accountability as it tracks each cylinder and generates reports to provide control of cylinder movement and inventory. For a copy of the pamphlet (Form #6937), write Liquid Carbonic, Advertising Dept., 135 S. LaSalle St., Chicago, IL 60603.

Microwave Instrumentation

A comprehensive eight-page report detailing how microwave-based instrumentation is being used for state-of-the-art sample preparation and/or analysis for heavy metals, total solids, total suspended solids, fixed and volatile solids, and microbiological determinations has been printed. Also included in the publication is an EPA-approved and pending microwave methods update, and a collection of studies from around the world comparing microwave methods with conventional methods. For a free subscription of "The CEM Report," contact Vickie Kiker, CEM Corp., P.O. Box 200, Matthews, NC 28106.

SITUATIONS WANTED

Twenty plus years experience, R&D, manufacturing operations, technical and general management. Ph.D. coatings chemistry (NDSU). Seeks challenging, responsible opportunity; prefer western location. F.D. Williamson, 7441 Muirwood Ct., Pleasanton, CA 94588, (510) 846-5052.

Golden Gate Society Manufacturing Committee To Sponsor "Ideas for the Future" Conference, on June 15

The Manufacturing Committee of the Golden Gate Society for Coatings Technology will sponsor an all-day conference entitled "The Forum . . . Ideas for the Future," on June 15, 1992, at the Holiday Inn, in South San Francisco, CA.

The seminar will be divided into three parts: environmental regulations which currently impact the coatings industry, presented by the Program Advocating Responsible Legislation for the Environment; solutions to problems that are created by regulations, including a panel discussion of ways in which those within the paint and coatings industry can cooperate with one another to meet regulatory requirements and reduce waste; and a review of legal rights of companies affected by environmental regulation, presented by the law firm of Fitzgerald, Abbot, and Beardsley. Environmental law and related topics also will be discussed during the final segment of the conference.

This year's Manufacturing Committee Seminar has scheduled the following topics and speakers:

"SB198—Injury and Illness Prevention Program"—Cecelia Stoddard, of Fuller O'Brien Paint Company;

"Permit by Rule"—Gerald B. Allen, of Eastman Kodak Company;

"Hazardous Waste Management in the Paint Industry"—Darren Bianchi, of Radiant Color;

"Regulations for the Recycling of Latex Paint"—Patricia Houle, of Fuller O'Brien Paint Company;

"Container Recycling"—Bob Jacobsen, of U.S. Can;

"Methods for Recycling Paint Waste"—Robert D. Athey, Athey Technologies;

"Emission Control and Waste Management"—Bill Marlin, of Kleinfelder, Inc.;

Panel Discussion: "Cooperation within the Law"—Roy Blackburn, of The Flecto Company; Paul Gasner, of Simpson Coatings Group; Dave Muggee, of E.T. Horn Company; Rocky Williams, of Napa Valley Paint Company; Frederick Parkinson, of U.S. Cellulose Company, Inc.; and Wayne Kino, of Bay Area Air Quality Management District; and

"Fuming over Regulations? How to Survive the Onslaught of New Hazmat Legislation and Enforcement Initiatives"—Jonathan W. Redding, of Fitzgerald, Abbot, and Beardsley.

Members of the Golden Gate Society Manufacturing Conference Committee in-

clude: Chairman—Louie Sanguinetti, of Jasco Chemical Corporation; Co-Chairman—Ron Hughes, of Ashland Chemical Company; Co-Chairman—Ernest "Bud" Harmon, Consultant; Adrian Adkins, of Schoofs, Inc.; Raymond Benedetti, of Triangle Coatings, Inc.; Robert A. Henshaw, of Hüls America; Don Mazzone, of O'Brien Corporation;

Tina Onderbeke, of Dowd & Guild, Inc.; Kevin Porterfield, of Pfizer, Inc.; A. Gordon Rook, Consultant; Leo Schinasi,

Consultant; Kendall Trautwein, of Triangle Coatings, Inc.; and Rocky Williams.

The seminar registration fee is \$70, which includes lunch and dinner. Registration is limited and enrollment will be on a

first come, first serve basis.

Tapes of the program will be available for a fee of \$20 for attendees and \$50 for others.

More information

on Conference '92 is available from Ron Hughes, Ashland Chemical, Inc., 8600 Enterprise Dr., Newark, CA 94560.

Golden Gate Society for Coatings Technology



MANUFACTURING COMMITTEE

Pacific Northwest Society's Spring Symposium Scheduled for April 30-May 2, in Portland, OR

The Pacific Northwest Society for Coatings Technology will conduct its 45th Annual Spring Symposium on April 30-May 2, 1992, at The Benson Hotel, in Portland, OR.

The theme for this year's conference is "Promoting Quality Coatings." Papers on the following topics are scheduled for presentation: associative thickeners, organic pigments dispersion, corrosion correlation, urethanes, low VOC N/C for wood, maintenance coatings formulation, newer types of TiO₂, and formulation of waterborne silicone product finishes.

Also scheduled during the event are a golf outing, at Heron Lakes Golf Course, in North Portland, and skiing at Timberline Lodge (6,000 ft), on Mt. Hood. The annual Thursday (April 30) affair will be a Cinco de Mayo Festival on the Sternwheeler Columbia Gorge. The spouses' program will consist of a fashion show and luncheon at The Benson Hotel.

Abel Banov, Co-Publisher/Editorial of *The American Paint and Coatings Journal* will be the featured speaker at the Luncheon on May 1.

For additional details on the 45th Annual Pacific Northwest Society Spring Symposium, contact John Westendorf, Pro-

gram Chairman, Lipscomb Chemical Northwest, 2627 NW Nicolai, Portland, OR 97210; Phone: (503) 241-3520.

Atlas Electric Devices to Host Weathering School and Seminar

Atlas Electric Devices Company, Chicago, IL, has announced that its 10th School of Natural and Accelerated Weathering will take place on May 4-8, in Miami, FL.

The school is designed to teach the fundamentals of natural and accelerated weathering of materials to the product manager, materials engineer, quality control supervisor, and others involved in determining the durability of their products.

Also, Atlas and South Florida Test Service, Miami, FL, will co-host a series of seminars entitled "The Fundamentals of Weathering."

A total of 14 seminars will be conducted, including: April 13—Chicago; April 15—Minneapolis, MN; May 19—Anaheim, CA; and May 21—Oakland, CA.

For more information, write Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613.

Southern Society Annual Meeting, on March 11-13, Featured Technical Sessions, Short Courses, Sports, and Social Events

The Southern Society for Coatings Technology held its Annual Meeting on March 11-13, at the Grosvenor Resort at Walt Disney World, in Lake Buena Vista, FL.

The meeting featured technical sessions, two short courses sponsored by the University of Southern Mississippi (USM), golf, tennis, and a spouses' program.

William F. Holmes, of National Pigments & Chemicals, Inc., and President of the Federation of Societies for Coatings Technology, officially opened the meeting with a welcoming address.

The theme of this year's meeting was "Industry and Education Working Together." The technical program sessions and the short courses ran concurrently on March 12 and 13. The technical sessions were devoted to new developments in the coatings industry. The short courses focused on the basic knowledge of coatings principles, including appearance and film formation.

The Keynote Address, which was based on the meeting's theme, was delivered by

Bruce Anderson, of Kemira, Inc. Other presentations included:

"Evaluation of a New Generation of Coalescing Agents for Industrial Acrylic Latexes"—Daniel N. King, of Exxon Chemical Company;

"Wax Emulsions in Aqueous Polymeric Coatings: Contributions and Mechanism"—John Specht, of Michelman, Inc.;

"Defoamers in the Coatings Industry: Theory and Application"—Al Simontis, of Byk-Chemie USA;

"Optimal Dispersion Design"—Thomas A. Daquila, of Daniel Products Company;

"Improved Corrosion Correlation: Prohesion Combined with QUV for Testing Resistance to Salt, UV, and Moisture"—Douglas M. Grossman, of Q-Panel Company; and

"Use of Oxazolines as a Route to High-Build, One-Component, Moisture-Cured Polyurethane Coatings for the Construction Industry"—Mitchell B. Bass, of Miles, Inc.

The USM-sponsored short courses were: "Appearance Properties of Coatings" and "The Principles of Film Formation." The

courses were conducted by Drs. Rob Storey and Shelby Thames, of USM, and were offered to the meeting's attendees at no cost.

Dr. Thames, Distinguished Research Professor and Professor of Polymer Chemistry, also served as the luncheon speaker.

The Spouses' Program featured a luncheon, a seminar on "Innovation in Action—Walt Disney World Behind the Scenes," and a wine and cheese reception.

Montreal and Toronto Societies To Cosponsor Symposium on "Surviving the 90s," April 29 & 30

The Protective Coatings Division, of the Chemical Institute of Canada, and the Montreal and Toronto Societies for Coatings Technology, will cosponsor the 46th Annual and 39th "Back to Back" Symposium on "Paint Technology—Surviving the 90s," on April 29, at The Old Mill, in Toronto, Ont., Canada, and on April 30, at the Hélène de Champlain Restaurant, in Montreal, Quebec, Canada.

The following topics and speakers have been scheduled:

"Vynate Latexes for Architectural Applications"—Peter Martin, of Union Carbide;

"Efficient Hiding—Formulating with TiO₂, Extenders, and Voids"—Rebecca Craft, of Du Pont Chemicals;

"Low-VOC Waterborne Coatings for Wood Based on Nitrocellulose-Acrylic Latex"—John Devido, of Aqualon Company;

"Propylene Glycol Ethers as Coalescing Aids in Waterborne Acrylic Emulsions"—James Bodwell, of Arco Chemical Company;

"What the Latex Formulator Should Know About Polymer Emulsions"—Ron Brown, of Unocal Chemical Division; and

"Role of Dispersants in Paint Formulating"—Eric Johnson, of Rohm and Haas Company.

For further details on "Paint Technology," contact: Steve Balmer, Bapco Inc., 8200 Keele St., P.O. Box 7000, Concord, Ont. L4K 1B6 (416) 660-8924; or Gordon Simpson, Sico Inc., 41 Bates Rd., Outremont, Que. H2V 1A6 (514) 495-5704.

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Cleveland Society to Host Symposium at NASA Research Center

The Cleveland Society for Coatings Technology will host their 35th Annual Technical Conference, on May 28, 1992, at the NASA Lewis Research Center.

The conference's tentative program is as follows:

"The Effects of CCA-Treated Wood on the Performance of Surface Finishes"—William C. Feist, of USDA Forest Products Research Laboratory;

"Formulating and Using Waterbased Thermoplastic Resins for Wood Finishing"—Nick Roman, of Rohm and Haas Company;

"UV Curing—A Compliance Technology for the 90s"—Donald L. Eshenbaugh, Jr., of R&D Coatings, Inc.;

"New Developments in High Solids Coatings"—Rich Johnson, of Cargill, Inc.;

"The Electrostatics of Powder Coatings"—Ed Meyer, of The Glidden Company;

"High Solids/Waterborne Silicone Resins for Lower VOC Applications"—William A. Finzel, of Dow Corning Corporation;

"The Role of UV Absorbers in Compliant Coatings"—Speaker to be announced, CIBA-GEIGY Corporation;

"Compliant Specialty Architectural Coatings"—Speaker to be announced;

"Novel Carborane Polymer Coatings for Protection Against Atomic Oxygen"—Morton Litt, of Case Western Reserve University; and

"Atomic Oxygen Protective Coatings for Materials Used in Low Earth Orbit"—Bruce A. Banks, of NASA Lewis Research Center.

The program's after-dinner speaker is Wayne Slempp, of NASA Langley Research Center. Mr. Slempp's topic is "Space Environmental Effects on Spacecraft Coatings: Results from the Long Duration Exposure Facility (LDEF) Mission."

For more information, contact Richard Mikol, Tremco, Inc., 10701 Shaker Blvd., Cleveland, OH 44104; (216) 292-5000.

Northwestern Society Hosts "Clean Air & Coatings" Seminar

A total of 77 people attended the Northwestern Society for Coatings Technology Annual Technical Symposium on March 3, at the Bloomington Marriott Hotel, Bloomington, MN.

The theme of this year's conference was "Clean Air & Coatings: Focus for the 90s." Presentations featured included:

"A Guide to the New Federal Regulations—How to Keep Your CEO Out of Jail"—William J. Stewart, of Valspar Corporation;

"The Clean Air Act and Its Effect on Minnesota and Other Environmental Legislation"—Steve Novac, Senator, Minnesota;

"Best Options in and Practical Application of Compliance Coatings"—Joseph E. Ziegewald, Consultant; and

"Complying with Emissions Regulations—A Suppliers View"—Daniel N. King, of Exxon Chemical Company.

The Symposium Committee consisted of the following Society members: Co-Chairman—Harold H. Christhif, of The Valspar Corporation; Co-Chairman—Denise R. Henning, of Frost Paint & Oil Corporation; Publicity—Eric Habeck, of The Valspar Corporation; and Registration—Joan B. Lamberg, of Horton-Earl Company.

35th Annual Cleveland Society Conference

on

Advances in Coatings Technology

"Advances in Environmentally Compliant Coatings Technology"

Thursday, May 28, 1992

NASA, Lewis Research Center, Cleveland, OH

Meet the Speaker Social Hour, Banquet, and After Dinner Speaker to Follow at:
The Sheraton Airport Hotel, Cleveland, OH

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Sheraton Airport Hotel Cleveland
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Cleveland, OH 44135

Phone: (216) 267-1500 or (800) 362-2244

Please make your reservation directly with the Sheraton Hotel. Use I.D. #GA8223 for CSCT Conference Rate of \$70.00 for Standard Room.

University of Waterloo's Institute for Polymer Research Offers Graduate Degree Program in Polymers

The Institute for Polymer Research (IPR) at the University of Waterloo, Waterloo, Ontario, Canada was established in 1984 to provide research services to the polymer-related industries, and for graduate instruction in polymer science and engineering.

IPR was founded originally as the Copolymer Group in 1979. It combines the polymer research capabilities of the University's Chemical Engineering and Chemistry Departments.

The Institute, made up of faculty members and representatives of major companies, is devoted to creating a program of graduate studies and research in experimental polymer science and engineering.

IPR performs applied and fundamental research in areas that are of interest to the plastics, coatings, adhesives, and elastomers industries. Work has been carried out in diverse fields, such as: molecular weight characterization, thermal characterization, emulsion polymerization, polymer processing, polymerization kinetics, copolymerization, polymer-based catalysts, polymer photochemistry, and development of new monomers, polymers, and polymer alloys.

Major funding support has helped to provide state-of-the-art research equipment and facilities, including: a polymerization pilot plant; twin screw compounding vessels; high pressure polymerization vessels;

extruders; an injection molder; polymer molecular weight, composition, and structural analysis; tubular film extrusion; rheological characterization of plastics, adhesives, and coatings; instrumented impact testers; thermal characterization equipment; cure characterization of rubbers and other polymers; on-line density/flow/viscosity sensors; and others.

Technological initiatives have been channeled in the development of polymers for wire and cable applications, polymer modifications to make heat and oil resistant rubber, new polymer alloys and blends, systems for recycling polyolefin containers, the computer design of extrusion screws and dies, and computer modeling and control of polymerization processes.

Every spring the University of Waterloo conducts a two-day Polymer Symposium. The program is aimed at presenting the latest developments in polymer research. Also, an IPR-sponsored seminar series at the university features speakers from industry, universities, and the government.

An industrial affiliates program has been established for member firms in Canada and the U.S. to work with IPR on research problems that concern the polymer industry.

The University of Waterloo's degree program include M.A.Sc., M.Sc., and Ph.D. disciplines. Polymer undergraduate and graduate students also can choose a cooperative work study option that emphasizes original research and hands-on expertise to industrial research conditions.

The polymer research group comprises 11 faculty and approximately 50 graduate students in Chemical Engineering and Chemistry.

In addition, IPR provides intensive short courses at the university or in-house for member firms.

Members of the faculty at IPR are: Dr. Charles M. Burns; Dr. Scott Collins; Dr. Thomas Duever; Dr. Mario Gauthier; Dr. Kenneth O'Driscoll, co-founder of IPR; Dr. Alexander Penlidis, Associate Director of IPR; Dr. Alan Plumtree; Dr. Garry L. Rempel; Dr. Alfred Rudin, current Director and co-founder of IPR; Dr. Morris Tchir; and Dr. Costas Tzoganakis.

IPR member firms include: Elf Atochem North America, BASF Canada Inc., Dow Chemical of Canada Ltd., ICI/Glidden, IBM Corporation, Kendall Company, Nova Husky Research Corporation, Polysar Rubber Corporation, Rohm and Haas Company, Shell Canada Ltd., Tremco Ltd., Uniroyal Chemical Company Inc., and Xerox Research Centre of Canada.

For further information about IPR, contact: Dr. Rudin, Chemistry Dept., or Dr. Penlidis, Chemical Engineering Dept., University of Waterloo, Waterloo, Ont. N2L 3G1, Canada.

USM Department of Polymer Science Announces Slate of Coatings Courses for May and August

The Department of Polymer Science of the University of Southern Mississippi (USM), Hattiesburg, MS, has released its schedule of three coatings short courses slated for May and August.

The courses and dates are as follows:

"Coatings Science for Coatings Technicians"—May 11-15;

"Coatings Science for Coatings Chemists"—May 25-29; and

"Formulating Coatings"—August 17-21.

The three short courses will be held at USM's new Polymer Science Research Center. The classes will include daily lectures.

Course director is Dr. Shelby F. Thames, Distinguished University Professor and founder and first Chairman of USM's Department of Polymer Science.

The course on "Coatings Science for Coatings Technicians" is designed to provide hands-on laboratory instruction. Lectures will focus on basic principles of coatings design, synthesis, performance, and testing for industrial and architectural coatings. Laboratory sessions will include instruction in and use of instrumentation and techniques for identifying, testing, and evaluating coating performance.

The "Coatings Technician" class enrollment is limited to 24 participants.

"Coatings Science for Coatings Chemists" will place special emphasis on coatings selection, design, formulation, testing, and durability. Topics will be discussed with the overall objectives of waste reduction and lowering VOCs, and will emphasize latex, high-solids, and powder coatings.

The coatings short course on "Formulating Coatings" is designed to highlight formulation techniques and formulating principles, with special emphasis on economic, VOC-regulatory, and coatings-performance criteria. The influence of formulation variations on physical and chemical properties, application properties, and end-use application will be explored.

The cost of the each course is \$975 and includes registration, instruction, reference materials, morning and afternoon coffee breaks, and a reception.

For more detailed information about the three coatings short courses, write USM, Department of Polymer Science, Southern Station Box 10076, Hattiesburg, MS 39406-0076.

Adhesion Society Meeting Slated for February 21-26, 1993

The Adhesion Society, Inc., has announced that "The Interphase" Symposium will be held during its 16th Annual Meeting, on February 21-26, 1993, at the Williamsburg Lodge, in Colonial Williamsburg, VA.

Oral and Poster Sessions will be devoted to the symposium topic and general papers.

The scope of the conference encompasses the creation, composition, structure, characterization, and properties of interphases, as well as the influence of interphases on the performance of systems of joined materials.

For more details on the Adhesion Society Meeting, contact Louis H. Sharpe, 28 Red Maple Rd., Hilton Head Island, SC 29928, or F.J. Boerio, Dept. of Materials Science and Engineering (ML12), University of Cincinnati, Cincinnati, OH 45221.

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (215) 940-0777, FAX: (215) 940-0292.

1992

(May 17-20)—Federation "Spring Week." Board of Directors Meeting on the 17th; Incoming Society Officers Meeting on the 18th; Spring Seminar on the 19th and 20th. Sheraton Boston Hotel and Towers, Boston, MA.

(June 8-10)—"How to Implement Total Quality Management and Secure ISO 9000 Series Certification." Sponsored by Professional Development Committee. Adam's Mark Hotel, Philadelphia, PA.

(June 11-12)—"Gauge/Measurement Process Assessment and Improvement." Sponsored by Professional Development Committee. Adam's Mark Hotel, Philadelphia, PA.

(Sept. 14-15)—"Statistical Process Control and Its Application in the Coatings Industry" (SPC Level I). Sponsored by Professional Development Committee. Atlanta, GA.

(Sept. 16-18)—"Practical Application of Intermediate Statistics in a Total Quality Management System" (SPC Level II). Sponsored by Professional Development Committee. Atlanta, GA.

(Oct. 21-23)—70th Annual Meeting and 57th Paint Industries' Show. McCormick Place, Chicago, IL.

1993

(Oct. 27-29)—71st Annual Meeting and 58th Paint Industries' Show. World Congress Center, Atlanta, GA.

1994

(Oct. 12-14)—72nd Annual Meeting and 59th Paint Industries' Show. New Orleans Convention Center, New Orleans, LA.

SPECIAL SOCIETY MEETINGS

1992

(Apr. 15)—Louisville Society. "Water Base Coatings" Symposium. Executive West Hotel, Louisville, KY. (Lloyd Browning, Kelley Technical Coatings Inc., 1445 S. 15th St., Louisville, KY 40210; [502] 636-2561).

(Apr. 30)—Detroit Society. 17th Annual FOCUS Conference. Mercy College, Detroit, MI. (Valerie E. Gunn, FOCUS Chairperson, Akzo Coatings Inc., P.O. Box 7062, Troy, MI 48007-7062).

(Apr. 30-May 2)—Pacific Northwest Society. 45th Annual Spring Symposium. The Benson Hotel, Portland, OR. (John Westendorf, Lipscomb Chemical Northwest, 2627 N.W. Nicolai St., Portland, OR 97210).

(May 28)—Cleveland Society. "Advances in Environmentally Compliant Coatings Technology." 35th Annual Technical Conference on Advances in Coatings Technology. NASA Lewis Research Center, Cleveland, OH. (Richard Mikol, Tremco, Inc., 10701 Shaker Blvd., Cleveland, OH 44104).

(June 15)—Golden Gate Society. "Ideas for the Future." Manufacturing Committee Conference. Holiday Inn, S. San Francisco, CA. (Louie F. Sanguinetti, Jasco Chemical Corp., P.O. Drawer J, Mountain View, CA 94042).

1993

(Mar. 23-25)—Golden Gate, Los Angeles, Pacific Northwest, and Rocky Mountain Societies. Western Coatings Societies' 21st Bien-

nial Symposium and Show, Disneyland Hotel and Convention Center, Anaheim, CA. (Geneva H. Wells, H.M. Royal of California, Inc., 6880 8th St., Buena Park, CA 90620).

OTHER ORGANIZATIONS

1992

(Apr. 26-30)—RadTech '92 Biennial Conference. Hynes Convention Center and Sheraton Boston Hotel & Towers, Boston, MA. (Chris Dionne, Executive Director, RadTech International North America, 60 Revere Drive, Suite 500, Northbrook, IL 60062).

(Apr. 27-29)—"Flexible Packaging Technology." Course sponsored by Center for Professional Advancement. Chicago, IL. (Center for Professional Advancement, P.O. Box H, East Brunswick, NJ 08816).

(Apr. 27-May 1)—"Applied Rheology for Industrial Chemists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education-Chemistry, KSU, P.O. Box 5109, Kent, OH 44242-0001).

(Apr. 29 and 30)—"Paint Technology—Surviving the 90s." 46th Annual and 39th "Back to Back" Symposium. Sponsored by The Chemical Institute of Canada, Protective Coatings Division. The Old Mill, Toronto, Ont., Canada; and Hélène de Champlain Restaurant, Montreal, Que., Canada. (For Toronto, contact: Steve Balmer, Bapco, Inc., P.O. Box 7000, 8200 Keele St., Concord, Ont., Canada L4K 1B6; for Montreal, contact: Gordon Simpson, Sico, Inc., 41 Bates Rd., Outremont, Que., Canada H2V 1A6).

(May 4-6)—"Advances in Polymer Colloids/Emulsion Polymers: Polymerization, Characterization & Applications." Short course sponsored by State University of New York (SUNY). New Orleans, LA. (Institute of Materials Science, CSB 209, SUNY, New Paltz, NY 12561).

(May 4-6)—"Fitting the Package to the Product." Course sponsored by Center for Professional Advancement. Chicago, IL. (Center for Professional Advancement, P.O. Box H, East Brunswick, NJ 08816).

(May 11-14)—Powder & Bulk Solids '92 Conference/Exhibition. O'Hare Exposition Center, Rosemont (Chicago), IL. (Cahners Exposition Group, Dept. Powder & Bulk Solids '92, 1350 E. Touhy Ave., P.O. Box 5060, Des Plaines, IL 60017-5060).

(May 11-15)—"Dispersion of Pigments and Resins in Fluid Media." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education-Chemistry, KSU, P.O. Box 5109, Kent, OH 44242-0001).

(May 11-15)—"Physical Testing of Paints and Coatings from Classical Methods to Modern Instrumental Techniques." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. Rolla Campus. (Norma Fleming, Sr. Coordinator, UMR, Continuing Education, 119 M.E. Annex, Rolla, MO 65401-0249).

(May 11-15)—"Coatings Science for Coatings Technicians." Short course sponsored by The University of Southern Mississippi (USM), Hattiesburg, MS. (Deborah Theisen, PSC Coatings Short Course, USM, Southern Station Box 10076, Hattiesburg, MS 39406-0076).

(May 11-16)—"Interpretation of IR and Raman Spectroscopy." Course and workshops sponsored by Fisk University. Vanderbilt University, Nashville, TN. (Fisk Infrared Institute, P.O. Box 15, Fisk University, Nashville, TN 37203).

(May 13-14)—Asia-Pacific Coatings Show. Sponsored by *Paint & Ink International* and *Polymers Paint Colour Journal*. Raffles City Convention Centre, Singapore. (Jane Malcolm-Coe, PR & Publicity Mgr., FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS, United Kingdom).

(May 13-15)—"Adhesion Science and Technology." Course sponsored by Center for Professional Advancement. East Brunswick,

NJ. (Center for Professional Advancement, P.O. Box 1052, East Brunswick, NJ 08816).

(May 18-22)—International Automation Conference and Training Course. Cosponsored by Instrument Society of America (ISA) and International and Scientific Computing and Automation. Montpellier, France. (ISA, 67 Alexander Dr., P.O. Box 12277, Research Triangle Park, NC 27709).

(May 19-21)—PaintCon '92. Conference and exhibition sponsored by *Industrial Finishing Magazine*. O'Hare Expo Center, Chicago (Rosemont), IL. (PaintCon '92, 2400 E. Devon Ave., Des Plaines, IL 60018).

(May 19-21)—"Additives for Coatings." Course sponsored by Center for Professional Advancement, East Brunswick, NJ. (Center for Professional Advancement, P.O. Box 1052, East Brunswick, NJ 08816).

(May 25-29)—"Coatings Science for Coatings Chemists." Short course sponsored by The University of Southern Mississippi (USM), Hattiesburg, MS. (Deborah Theisen, PSC Coatings Short Course, USM, Southern Station Box 10076, Hattiesburg, MS 39406-0076).

(June 1-4)—Fifth International Symposium on Polymer Analysis and Characterization. Inuyama Hotel, Inuyama City, Japan. (Howard Barth, Du Pont Co., Experimental Station, P.O. Box 80228, Wilmington, DE 19880-0228).

(June 1-5)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education-Chemistry, KSU, P.O. Box 5109, Kent, OH 44242-0001).

(June 2-6)—"Advances in Emulsion Polymerization and Latex Technology." Short course sponsored by Emulsion Polymers Institute, Lehigh University, Bethlehem, PA. (Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18105).

(June 8-12)—"Environmentally Compliant Coatings." Short course sponsored by North Dakota State University (NDSU), Fargo, ND. (Jeanette Shaw-Lynch or Deborah M. Shasky, Dept. of Polymers and Coatings, NDSU, Fargo, ND 58105).

(June 8-12)—"Water Based Polymers." Course sponsored by Center for Professional Advancement. Chicago, IL. (Center for Professional Advancement, P.O. Box 1052, East Brunswick, NJ 08816).

(June 9-12)—"Getting into Compliance with Air Quality Regulations for Paints, Coatings, and Printing Facilities." Course sponsored by University of California-Berkeley. The Cathedral Hill Hotel, San Francisco, CA. (Continuing Education in Engineering, University Extension, University of California, 2223 Fulton St., Berkeley, CA 94720).

(June 14-18)—XXIth FATIPEC Congress. RAI International Congress Centre, Amsterdam, The Netherlands. (General Secretary Francis Borel, 34 Chemin du Halage, La Bonneville, Mery sur Oise, France).

(June 15-17)—Euroformula '92. International Trade Fair. RAI International Exhibition and Congress Centre. Amsterdam, The Netherlands. (RAI, Europaplein, 1078 GZ, Amsterdam, The Netherlands).

(June 15-26)—"Coatings Science." Short course sponsored by North Dakota State University (NDSU), Fargo, ND. (Jeanette Shaw-Lynch or Deborah M. Shasky, Dept. of Polymers and Coatings, NDSU, Fargo, ND 58105).

(June 16-18)—"Radiation Curing: Ultraviolet Light and Electron Beam Technology." Course sponsored by Center for Professional Advancement. Chicago, IL. (Center for Professional Advancement, P.O. Box H, East Brunswick, NJ 08816).

(June 21-24)—ISCC 61st Annual Meeting and AIC 25th Anniversary. International symposium on "Computer Color Formulation." Princeton University, Princeton, NJ. (Danny Rich, ISCC Secretary, ACS Datacolor, 5 Princess Rd., Lawrenceville, NJ 08648).

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(July 13-17)—International Symposium on Surface Phenomena and Latexes in Water-Based Coatings and Printing Technology. Sponsored by Fine Particle Society. Riviera Hotel, Las Vegas, NV. (M.S. El-Aasser, Emulsion Polymers Institute, 111 Research Dr., Iacocca Hall, Lehigh University, Bethlehem, PA 18015).

(July 22-24)—"Basic Coatings for Sales and Marketing Personnel." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. Airport Marriott Hotel, St. Louis, MO. (Norma Fleming, Sr. Coordinator, UMR, Continuing Education, 119 M.E. Annex, Rolla, MO 65401-0249).

(Aug. 16-21)—"Polymer Chemistry: Principles and Practice." Seminar sponsored by The American Chemical Society (ACS), Washington, D.C. Marriott Inn, Blacksburg, VA. (ACS, Dept. of Continuing Education, Meeting Code VPI9203, 1155 Sixteenth St., N.W., Washington, D.C. 20036).

(Aug. 17-21)—"Formulating Coatings." Short course sponsored by The University of Southern Mississippi (USM), Hattiesburg, MS. (Deborah Theisen, PSC Coatings Short Course, USM, Southern Station Box 10076, Hattiesburg, MS 39406-0076).

(Sept. 14-18)—65th Introductory Short Course, "The Basic Composition of Coatings." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. Rolla Campus. (Norma Fleming, Sr. Coordinator, UMR, Continuing Education, 119 M.E. Annex, Rolla, MO 65401-0249).

(Sept. 28-Oct. 2)—25th Introductory Short Course, "Paint Formulation." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. Rolla Campus. (Norma Fleming, Sr. Coordinator, UMR, Continuing Education, 119 M.E. Annex, Rolla, MO 65401-0249).

(Oct. 5-8)—"Introduction to Coatings Technology." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education-Chemistry, KSU, P.O. Box 5109, Kent, OH 44242-0001).

(Oct. 6-8)—Powder Coating '92. Sponsored by the Powder Coating Institute (PCI), Cincinnati Convention Center, Cincinnati, OH. (PCI Headquarters, 1800 Diagonal Rd., Suite 370, Alexandria, VA).

(Oct. 14-16)—"Accelerated and Natural Weathering Techniques for Coatings and Polymers." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education-Chemistry, KSU, P.O. Box 5109, Kent, OH 44242-0001).

(Oct. 25-30)—Fourth Corrosion and Protection Iberoamerican Congress and First Panamerican Congress on Corrosion and Protection. Mar del Plata, Argentina. (CIDEPINT, 52 entre 121 y 122, 1900 La Plata, Argentina, South America).

(Nov. 4-6)—'92 International Conference on Colour Materials. Sponsored by the Japan Society of Colour Material. Osaka Sun Palace, Expo Park Senri, Osaka, Japan. (S. Tochiwara, Chairman of Executive Committee of the '92 ICCM, c/o Japan Society of Colour Material, Kitamura Bldg. 5F, 9-12, 2-chome, Iwamoto-cho, Chiyodaku, Tokyo 101, Japan).

(Nov. 8-12)—Annual Conference 32. Sponsored by the Australasian Corrosion Association Inc., Hobart, Tasmania. (Conference Secretariat, Australasian Corrosion Centre, P.O. Box 250, Clayton, Victoria 3168, Australia).

(Nov. 15-20)—SSPC '92 National Conference and Exhibition. Sponsored by Steel Structures Painting Council (SSPC), Pittsburgh, PA. Kansas City Convention Center, Kansas City, MO. (Rose Mary Sargent, Manager of Conferences and Exhibits, SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

(Nov. 16-20)—"Fundamentals of Chromatographic Analysis." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education-Chemistry, KSU, P.O. Box 5109, Kent, OH 44242-0001).

(Dec. 6-11)—"Polymer Chemistry: Principles and Practice." Seminar sponsored by The American Chemical Society (ACS), Washington, D.C. Marriott Inn, Blacksburg, VA. (ACS, Dept. of Continuing Education, Meeting Code VPI9203, 1155 Sixteenth St., N.W., Washington, D.C. 20036).

(Jan. 19-20)—"Accelerated and Outdoor Durability Testing." Symposium sponsored by ASTM Committee G-3 and Subcommittee D01.27. Ft. Lauderdale, FL. (Warren D. Ketola, 3M Co., Bldg. 553-A, 3M Center, St. Paul, MN 55144, or Douglas Grossman, The Q-Panel Co., 26200 First St., Cleveland, OH 44145).

(Feb. 21-26)—16th Annual Meeting of The Adhesion Society, Inc. Williamsburg Lodge, Colonial Williamsburg, VA. (Louis H. Sharpe, 28 Red Maple Rd., Hilton Head Island, SC 29928, or F.J. Boerio, Dept. of Materials Science and Engineering (ML 12), University of Cincinnati, Cincinnati, OH 45221).

(Apr. 18-23)—"Durability of Coatings" Symposium sponsored by American Chemical Society, Division of Polymeric Materials: Science Engineering, Denver, CO. (Jonathan W. Martin, NIST, Bldg. 226, Rm. B348, Gaithersburg, MD 20879; David Bauer, Ford Motor Co., SRL-E3198, P.O. Box 2053, Dearborn, MI 48121; F. Louis Floyd, Glidden Research Ctr., 16651 Sprague Rd., Strongsville, OH 44136).

(Apr. 20-22)—Surface Treatment '93. "Computer Methods and Experimental Measurements for Surface Treatment Effects." International Conference sponsored by Wessex Institute of Technology. Novotel, Southampton, United Kingdom. (Sue Owen, Conference Secretariat, Wessex Institute of Technology, Ashurst, Southampton, Hants, United Kingdom So4 2AA).

(May 2-6)—RadTech Europe '93. Third Annual RadTech conference. Sponsored by RadTech Europe. Italian vessel T/S Eugenio Costa. (RadTech Europe, Business Office, Péroles 24, CH-1700 Fribourg, Switzerland).

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'Humbug' from Hillman

Mike Baker, who recently sent Humbug some "Words of Wisdom," has also offered to send us an abstract of a paper turned down by the ACS entitled, "The Law of the Obstinacy of Inanimate Objects." As our faithful readers know, Humbug celebrates those who look askance at any reasonable scientific theory and therefore favors featuring his treatise. However I leave it to our faithful readers to decide. No matter how many letters we receive protesting its publication, if we get one letter in favor of Mike's article, we shall request a copy for review by Humbug's Editorial Board (of one). Meanwhile, here's a few more "Words of Wisdom."

—No matter how often we say that money doesn't bring happiness, we're always willing to give it another chance.

—Out of the mouths of babes often come remarks their parents should never have said in the first place.

—When someone says they approve of something in principle, it means they haven't the slightest intention of putting it in practice.

—One of the mysteries of life is how the boy who wasn't good enough to marry your daughter can be the father of the smartest grandchild in the world.

Jay Adams found this headline in an issue of the *Detroit Free Press*:

"Flakes from Antiperspirant Raise
a Stink at Jeep Plant"

And the story? Here's an abstract:

Toledo—Paint line workers at Chrysler's Jeep plant were asked to stop using all antiperspirants after the company discovered that falling flakes left costly blemishes on new Jeeps.

Some 380 workers who wash, wipe, and prepare Jeep Cherokees to be painted were asked to stop using all antiperspirants and deodorants that can flake. The paint flows away from the fallen flakes, causing a depression the size of the tip of a baby's finger, the company said.

Chrysler would not say how much it cost to fix blemishes.

One woman filed a grievance last year after a supervisor asked to check her armpits.

Women to doctor: "Doctor, my arm hurts in two places."

Doctor: "So, don't go to those places."

Customer to waiter: "Waiter, look how filthy this napkin is."

Waiter: "Eleven customers before you used that napkin and you're the only one who complained."

—Finkel's Follies

Steel yourselves folks, here comes Bob Ahlf:

—I would tell you what I would do but it doesn't work.

—Theodor Seuss Geisel had no children, but Doctor Seuss did.

—What is given to you is taken back, eventually.

—I saw my boss talk while his boss drank a glass of water.

—Do they swab your arm with alcohol before giving you a lethal injection?

—Well, now when you wake in the middle of the night screaming, you'll have a reason.

The Age of the Skinnies By Doris Platt

There are a certain few who are lucky indeed,
They eat all they want and stay slim as a reed.
But for me life is not as easy as that.
If I eat what I want, I pile on fat.

I tried starving, fad diets, pills and such.
I lost a few pounds, then gained twice as much.
After years of fighting the battle of weight,
I decided for me, there must be a better fate.

So I turned to a doctor who I thought must know
How to help me get thinner and eat all my woe.
He had absolute proof of "fatties" turned thin,
But he was so fat, he had a triple chin.

He sat and he talked in a kind gentle voice
And said it's up to me to make the choice.
He had made his choice a long time ago,
He'd rather eat than starve, and told me so.

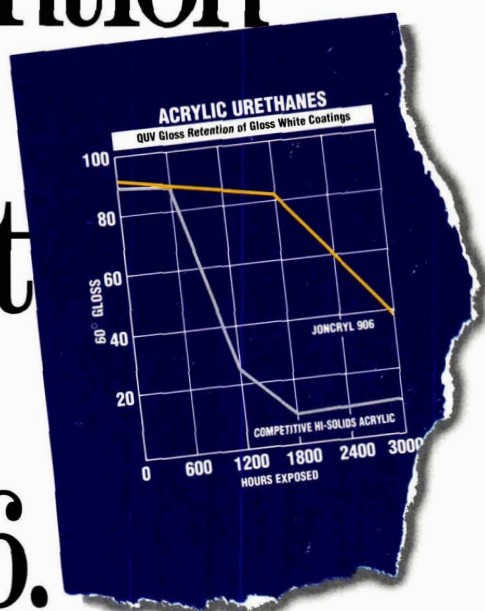
He didn't think I was heavy, but I was the one
Whose size fourteen made me feel like a ton.
I was absolutely elated when he gave me a diet
I just couldn't wait to go home and try it.

To look young and thin was all in my dreams,
To wear lovely clothes, not tight in the seams.
When I left his office, I was in Heaven.
Then I wondered why everyone must wear size seven.

Ah, Doris, here's a tip from Doctor Bob Ahlf who certainly should know. He says, "Pretty + Soul = Beauty!"—Eat, be happy and save your dough.

—Herb Hillman
Humbug's Nest
P.O. Box 135
Whitingham, VT 05361

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